




BEML LIMITED BANGALORE

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Procurement Technical Specifications for Link Arm type Axle Box Assembly

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1. Introduction

This document describes the technical requirements of link arm type axle box, bearing, axle end covers(front and rear) and o-rings here after referred as axle box assembly for Mumbai Metropolitan Regional Development Authority (MMRDA), hereafter MRS1 project. The Axle box assembly shall comply in all respects with Employer's Requirements General Specifications (ERGS) & Employer's Requirements Technical Specifications (ERTS).

BEML shall carry out all required works and activities as contractor for MRS1 project, while supplier shall be responsible for all works required in this PTS with regard to Design, testing and supply of Axle Box assembly and shall be responsible for supporting the BEML activities.

2. General Specifications

The supplier shall supply axle box assembly with necessary subsidiary materials to ensure its functionality. The supplier shall have responsibility for investigation & consideration of suitability of Axle Box assembly for the environmental condition specified in ERTS.

The scope of work covers design, development, manufacture & supply, testing & commissioning and training of operation and maintenance personnel of the Employer and includes 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 PTS and/or in ERTS section-1.1.3 (i) to (ix) and ERTS 1.1.7.

The scope also covers supply of spares, special tools, testing and diagnostic equipment, jigs and fixtures for maintenance, repair and overhaul.


The subcontractor shall comply with GTC, ERGS, PTS and chapter - 1, 2, 3, 5, 14 & 15 of ERTS to a minimum.

2.1. Car Configuration

The configuration of train formation is as follows.

DM: Driving Motor Car, M: Non-driving Motor Car, T: Trailer Car with pantograph

*DM - T - M- - (3 car unit formation)

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DM - T - M - M - T - DM - (6 car train formation)

2.2. Car Weight

The subcontractor shall make all attempts in reducing the weight of supplied equipment as specified in the ERTS 3.21.3 to minimize energy costs, whilst meeting specified structural and performance requirements.


Approximate car weights and train configuration are show below:

	DMC	TC	MC
Tare	≤42,000 kg	≤41,000 kg	≤41,000 kg
Crush	≤68,000 kg	≤68,000 kg	≤68,000 kg
Axle load	17,000 kg	17,000 kg	17,000 kg

2.3. Vehicle performance

The sub-contractor shall meet vehicle performance requirements as specified in section - 3.22 of ERTS.

Item		All Corridors
Safe speed	With inflated secondary suspension	90 kmph
	With deflated secondary suspension	80 kmph
Maximum operational speed	With inflated secondary suspension	80 kmph
	With deflated secondary suspension	70 kmph
Minimum Design Average Acceleration rate for fully loaded (AW3) train on level tangent track shall be as under:		
0 kmph to 40 kmph		1.0 m/s ²
0 kmph to 60 kmph		0.75 m/ s ²
0 kmph to 80 kmph		0.40 m/ s ²
Minimum Operational Average Acceleration rate for AW2 loaded train on level tangent track shall be as under:		
0 kmph to 35 kmph		1.20 m/ s ²
0 kmph to 60 kmph		0.80 m/ s ²
0 kmph to 80 kmph		0.45 m/ s ²
Average Service braking rate from 80 kmph to standstill for fully loaded (AW3) train on level tangent track.		1.0 m/ s ²
Average Service braking rate from 80 kmph to standstill for AW2 train on level tangent track.		1.1 m/ s ²

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Average Emergency braking rate from 80 kmph to 0 kmph for fully loaded trains on level tangent track	1.3 m/ s ²
Jerk rate (Maximum)	0.75 m/ s ³
Annual running distance of one train (for design purpose)	150,000 km
The specified average minimum acceleration shall be the finally achieved values inclusive of the specified jerk rate. Test procedure has been specified in Chapter 15 of ERTS.	


2.4. Wheel Diameter

Wheel Diameter (New)	860 mm
Wheel Diameter (Half Worn)	820 mm
Wheel Diameter (Fully Worn)	780 mm

2.5. Track parameters

The subcontractor shall use track parameters as specified in section-3.14 & 3.15 of ERTS for designing of axle-box and bearing to be used for MRS1 project.

Description	Elevated and At-grade Corridor		Underground Corridor
	Ballasted	Ballast less (DFF)	Ballast less (DFF)
Track Laying Gauge	1435 mm		
Rail Type (Main Line & Depot)	60EI(UIC 60) 880/HH	60EI(UIC 60) 1080/HH	60EI(UIC 60) 1080/HH
Rail Profile	UIC 861-3		
Inclination of Rail	1 in 20		
Sleeper Spacing (Main line)	600mm±10mm	600mm±10mm	700 mm ± 10mm
Sleeper Spacing (Depot)	650mm±10mm	Not applicable	
Ballast Cushion Depth(Main line)	300mm	Not applicable	
Ballast Cushion Depth (Depot)	250mm	Not applicable	
Standard Rail Length	13m and 18m	18m	18m
Rail Panel Lengths	Longer than 200m		
Minimum Radius of Curvature	200m-Underground 110m-Elevated 100m-Depot		


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Minimum Turn out Radius (Main line)	1 in 9 - 300m radius 1 in 7- 190m radius		
Minimum Turn Out (Depot)	1 in 7 - 190m radius		
Maximum Cant Permissible	110 mm		
Maximum Cant Desirable	110 mm		
Maximum Cant Deficiency Permissible	85 mm		
Maximum Cant Deficiency Desirable	85 mm		
Maximum Permissible Cant Gradient	1 in 440		
Maximum Desirable Cant Gradient	1 in 720		
Turn-out Speed : Turnout (1 in 9) R-300	45 km/h	45 km/h	40 km/h
Turn-out Speed : Scissors (1 in 9) R-300	45 km/h	45 km/h	40 km/h
Turn-out Speed :In Depots (1 in 7) R-190	35 km/h	35 km/h	25 km/h
Turn-out Speed : Turnout (1 in 7) R-190	35 km/h	35 km/h	25 km/h
Turn-out Speed : Turnout(1 in 12) R-410	50 km/h	50 km/h	50 km/h
Turn-out Speed : Turnout(1 in 12) R-410	50 km/h	50 km/h	50 km/h
Turn-out Speed : Turnout (1 in 8.5) R-218	30 km/h	30 km/h	30 km/h
Turn-out Speed : Turnout(1 in 8.5) R-218	30 km/h	30 km/h	30 km/h
Maximum Gradient Main Line	4%		
Maximum Gradient Depot Connection	4%		
Minimum vertical curve radius of curvature	1500m		

2.6. Climatic Conditions

The subcontractor shall supply Axle box assembly to satisfy climatic & environmental conditions as specified in section - 3.10 & 3.11 of ERTS.

Description	Limiting Values
Maximum ambient temperature (See note below)	36°C
Minimum temperature	14.3°C
Humidity	≥ 95% RH
Rainfall	The annual precipitation is 2,078 mm with 34% (709mm) falling in the month of July.
Atmosphere during hot season	Extremely dusty including bird feathers

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Maximum wind speed	150 km/h
Vibration and 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.
SO2 level in atmosphere	80 – 120 micro gram/m3
Suspended particulate matter in atmosphere (TSPM)	360 – 540 micro gram/m3
Flood Proofing	The traction sub-systems mounted on the underframe will be designed to permit propulsion of the train at 10 kmph through water up to a depth of 50 mm above rail level. Traction sub-systems shall be made splash proof in accordance with International Standards
Life	The Metro car is designed for min. 35 year of life. Accordingly, the subject items & accessories shall also not deteriorate in their performance for 35 years

Note:

- 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.
- Any moisture condensation shall not lead to any malfunction or failure.
- Adequate margin shall specially be built into the design particularly to take care of the higher ambient temperatures, high humidity, dusty and corrosive conditions, etc. prevailing in Mumbai area.

2.7. Principal notional vehicle dimensions

Description		Dimension
Gauge		1435 mm
Maximum Length over body (including end-fairings)	DM car	22,010 mm
	T and M cars	22,010 mm
Maximum Length over couplers for all cars		23,000 mm
Maximum Width over Body		3,200 mm
Minimum Passenger Saloon Headroom		2,050 mm
Locked down pantograph height for 25kV AC cars from rail level		4,048 mm

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at Car Centre Line		
Maximum Floor height above rail level of any unloaded vehicle		1,130 mm
Minimum Floor height above rail level of fully loaded vehicle		1,100 mm
Maximum height of coupler above rail level for unloaded vehicle		815 mm
Minimum height of coupler above rail level for fully loaded vehicle		740 mm
Bogie Wheel Base		2300 mm
Distance between bogie centers		15,000 mm
Wheel diameters	New	860 mm
	Fully worn	780 mm

2.8. Unclear Aspects

If any term/clause/definition is unclear in this specification, supplier shall seek clarifications from design team in BEML, prior to signing the contract, to confirm the same.

After signing the contract, supplier shall follow the definition and opinion of design team in BEML.

2.9. Responsibility of subcontractor

The supplier shall be responsible for design, development, manufacture & supply, testing and training for maintenance personnel of BEML and the Employer for assembly and dis-assembly of Axle Box assembly.


The responsibility of BEML as a contractor for axle box assembly in MRS1 project as per requirements of GTC, ERGS & ERTS shall be obligatory for subcontractor.

2.10. Precedence of Documents

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

To the extent that any provision of GTC is inconsistent with any provisions of the ERGS and ERTS, the provisions of ERTS & ERGS shall prevail.

This PTS in no way relieves the supplier from any requirements specified in the technical specification. It shall be the subcontractor's responsibility to ensure that

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equipment, documentation and services furnished against this PTS are in full compliance with all the above documents.

However, if a conflict is discovered among any of the above documents, the following order of priority shall govern:

Order of Precedence	Document Title
1	ERTS, ERGS
2	GTC
3	PTS

2.11. Standards

The design, manufacture, testing and supply of the proposed aggregates by subcontractor shall conform to the latest editions of UIC/EN standards or equivalent international standards on first priority. Metric system with SI units shall be used wherever applicable.


The subcontractor's own standards shall be on second priority. The subcontractor shall request and justify with reasonable, sufficient & necessary support documents for choosing alternate standards as compared to UIC/EN/any other international standards.

Test and inspection applicable for the castings shall conform to the UIC/EN/any other international standards.

BEML/Employer reserves the right to accept or reject any such request (s).

STANDARD	DESCRIPTION
ISO 281/1	Rolling bearings - Dynamic load ratings and rating life
EN 1563	Founding - Spheroidal graphite cast irons
UIC 515-5	Powered and trailing stock bogies – Running gear “Tests for axle – boxes
EN 45545	Railway applications - Fire protection on railway vehicles
EN 12080	Railway applications - Axleboxes - Rolling bearings
EN 12082	Railway applications - Axleboxes - Performance Testing
IS 5139	Repair of cast iron castings by oxy-acetylene and manual metal arc Welding - recommendations

Subcontractor shall specify the standards list for design, manufacture, supply and performance/testing of Axle Box assembly and all its sub-components.

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3. Definitions and Abbreviations

3.1. Definitions


The following definitions are applicable:

- “MMRDA/DMRC” means the Employer for the Mass Rapid Transport System (MRTS) in Mumbai.
- "MMRDA/DMRC Representative" mean such persons appointed by MMRDA / DMRC to act as Engineer for the purpose of MRS1 project.
- “BEML” means the contractor to procure the Axle Box with Bearing for MRS1 project.
- "Supplier/Subcontractor" means the supplier of Axle Box with Bearing to BEML.
- "PTS" means Procurement Technical Specifications.

3.2. Abbreviations

The following abbreviations shall be used as applicable:

- GTC: General Terms and Conditions of contract of BEML
- ERGS: Employer’s Requirement General Specifications
- ERTS: Employer’s Requirement Technical Specifications
- PTS: Procurement Technical Specifications
- MMRDA: Mumbai Metro Rail Development Authority
- DMRC: Delhi Metro Rail Corporation
- RAMS: Reliability, Availability, Maintainability & Safety
- ISO: International Standard Organization
- MDBF: Mean distance between failures
- MDBCF: Mean distance between component failures
- LCC: Life cycle cost
- LRU: Line Replaceable Unit
- DLP: Defect liability period
- OEM: Original Equipment Manufacturer
- MRTS: Mass Rapid Transport System
- CG: Center of Gravity
- MTTR: Mean Time to Repair
- FAI: First Article Inspection
- QAP: Quality Assurance Plan

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- RDSO: Research Design & Standards Organization
- O&M: Operation & Maintenance

4. Qualifying Criteria & Vendor Approval

Subcontractor should be a reputed OEM of the proposed aggregate for Metro Railway Rolling stock and should have capability to design & manufacture and testing & commissioning. The firm shall submit company profile and the infrastructure details along with the technical bid.

The subcontractor shall meet the qualification criteria mentioned in ERTS 3.2.2 for supply of axle box assembly.

Proposed link arm type axle box and bearing shall have been in use and have established their satisfactory performance and reliability on at least three mass rapid transit systems in revenue service over a period of three years or more (in each MRTS) either outside the country of origin in three different countries or in an MRTS in India. The subcontractor shall provide necessary documents for obtaining vendor approval for link arm type axle box and bearing separately as per ERTS 3.2.5


The submissions for vendor approval may require further modifications, additional documents & updates based on BEML/Employer feedback. The subcontractor shall provide the same within 5-7 working days to BEML/Employer.

The vendor approval format is attached as an enclosure to this PTS (Annexure - 4).

Vendor approval is mandatory for all the subcontractors. Only approved vendors are considered for the supplies. The acceptance of technical offer by BEML submitted by subcontractor is subject to approval of Employer.

The subcontractor should undertake to provide support during testing & commissioning, service trials, revenue service and DLP period either by themselves or through sister company or a partner in India. The subcontractor shall submit detailed proposal in this regard.

The subcontractor should give an undertaking to supply spares for axle box assembly for a minimum period of 10 years from the date of last car supplied by BEML to MMRDA.

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5. Technical Requirements

5.1. General

The subcontractor shall be responsible for meeting the all technical requirement in PTS and requesting the all required data for Axle box assembly.

The following is a brief of requirements for a quick reference.

- Axle box assembly
- Link arm type axle box
- Axle bearing
- Front axle End Covers
- Rear axle end covers
- O-rings
- ERTS Chapter 5 "Bogie"

5.2. Interface

The link arm type axle box, bearing, axle end covers and o-rings shall be assembled and shall not interfere with any of the bogie equipment in any operating condition.


5.2.1. Link arm type axle box

The link arm axle box has following connections in bogie:

- Link arm bush.
- Axle bearing
- Vertical damper
- helical coil springs
- Axle end cover (Front and Rear)
- O-rings

The preliminary interface dimensions are shown in the drawing 525-81153 attached to PTS. The interface details/dimensions will be confirmed by BEML in detail design stage.

There are three types of front covers that will be required. The preliminary drawings of

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these covers are provided with PTS. The design requirements of the covers are brought in section 5.7. The interface details/dimensions will be confirmed by BEML in detail design stage.

The rear cover is connected to the link arm type axle box to support the bearing. The preliminary drawing of the rear cover is provided. The dimension requirements of the cover and its interface to the axle is provided in drawing. The interface details/dimensions will be confirmed by BEML in detail design stage.

The o-rings are part of axle box assembly and shall ensure no water ingress to the other parts like bearing and axle mounted equipments on the axle box assembly.

5.2.2. Subcontractor's advice to BEML

Advice all the interface issues related with the link arm type assembly(link arm type axle box, bearing, axle end covers and o-rings) for information of other designated systems/ equipment.

Provide BEML with the interface information in detail that is requested by other systems / equipment for interface compatibility.

Depute an interface engineer at either/both at depot and/or manufacturing site on request by BEML/DMRC

5.2.3. BEML's advice to subcontractor


Advice all the interface issues related with the link arm type assembly (link arm type axle box, bearing, axle end covers and o-rings) as requested by subcontractor.

Provide subcontractor with the interface information in detail that is requested by the subcontractor for interface compatibility.

5.3. Design Philosophy & Requirements

The design philosophy and requirements should meet the following criteria:

- Application of state-of-the-art technology
- Service proven design
- Minimum life cycle cost
- Low maintenance and overhaul cost
- Use of interchangeable, modular components.

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- Extensive and prominent labelling of parts
- Use of unique serial numbers for traceability of components
- High reliability
- System safety
- Fire, smoke detection and protection
- Use of fire retardant materials
- Low noise level
- Adherence to operational performance requirements
- Maximum utilisation of indigenous materials and skills, subject to quality conformity to performance requirements and quality standards.
- Adequate margin shall specially be built into the design particularly to take care of the higher ambient temperatures, high humidity, dusty and corrosive conditions, etc. prevailing in Mumbai area.

5.4. Axle Box assembly requirements

The cast link arm type axle box connects bogie frame through link arm bush at one end and the other end is connected to the wheel set via axle bearings and supports primary suspension, vertical damper and lifting hanger. The axle end covers (front and rear) are fastened to the axle box.


Cast Axle box is installed between the axle bearings and the primary suspension springs (Helical springs). Lift-off safety device, earth brush, brake system speed sensor, hotbox temperature sensor and signaling speed sensor adapter plates are installed on axle box covers.

Cast link arm type axle box and front covers provides support to the wheelset during wheel re-profiling.

As per ERTS clause 5.7: Bogie Mounted Equipment: The train equipment shall conform to IEC 61373 in respect of shocks and vibrations including the endurance limits. These shall be incorporated in the type test of the equipment.

As per ERTS cl. 5.8: Finite Element Analysis: Finite element analysis shall be demonstrated using validated software, and detailed calculations submitted for the above-mentioned strengths (including static and fatigue loads).

The axle box assembly shall be tested for water leakage. There shall not be any water

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ingress to the bearing area from the front covers or from the rear covers. There shall not be any leakage like water, grease, lubricant from axle box assembly during the service life of 35 years.

Assuming normal operating conditions in respect of shock and vibration, the life of Axle Box assembly shall be more than 35 years.

5.4.1. Material

The casting material for link arm type axle box shall conform to EN-GJS-400-18-LT and for axle covers material shall conform to EN-GJS-400-15 of EN1563 or relevant BEML drawings.

The material grade in respect of chemical composition, heat treatment, microstructure and mechanical properties shall be as stipulated in the drawing and applicable national/ international standards. The supplier shall submit the reports for the above along with the casting supplies.

5.4.2. Fettling and Dressing

All castings shall be properly fettled and dressed, and all surfaces shall be thoroughly cleaned.


5.4.3. Heat Treatment

The castings shall be heat treated in a properly constructed furnace, having adequate means of temperature control, which shall permit the whole of the casting being uniformly heated to the necessary temperature. All castings shall be suitably heat treated as per the requirements and corresponding material standards. The supplier shall maintain time-temperature records for the heat treatment carried out and submit the same along with supplies.

Test pieces shall be heat treated along with the castings they represent.

5.4.4. Rework on surfaces

The castings shall be sound, clean and free from porosity, blow holes, hard spots, cracks, hot tears, cold shuts, distortion, sand and slag inclusions and other harmful defects. They shall be well dressed and fettled, and shall be readily machinable.

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No welding or repairs shall be carried out without the prior permission of BEML. Welding referred here includes fusion welding in accordance with the common foundry practice. The method of repair by welding and subsequent stress relieving shall be as agreed to between the BEML and supplier. The method of repair of welding shall follow IS 5139.

5.4.5. Machining

Machining as per the approved drawing/interface requirement shall be carried out. Care shall be taken to ensure that the tolerances as specified in the drawing are achieved. Dimensional inspection report shall be submitted along with the castings.

If specified in the approved drawing/interface, the machined casting shall be measured for dimensions on a 3-axis co-ordinate measuring machine (CMM) and the report shall be submitted.

5.5. Axle Bearing Requirements

Axle bearing should be manufactured as per EN 12080:2007

Axle bearings shall be of a proven type. The roller bearings shall have a minimum life rating of 3 million kilometers when computed in accordance with the method given in ISO 281/1.


The AW3 load shall be taken for the design of axle bearings. Bearings shall be arranged not to carry any traction return current.

The Vendor shall provide adequate training to the Project Owner's Maintenance Personnel for overhauling of the axle bearings and shall also provide two sets of the special tools required for overhauling in each depot. The cost of such tools shall be deemed to be included in the quoted price. Details to be finalized during design stage.

Wide range of lubricants with different characteristics is already available in India. Use of any of these lubricants, especially those that have performed well in similar uses is preferred. In case the subcontractor proposes to use other lubricants, he shall simultaneously evaluate the characteristics of lubricants available in India and indicate the equivalent lubricant that can be used for maintenance.

The bearing shall be grease lubricated cartridge type.

The front and rear seal shall prevent the ingress of water and/ or cleaning fluids to the

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bearing both during normal running and during cleaning.

The bearing shall be such that no attention is required between bogie overhauls

The subcontractor shall present the selection criteria and calculation memory for the rolling bearings.

There shall not be any defects like scares etc. on the appearance, which are any harmful to the function of the axle bearing.

The bearing shall be made of self-compensated or tapered rolling bearings, mounted in grease boxes with well service-proven sealing type.

The basic dimension and shape of axle bearings shall be in accordance with the standard UIC 130 (inner race Ø130mm, outer race Ø230mm).

Any design incorporating a wearing surface between the axle bearings shall not be used.

The subcontractor shall provide the anti-corrosive treatment plan for axle bearing.

Shock and Vibration to be taken in consideration

	Longitudinal direction	Lateral direction	Vertical direction
Continuous vibrations up to 100Hz	15g	20g	25g
Shock load	20g	30g	50g


5.6. Sealing(O-rings) Requirements

O-rings shall perfect sealing as per the proposed drawings (525-81130 & 525-81131) or vendor can proposed there proven available o-rings to suit MRS1 requirement of axle box assembly. There shall be no ingress of water into axle box assembly. There shall be no leakage of grease/lubricants for the service life of 35years.

5.7. Front and rear axle box covers

The complete design and warranty against failure/leakage of the front and rear covers are under the scope of vendor.

The rear covers shall ensure that it supports the bearing and shall not have any leakage of lubricants from bearing or water ingress it to the bearing area.

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There are 3types of front covers as mentioned below:

1. WSP cover
2. Tacho / WSP cover
3. Earth Brush cover

The preliminary drawings of the cover are provided along with PTS. The interface dimensions will be finalized in detail design stage.

During maintenance of vehicle, the bogie will be supported on front covers by applying load of 5tons(refer drawing 525-81102, 525-81103 and 525-81104). The axle box assembly, its sub-components and its sealing against leakage shall not get affected.

5.8. Material & Workmanship

The subcontractor shall be responsible for meeting the requirement of constructional details, material and workmanship. All materials and workmanship in every aspect shall be as per proven up-to-date best practices (chapter 14 of ERTS)

All Castings shall be made to conform to the dimensions on approved drawings. The castings shall be free from injurious defects that will adversely affect machining or utility of the Castings.

In the event of any casting proving defective from foundry causes in the course of preparation, machining or erection, such a casting may be rejected notwithstanding any previous certification of satisfactory testing and/or inspection.

5.9. Weight


5.9.1. Target Weight Limit

The Subcontractor shall specify the following equipment weight limit.

The maximum weight of Axle Bearing assembly shall never exceed 30 kg.

The maximum weight of Axle Box shall never exceed 65 kg.

The maximum weight shall cover the equipment manufacture weight tolerance. The subcontractor shall control the equipment weight with 0/-4% manufacture tolerance. If any equipment weight, i.e. estimated, calculated and measured, exceeds the target

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weight limit, the subcontractor should immediately advise BEML of the steps to be taken to achieve the target weight limit.

5.9.2. Subcontractor Weight Control Activity

a) Weight Progress Report.

The subcontractor shall submit a weight control document on a monthly basis. The weight control document shall list the estimated (or measured weight) with tolerance and CG (center of gravity) of all components shall be included in each drawing.


The list shall be broken down for each separate enclosure or part of the equipment that is independently installed on the vehicle. 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 document shall provide a listing as well as computed single value of weights and CG locations with tolerances for each of the supplied enclosures.

Even for the existing design, weight progress report should be submitted on a change basis. The sheet includes equipment name, equipment quantity, equipment unit weight, equipment CG, etc. as following table. This sheet shall be updated on a change basis by subcontractor up to manufacturing stage. The subcontractor shall also submit the weight and CG revision history sheet to BEML on a change basis that includes previous figure(weight and CG) of breakdown list, updated figure, the detail reason about updated figure, etc. Subcontractor shall provide the evidence for weight calculation data, CG calculation data, etc., if BEML asks for.

b) Equipment Weighing Test

The weighing facility shall be calibrated, then the calibration certification shall be submitted prior to equipment weighing type test. The subcontractor shall submit the actual weight of equipment to BEML prior to start mass production.

Sl. no.	Drawing no.	Description	Unit	Unit weight	CG			Status	Remark
					x	y	z		
1	525-81153	Axle Box	EA					E	Estimated weight
2	525-81023	Bearing	EA					C	Calculated weight

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3	525-81102	Cover Earth Brush	EA					M	Measured Weight
4	525-81103	Cover WSP	EA						
5	525-81104	Cover WSP-Tacho	EA						
6	525-81105	Cover Rear	EA						

5.10. Coating and painting System

Axle box assembly (Link arm Axle Box, axle box covers, axle Bearing and o-rings) shall be protected using an internationally accepted painting/coating system proven in railway applications, which will protect the from damage by corrosion in climate conditions prevailing in MRS1 project, for at least the period between major bogie overhauls without maintenance. The subcontractor shall furnish details of guaranteed life cycles of paint system, class details, reference standards, painting procedure etc. for review and approval of BEML (ERTS 14.19)

The systems shall have excellent substrate and inter-coat adhesion, outstanding long term corrosion protection, very high order of abrasion resistance, chip & impact resistance and shall meet fire safety standards.

The machined surfaces to be covered with anti-corrosive coat. The anti-corrosive coating plan shall be submitted to BEML for approval


Color of finish coat shall be decided by BEML/Employer before painting process

The supplier shall apply rust preventive coating on machined surfaces and any tapped holes etc. The tapped holes shall be plugged with dummy plugs after application of rust preventive coating.

The supplier shall provide proper packing to avoid transit damages during shipment of the castings

The painting of all surfaces except machining surface shall follow below requirements:

Paint	Nominal Value	Minimum Value	Maximum Value	Maximum Point
Primer	50 µm	40 µm	80 µm	120 µm
Finish	50 µm	40 µm	80 µm	120 µm

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The paint shade shall conform to NCS 8500N

6. Scope of Supply

6.1. General


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

- Tapered Roller bearing assembly
- Link arm type axle box casting
- Axle covers (front and rear)
- O-rings
- Spare parts
- Mounting and dismounting equipment for axle bearing: 4 set
- Special tools and testing equipment if required.
- Materials needed for assembling / disassembling of Axle Bearing (paste, grease, etc): required amount for 504 cars and spare parts.

6.2. Hardware

The subcontractor shall be responsible for supplying Axle Box and Bearing set with all necessary hardware/accessories.

Sl. No.	Drawing No.	Description	Qty./car in Nos.		
			DM	M	T
1	525-81153	* Axle Box/Link Arm	8	8	8
2	525-81023	* Bearing	8	8	8
3	525-81102	* Cover Earth Brush	4	4	4
4	525-81103	* Cover WSP	4	4	3
5	525-81104	* Cover WSP, Tacho	-	-	1
6	525-81105	* Cover Rear	8	8	8
7	525-81130	* O-Ring	16	16	16
8	525-81131	* O-Ring	4	4	4
Spares Requirement					
Sl. No.	Drawing No.	Description	Unit		
1	525-81153	* Axle Box/Link Arm	As per RFQ		
2	525-81023	* Bearing			
3	525-81102	* Cover Earth Brush			
4	525-81103	* Cover WSP			
5	525-81104	* Cover WSP, Tacho			
6	525-81105	* Cover Rear			
7	525-81130	* O-Ring			
8	525-81131	* O-Ring			

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9	525-81091	\$Kit for consumable and recommended Spares till DLP	
10	525-81092	Bearing cleaning, assembly & disassembly tools	
11	525-81093	Kit for overhauling of Axle boxes	
* Procurement for serial no. (1) to (8) shall be from the same vendor.			
\$ Consumable spares for bearings till DLP shall not include items like lubricants, oil, grease, paint, polish, etc.			

NO	DESCRIPTION	BEML			Subcontractor		
		Design	Supply	Fit	Design	Supply	Fit
1	Axle Box	X2			X	X	X
2	Bearing assembly	X2			X	X	X
3	Bearing force fit to axle			X	X	X	X2
4	Bearing force fit to axle box			X	X	X	X2
5	Axle Box covers(Front and Rear)	X2			X	X	X
6	o-ring	X2			X	X	X

X: Leader, i.e. responsible for the design activity required for the specified element of the scope of supply including any calculation, drawing, documentation and test connected with the design.

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


6.3. Spares

The subcontractor shall supply spares (if any) as per requirements specified in chapter - 8 of ERGS for a period of 10 years to BEML/MMRDA from the date of last car supplied by BEML.

6.4. Split of Responsibilities

The subcontractor shall be responsible for the complete design, engineering and testing of Axlebox assembly(Axle Box, Bearing, axle box covers and o-rings) in accordance with his scope of supply and work.

The subcontractor shall be responsible for design change of his scope of supply and work from the technical discussion between BEML and/or the End User and/or the

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subcontractor under the contracted price and delivery between BEML and the subcontractor.

The subcontractor shall be responsible of supporting BEML or the place designated by BEML for the technical meeting as required from BEML.

The technical details may change on minor aspects as requested by Employer or as required by BEML. Such a change request must not be considered as change order issue for revision of contract pricing, delivery conditions etc after acceptance of contract.

Finalization of drawings or design documents may take considerable time from Employer end. Hence, the subcontractor shall ensure that all reviewed & commented drawings or documents after proper revision & updates are submitted to BEML/Employer acceptance within 1-2 weeks at maximum.

The procedure for assembly & installation shall be provided by subcontractor to BEML in order to avoid any mechanical interference with other equipments/systems of the vehicle.


The subcontractor shall be responsible for providing all design documents, calculations, conducting type test & routine test, finish painting, technical documentation, training (if any) and warranty against defects.

The Axle Box assembly, Axle Box, Bearing, axle box covers and o-ring drawings shall be approved by BEML/Employer before mass production is started.

The supplier shall submit the documents conforming to the applicable Drawing/standards/specifications/PTS along with every batch of supplies specified in the drawing

The table below provides activity & responsibility details for contractor & subcontractor:

No	Description	Details	Scope		Remarks
			BEML	Sub contractor	
1	Interface	According to PTS	X2	X	
2	Design	According to PTS		X	
3	RAMS	According to PTS		X	


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4	Calculation documents for bearing selection, bolt strength calculation, sealing selection	According to PTS		X	
5	FEA Engineering specification for axlebox assembly, axle box, front covers				
6	FEA of axle box assembly, axle box, front covers	As per applicable standard/ERTS			The loads will be provided by BEML at detail design stage
7	Technical documentation	According to PTS		X	
8	Approval of drawing	According to PTS	X2	X	
9	Type & routine test	According to PTS		X	
10	Manufacturing	According to PTS		X	
11	Commission test	According to PTS		X	
12	Technical Documentation	According to PTS		X	
13	Training	According to PTS		X	
14	Warranty for each components	According to PTS		X	
15	Manual	According to PTS		X	

NOTE:

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

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

The above mentioned documents are required as minimum. Any additional documents within the scope of vendor shall be provided as and when requested. Additional documents from the vendor for supporting their scope of work shall be provided by the vendor.

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7. Design Information

7.1. General

The objective of the design submission process is to ensure that the proposed systems comply with the specifications and are capable of being produced consistently to exact quality standards with minimum LCC and can be operated safely to the satisfaction of the Engineer.

The design submissions shall include design calculations, design reports, design drawings and testing reports. All design submissions shall include a 'clause by clause' compliance status to all applicable contract clauses of ERTS.

The design submissions acceptable to BEML shall be further submitted to Employer for approval/acceptance. If any review comments are given on such design submissions, the subcontractor shall update/revise its design submissions for re-submission to the satisfaction of BEML/Employer. Each revision shall consist of response sheet enclosed with the revised documents.


The subcontractor shall submit revised documents incorporating BEML/Employer's request/comments in no later than 2 weeks.

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/ Employer.

Along with the offer, the subcontractor shall submit a list of documents each for Axle Box, Bearing, axle box covers(front and rear) and o-ring and completely assembled axle box that will be submitted by the subcontractor during the project execution.

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.

A monthly progress report for weight details in BEML/Employer format in MS-Excel file shall be submitted by subcontractor. The worksheet shall include equipment breakdown list, quantity, unit weight, CG etc. The subcontractor shall update the

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worksheet on monthly basis during design stage.

All necessary interface information must be provided by the subcontractor to ensure that the proposed aggregates satisfy ERTS & ERGS requirements with respect to complete running/operation of rolling stock.

The subcontractor shall also submit weight & CG revision history sheet to BEML on monthly basis which includes previous figures also the detail reason for revision shall also be mentioned in the progress report

Any other additional documents as required by BEML/Employer shall be provided by the subcontractor.


The Design Phase will be undertaken in three stages:

- Preliminary Design
- Pre-final Design and
- Final Design

7.2. Preliminary Design

The purpose of the Preliminary Design submission is as follows:

- State the design criteria;
- Design the overall system and propose the system configuration;
- Identify the functions of each system, sub-system, equipment or other element within the overall design and specify the relationships and interfaces between elements of the system;
- Identify the functions of each system, sub-system, equipment or other element within the overall design and identify the relationships and interfaces between elements of the Contractor's system and those of other Designated Contractors; and
- Verify the tender designs and calculations. In case of simulations, the inputs, relevant formulae, principles, assumptions, algorithm and logic followed shall be submitted with a sample calculation for each case. It shall be obligatory on the subcontractor to submit any further details as required by the Engineer to approve the results. Any spreadsheet if submitted shall be supported with the linked formulae and calculations.
- Incorporate the Engineer's suggestions and changes based on the Technical Specification and/or operational requirements.

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7.3. Pre-Final Design

- In the Pre-final design stage the conceptual designs (including interfaces with those of Designated Contractors of the Employer, and of the Contractor's vendors) are required to be fully developed. In this stage, each element of the system will be considered and preliminary specifications with supporting calculations developed.
- Manufacturing units will be allowed to commence production only after receiving 'no objection' advice from the Engineer. This submission shall include sufficient detail from prospective suppliers to demonstrate that they have adequate understanding of the requirements. It will include either evidence of or proposals for design verification. Interfaces with other designated subcontractors shall be finalised by this stage.
- Development of maintenance manuals & methodology of other derived maintenance activities. At pre-final design stage, the subcontractor will develop this FMEA to include required maintenance derived from each failure mode. Any other maintenance required for the train should be indicated at this stage. Methodology for the deriving maintenance activities including service checks, maintenance work instructions etc. based on failure modes shall be finalized at pre-final design stage only and the same shall be further reviewed by the Engineer during the DLP period.

7.4. Final Design

The purpose of the Final Design submission is to agree with the Engineer that the equipment is satisfactory, compliant with the specification, fit for purpose and safe. The Final Design shall be the level of design developed to the stage where all manufacturing drawings (including those received from Designated Contractors of the Employer, and Vendors of the Contractor) are fully defined and specified and in particular:

- calculations and analyses are complete;
- all main and other significant elements are delineated;
- all other work, including studies, investigations and reports are complete.

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7.5. Design Stages

Sl. No.	Description of stage	Submission from subcontractor to BEML(from LOI / contract award)
1	Preliminary design completion including Employer's approval	15 days
2	Pre final design completion including Employer's approval	30 days
3	Final design completion including Employer's approval	45 days

The subcontractor shall provide BEML with all necessary drawings, reports, calculations, specifications, technical design data, system safety plan, quality assurance plan, manufacturing process, testing and training with respect to PTS, ERTS and ERGS strictly within time schedule defined by BEML and MRS1 project requirements.

The technical details, drawings and documents shall be delivered in English language only. These shall be compatible with AutoCAD 2000 (dwg file), 3D model (stp / iges file) and MS office version 2003 (document MS word, spread sheet – MS excel, data base files – MS access, Presentation file – MS PowerPoint). The quantities of these drawings and documents submitted to BEML shall conform to chapter - 5 of ERGS. The soft copy of documents/drawings shall be submitted in pdf format compatible with Adobe Acrobat Reader version-6 or above.

The subcontractor shall request relevant interface information from BEML, which possibly affects performance, fitting and form of the aggregate to be supplied. The subcontractor shall comply, but not be limited to, chapter-5 of ERGS & ERTS section 3.7

7.6. Design Documents

The subcontractor shall provide, but not be limited to the design documents / information of the Axlebox assembly, Axle Box, Bearing, axle box covers and o-ring as mentioned below:


Sl. No.	Document
1	Axlebox assembly & its sub-parts 2D drawings and 3D files (preferably catia)



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2	Bearing drawing and 3D file
3	Marking/stamping drawings
4	Axlebox FEA (Engineering specification and analysis report)
5	Bolt strength calculation
6	Interface document and drawing for axlebox assembly
7	Manufacturing process flow chart for sub-components of axle box assembly
8	Selection criteria for bearings
9	Casting defects and severity limits
10	Manufacturing standards list
11	Axle box and Bearing press fit calculation
12	Routine test specification of Axle bearing
13	Routine test check sheets/report of Axle bearing
14	Type test specification of Axle bearing
15	Type test report of Axle bearing
16	Life Cycle calculation of Axle Bearing
18	Routine test specification of Axle box
19	Routine test check sheets/report of Axle box
20	Type test specification of Axle box
21	Type test report of Axle box
22	Test Specification of assembled axle boxes
23	Test reports of assembled axle boxes
24	Estimated/measured noise attenuation data
25	UT films and reports
26	General Assembly Procedure
27	Operation & Maintenance manual
28	Hazard Analysis
29	RAMS details
30	The manufacturing details of all Equipment
31	Installation Instruction of all Equipment
32	Cleaning, storage and handling instruction of Equipment
33	Maintenance & Inspection Instructions

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34	Monthly progress report
35	Sealing (O-rings) material, composition and characteristics
36	Sealing (O-rings) test reports

8. Marking

Manufacturing date and bearing designation shall be discussed with BEML.

Each bearing i.e. inner race, outer race assembly shall be visibly and indelibly marked for easy identification, with following description.

Vendor's trade-mark;

Complete designation of the bearing, defining type; dimensions, radial internal clearances etc.

Year of manufacture with batch number.

Each Axle Box shall be legibly marked with the following details for traceability.

The number or identification mark by which it is possible to trace the melt and the heat- treatment batch from which it was made

The serial no. of the Axle Box

The month & year of manufacture and


The manufacturer's name or trade-mark.

9. Inspection & Testing for Axle box assembly (Axle Box, covers, bearing & o-rings)

9.1. General

The validation, inspection, and test plan shall describe the subcontractor's overall validation, inspection and test process, including the responsibilities of individuals and the documentation of the validation and test results and shall include, but not be limited to, the following items:

The Inspecting Official shall have free access to the works of the manufacturer at all reasonable times. He shall be at liberty to inspect the Axle box assembly, Axle Box, covers, Bearing and o-rings at any stage of manufacture and to reject any material that does not conform to the PTS.

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The manufacturer shall provide the inspecting official, free of charge, all reasonable facilities by way of labour, appliances and necessary assistance for such tests as may be required to be carried out in accordance with this specification. Where facilities are not available at manufacturer's works, the manufacturer shall arrange for carrying out such tests elsewhere and bear the cost of testing.


The finished Axle Box, covers, Bearing and o-rings shall be presented for inspection in batches of not more than 500. The Axle Box, covers, Bearing and o-rings shall be presented for inspection after the application of the protective coating against corrosion. The Inspecting Official is free to have the sample for various tests.

- A flow diagram indicating the logical sequence of validations and tests starting with material receiving tests and inspections and concluding with system demonstrations tests.
- Validation schedule.
- Test schedule.
- Responsibilities of the subcontractor.
 - Record-keeping assignments, procedures and forms.
 - Procedures for performing validation.
 - Procedures for monitoring, correcting and re-testing deficiencies.
 - Procedures for controlling and documenting all changes made to the hardware and software after the start of testing.
- The performance testing should be done as per EN 12082.

9.2. Test Procedures

Test procedures shall describe the individual test cases and the steps comprising each case, with emphasis on the methods and processes to be followed. Test procedures shall include, but not be limited to, the following:

- The objective of the test.
- For each test case, the requirement(s) to be demonstrated and verified.
- The required setup and conditions for each test case, including descriptions of the test equipment and data to be supplied by the subcontractor.
- Descriptions, listings and instructions for all test software tools and displays.
- Step-by-step descriptions of each test case, including the inputs and user actions for each test step.

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- The expected results for each test case including the Pass/ Fail criteria.
- Descriptions of the techniques and scenarios to be used to simulate system field inputs and controlled equipment.

9.3. Test Records


Complete certified test records of all factory and field acceptance test results shall be maintained by the subcontractor and submitted to BEML. The test records shall be keyed to test procedures and shall include, but not be limited to, the following:

- The reference to the corresponding test procedure.
- The date the test procedure was executed.
- Description of any test conditions, input data, or user actions differing from that described in the Test Procedure.
- The test results for each test case including a Pass/ Fail indication.
- Identification of the subcontractor's test engineer.
- Provision for comments by the Employer/his Representative's.
- Copies of any deficiency reports generated as a result of the execution of the test procedure.
- Copies of reports, display copies and any other hard copy generated as a result of the execution of the test procedure.
- Configuration data that fully describes the hardware and software that was tested, including software version and build numbers/ identifiers for every software module.
- Calibration certificate of equipment and tool which are used for test and inspection.

9.4. Inspection & Testing for Axle Box and axle box covers

9.4.1. General

The Supplier shall perform all tests in accordance with the standards specified in the drawing, related material standard and purchase order. BEML and/or DMRC Representative have the right to witness any of these tests at any stage of test progress.

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9.4.2. Inspection

Every casting, irrespective of lot size shall be examined visually for surface defects and irregularities. The Castings shall be free from cracks, shrinkage cavities, blow holes, pin hole, porosity, sand inclusions and any other defect that would impair the utility of the Castings.

Following tests for detecting surface and volume defects has to be carried out.

- casting quality grades, test zones and extent of testing
- visual test of the surface
- surface crack test
- volume test

9.4.3. Chemical Composition Analysis

The supplier shall carry out ladle analysis on a sample of each melt and product analysis on a test piece or a casting representing each melt as per the material standards mentioned in the drawings and shall submit test reports.


9.4.4. Mechanical tests

The hardness test, tensile test, impact test, bend test, microstructure fracture and any other test as per the requirements of the applicable/approved drawings and corresponding material standards shall be carried out by the supplier on the test bars cast either separately from or attached to the castings to which they refer and heat treated along with the castings. Reports shall be submitted along with the casting supplies.

9.4.5. Non-Destructive tests

Non-destructive testing has to be carried out as per agreed standards between BEML and subcontractor. Supplier shall ensure that the same is carried out by a reputed third party NDT agency having ISO 9001 certification, preferably having NABL accreditation and all the reports shall be certified by ASNT/ ISNT Level II qualified personnel.

The details of the agency with whom the vendor has tied up for NDT and the certificates of the qualified personnel shall be submitted along with the offer. For radiography inspection the site in charge & X-ray / Gamma rays cameras shall be

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approved by AERB/BARC. Agency employed for NDT testing shall be approved by BEML before executing order. The extent of testing shall be as per the drawing requirement. Test reports along with the X-ray films shall be submitted with the casting supplies. The serial number and heat number of the casting shall be clearly visible on the X-ray film to have traceability.


9.4.6. Performance tests

Performance test as per applicable standard and mutually agreed between BEML and subcontractor has to be carried out by the subcontractor and test reports should be submitted. The test procedure shall be approved by BEML.

9.4.7. Interface and Dimension Tests

1. Dimensional and squareness checks, etc.
2. The dimensions shall conform to relevant approved drawings.
3. The following main aspects shall be checked meticulously:
 - Axle Box and covers wall thickness – At multiple locations.
 - Axle Box Bore – Size, taper, ovality and surface finish of bore.
 - Axle covers - dimensional accuracies for seating on axle box and installation of o-rings
 - Bearing Seating Face – Distance from end face for ensuring central location of the bearing to journal i.e. main bore depth.
 - Suspension seating area – Size, height and centrality of suspension seat from the journal centre.
 - Liners – Over liners distance, parallelism and squareness of the faces to the suspension seating area. Lateral location (distance from the box front face to the liner face), parallelism and squareness of side liners to the face liner.
4. Dimensional checks for axle box assembly components:

Thrust rings, end cover, distance rings, locking plates, etc. shall conform to dimensions of relevant approved drawings of supplier

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9.4.8. First Article Inspection (FAI)

The sample machined casting submitted by the supplier before mass production shall be subjected to First Article Inspection by BEML and/or DMRC/his Representative. BEML may decide to conduct destructive tests also on the casting. Only, after clearance from BEML, mass production shall be taken up. Castings shall be offered to BEML representative(s) for inspection before dispatch for pilot / proto lot.

9.5. Inspection & Testing for Axle Bearing

The subcontractor shall carry out the type test and routine test of the axle bearing.


All test procedures, type test reports including all corrective actions and checklists shall be submitted by the subcontractor and approved by BEML and/or Employer /Representatives. Test procedure submitted shall show all the safety aspects. In addition, the subcontractor shall prepare a test plan listing for tests to be performed. The plan shall briefly describe the scope of each test.

In the event that any test for axle bearing fails, the subcontractor at his own expense and responsibility shall take corrective action as deemed necessary, to the satisfaction of BEML and/or Employer/Representative, in order to meet the testing requirements.

Only with the written consent of BEML/Employer the type test or certification requirements may be waived off. Nevertheless, if the type test should be carried out, the subcontractor at his own expense shall perform the type test which shall be witnessed by BEML/Employer/Representative.

In case BEML seeks to waive off type test for the axle bearing already type tested or certified for other projects of identical design, the subcontractor shall provide all the requisite documents including supply details, customer details, and year of supply, quantity, etc and certificates necessary for getting waiver. For variations in design parameters between the previous tests and the specifications, extrapolated calculations must support the test report.

After testing, the subcontractor shall document the test conditions and results. Report shall be submitted to BEML for approval. Any design changes, adjustments, etc., that are required to meet the performance requirements, shall be fully retested and documented at the sub contractor expense. Equipment design changes shall be

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subject to prior approval by BEML and/or the end user /his representative.

9.5.1. Type Testing

The subcontractor shall prepare and conduct type testing to demonstrate that all of the equipment to be supplied will operate properly within the limits of the environmental and/or physical parameters listed in PTS and test procedure. These tests shall be performed in accordance with a type testing procedure prepared by the Subcontractor and approved by BEML and/or the Employer/his Representative. In addition, the subcontractor shall prepare a Test Plan listing all tests to be performed; the plan shall briefly describe the scope of each test. No testing that requires an approved test procedure shall be started until test procedure has been approved by BEML and/or the Employer/his Representative. BEML and/or the Employer/his Representative reserve the right to witness all qualification tests.

After testing, the subcontractor shall write a report documenting the test conditions and results, and shall submit the report to BEML for approval. Any design changes, adjustments, etc. that are required to meet the performance requirements, shall be fully re-tested and documented at the Subcontractor expense. Equipment design changes shall be subject to prior approval by BEML and/or the Employer/his Representative.

9.5.2. First Article Inspection (FAI)


The axle bearing shall be subjected to First Article Inspection (FAI) at supplier's manufacturing unit by BEML and/or Employer / Representative(s).

Only after verification and approval of FAI reports by BEML, parts shall be taken up for mass production. The subcontractor shall inform BEML for carrying out FAI at least one month before the FAI date.

9.5.3. Production Conformance Testing

The subcontractor shall conduct Production Conformance Testing on each bearing to ensure that the assembly is functioning correctly. These tests shall be performed in accordance with a Production Conformance Testing procedure prepared by the subcontractor and approved by BEML and/or the Employer/his Representative.

The subcontractor shall perform the routine test of equipment/assembly under his

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responsibility.

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

The routine test records shall be held by the subcontractor and should be available during inspection by BEML and/or the Employer/his Representative's. Copies of the routine test records shall be submitted together with the associated log book.

Additional copies of records of all tests/inspections result held at the subcontractor workplace shall be made available to BEML and/or the Employer/ his Representative on demand.

9.5.4. Noise and Vibration Test

The subcontractor shall perform the noise and vibration performance test of the Axle Bearing in accordance with the requirements specified in type test procedure approved by BEML and/or the Employer.

BEML will perform the noise and vibration type test on the train. So, the subcontractor shall assist BEML team to achieve the noise requirements of train basis.

In addition, the subcontractor shall comply with clause 2.18 of ERTS

9.5.5. Type Test & Commission Test for completed car and train, service trials


The vehicle level type test shall be performed by BEML on the basis of information from subcontractor. The subcontractor shall provide BEML with full record of the modification status at the type test.

In case of any problems happening in the Axle Box and Bearing during the test of train, the subcontractor shall immediately appoint appropriate staff in order to aid BEML in rectifying the problems and be responsible for correcting any interfacing defects.

The subcontractor shall provide full support by way of instructions, staff and materials during the integrated test at the request of BEML. BEML will perform the service trials for the trains.

9.6. Prototype testing of assembled Axle Boxes

Prototype inspection shall involve the following:

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9.6.1. General tests

Centrality and parallelism of the horn faces to the axle of the journal.

9.6.2. Water tightness/ seal test before and after loading

After successful completion of above tests, one or two complete axle box assemblies shall be tested for water tightness/ seal test as per UIC Code 515-5 or equivalent specification for cylindrical roller bearing.

Following test condition shall be carried out:

1. Before loading the axle box assembly, water tightness test to be done.
2. The axle box assembly shall be loaded for 1T, 2T, 3T, 4T and 5T at the axle box cover end as shown in the drawings 525-81102, 525-81103, 525-81104. In this condition, water tightness test shall be carried out. No leakage shall be observed.
3. After removing the above loads at every stage, the water leakage test shall be carried out. No leakage shall be observed.

The test specification shall be submitted for approval before testing.

9.6.3. Fatigue testing of Axle box assembly

The axle box assembly shall be fatigue tested. The test conditions shall be finalized during the detail design stage.


The test specification shall be submitted for approval before testing.

9.6.4. Fatigue Test for Axle Bearing

After water tightness or seal test, the bearing shall be subjected to fatigue test as per UIC Code 515-5 or equivalent specification, if the offered bearing is already approved by UIC, AAR or equivalent, and has successfully given field service for two years in at least 50 numbers of locomotives. Approval certificate from UIC or equivalent authority shall be submitted by the vendor.

10. Acceptance criteria for Axle Box, Bearing, Covers & o-rings

Any deviation from the stipulations found by inspection of a sample bearing may result in the rejection of the corresponding lot.

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If the firm is failing to fulfill any criteria as specified in the specification, that firm shall not eligible to supply the item till further clearance from BEML.

11. Handling of Axle Box, Bearing, Covers & o-rings

The subcontractor shall hand over the Axle Box and Bearing to BEML in accordance with the time schedule defined by BEML. The subcontractor shall provide the instruction for proper storage, handling and logistic function of components supplied by the subcontractor two months before handing over the first batch of the complete Axle Box and Bearing to BEML. The packing and transportation should be commercially discussed.

12. Protection against corrosion

The type of protection against corrosion shall be decided by the vendor depending on the packing material used. Under proper storage conditions, anti-corrosive treatment shall be effective for at in order to ensure a satisfactory functioning of the rolling bearings.

13. Operation & Maintenance Manual

The following are the requirements


The requirements for the O&M manual shall meet, but not be limited to Chapter 12 in ERGS. The subcontractor shall support BEML in meeting timelines for submission of manuals.

It shall be the responsibility of subcontractor to provide O&M manual complete in all aspects which includes spare parts catalogue, general maintenance instructions, heavy maintenance instructions, details of special tools and test equipment, technical description, defects identification & rectification details, etc

The O&M manual provided by the subcontractor must contain all the information necessary to operate and maintain the equipment within his scope of supply in a safe and efficient manner.

The subcontractor shall deliver six hard copies in color in English language as well as soft copy strictly within timeline as specified by BEML.

The technical information provided in each volume of the O&M manual must be in sufficient detail to ensure that the different categories of readers/users are provided with all the information in the form of text, illustrations and tables, which can be readily

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understood and assimilated.

The O&M manual shall provide detail testing procedure as per the supplied special tools for overhauling of the axle bearings and shall also provide two sets of the special tools required for overhauling in each depot. The cost of such tools shall be deemed to be included in the quoted price. Details to be finalized during design stage

14. Training Needs

The subcontractor shall meet training requirements as specified in chapter-9 of ERGS.

15. Warranty

The subcontractor shall be responsible for warranty of its supplies as per Chapter 1 section-1.8 of ERGS.

16. Delivery

The subcontractor shall deliver link arm type axle box, axle bearing, axle covers and o-rings as per delivery schedule agreed by BEML.

The subcontractor shall provide instructions for proper storage, handling and logistics of components 4 weeks before handing over the first shipment.

The subcontractor shall pack & deliver the link arm type axle box, axle bearing, axle covers and o-rings suitably to avoid any damage during transit/transportation.

The O&M manuals shall be supplied 4 weeks before the first supply.

17. System Assurance and Safety


The subcontractor shall comply with ERGS 2.7 & ERTS 2.4 for system safety assurance. The safety assurance program for Axle Box and Bearing shall be consistent with the assurance program of the overall rolling stock.

18. Quality

All works shall be executed and controlled by a quality management system, in accordance with the requirement of ISO 9001. The subcontractor shall comply with ERGS 2.6 & ERTS 2.3 to a minimum.

18.1. Quality System Requirements

The subcontractor shall have relevant quality certification and shall manufacture the

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product accordingly. The subcontractor shall maintain and perform his internal management plans for the following:

- Design change control
- After sales service
- Purchasing control
- Process control

In addition, the subcontractor shall submit a copy of his ISO certificate including the certification body details. In case the certificate is expired, the subcontractor shall renew and submit the same.

18.2. Quality Assurance Plan (QAP)


The subcontractor shall issue the QAP in accordance with the relevant Quality System and the Employer's Requirements, and submit it to BEML for approval. Following content shall be included in the QAP:

- Process Control
- Purchasing
- Quality Audit
- Inspection and Test Plan (ITP)
- Quality Record
- Design Control
- Nonconformity control
- Inspection and Test procedure

18.3. Inspection and Test Plan (ITP)

ITP shall be submitted to the BEML within 2 weeks from purchase order placement date. It shall include at least the following:

- Sequence of inspection/testing activities
- Inspection and testing requirements of either activities or materials
- Acceptance criteria or relevant specification
- Level of inspection required including the provision for witnessing by BEML and/or End User/his Representative
- Any certification requirements or records to be kept; and
- Records of any non-conformance identified during inspection or testing

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- BEML will designate witness/Hold point of BEML and/or Employer /his Representative and notify it to the subcontractor.

18.4. Quality Audit

The subcontractor shall develop a quality audit program in accordance with the ISO 9000 Quality System and submit to BEML for information. The subcontractor shall comply with ERGS 2.6.3 to a minimum and shall submit the audit report to BEML for information. In addition, a copy of audit report issued by the accredited ISO certification body shall also be submitted to BEML on demand.

19. Project Management Plan

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

A diagram showing the organizational structure for the management of the contract, with locations, names and position titles of staff and their line and staff relationship. The diagram shall include associate organizations and sub-suppliers and show clearly the individuals and lines of responsibility linking the various groups. It shall also identify the persons designated as contacts with BEML.


The names, qualifications, positions and current resumes of key executive, supervisory and engineering staff to be employed full-time for the works.

A narrative describing the sequence, nature and inter-relationship of the main contract activities including timing for exchange of information.

Procedure for documentation control.

The subcontractor shall nominate a suitably qualified and experienced English speaking engineer from his staff to be Project Manager. The proposed Project Manager shall have total experience of minimum 15 years and shall have been Project Head in at least one Rolling Stock Project in last 10 years.

The proposed project manager shall be the employee of the subcontractor. The

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CV of the Project Manager shall be submitted along with the technical offer.

To fulfill the subcontractor's obligations during the testing and commissioning and the DLP, the subcontractor shall nominate experienced maintenance engineers and organize deployment before undertaking testing and commissioning in depots. Separate maintenance engineer shall be positioned in each depot.

The subcontractor shall submit relevant CV's of the design manager, production manager, quality manager, interface manager & maintenance engineer in addition to project manager in the technical offer.

20. RAMS Requirements

The subcontractor shall comply in every aspect with the requirements of RAMS as per section 2.7 to 2.13 of ERTS and section 2.8 of ERGS. During DLP, the values from RAMS target shall be calculated from the records of all the faults and service failures. In the event that the target is not achieved, the subcontractor shall, at his own expense, take whatever action necessary to meet the target specified. The subcontractor shall comply with, but not limited to, the following ERTS requirements:

20.1. General


The subcontractor shall comply with ERTS 2.7 for general RAMS requirements.

20.2. Reliability Requirements

The subcontractor shall comply with reliability requirements as specified in ERTS 2.8. Additionally, for pattern failure, following method shall be used:

Three or more relevant service failures of the replaceable part, item or equipment in same manner in identical or equivalent applications occurring at a rate which is at least 20% higher than the predicted failure rate of the part, item or equipment and/or

At least 20% of the same replaceable part, item or equipment in the fleet has a relevant failure in the same manner in identical or equivalent applications during a moving 18 months window starting when the reliability demonstration starts and ending at the end of the DLP

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20.3. Reliability Analysis

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

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

The reliability block diagrams and prediction of reliability performance shall be submitted to BEML for acceptance in the format, units and parameters as desired by the Employer.

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

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

20.4. Reliability Target

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


Duration	Minimum fleet average MDBF
	6 -car fleet
After 6 months of start of revenue service plus stabilization period of 6 months	100,000
After 12 months of start of revenue service plus stabilization period of 6 months	125,000

$$MDBF = \frac{\sum \text{Travelled kilometer per train} - \text{set}}{\sum \text{Number of service failures}}$$

Mean Distance Between Failures (MDBF): The MDBF is the ratio of the total operating distance accumulated by the total available fleet of the trains to the total number of Service Failures.

MDBF for Axle Bearing in 6 cars train-set shall meet the train level MDBF (shall be provided by BEML) during detail design phase.

The Reliability performance shall be assessed by the following measure:

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$$MDBC F = \frac{\sum \text{Travelled kilometre per train-set}}{\sum \text{Number of relevant Failures}}$$

where,

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

$$MDBSF = \frac{\sum \text{Travelled kilometre per train-set}}{\sum \text{Number of Service Failures}}$$

Where,

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

Relevant Failure

A relevant failure of an item is an independent failure which results in a loss of function of that item caused by any of the following:

A fault in an equipment or sub-system while operating within its design and environmental specification limits;


Improper operation, maintenance, or testing of an item as a result of the subcontractor supplied documentation.

Failures of transient nature including those with post investigation status as 'No fault found', shall be considered as relevant failure if in the opinion of the Engineer these are attributable to rolling stock. The decision of the Engineer shall be final.

Service Failure

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

Non-availability of the train to start revenue service after successful completion of pre-

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departure checkout.

Withdrawal of the train from revenue services.

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

The discretion of declaring a train as not-available to start revenue service after successful completion of pre-departure checkout or withdrawing a train from revenue service on account of any relevant failure rests solely with the Engineer and shall be final. The train withdrawal scenario is placed at Appendix TG of ERTS and includes possible anticipated failure scenarios which can affect safety, punctuality and passenger comfort. The train withdrawal scenario defined in Appendix TG shall be considered as a service failure irrespective of whether the DMRC is able to withdraw the train or not due to its operational constraints. This list shall be further developed during DLP.

Pattern Failure:


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

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

20.5. Maintainability Requirements

The subcontractor shall comply with ERTS 2.12 & 2.14 for maintainability and maintenance requirements as given below:

- The design of all components will be such that maintenance is reduced to a minimum, substantially improving service intervals.
- Components shall be so arranged that those requiring frequent attention are easily accessible and readily removable. All equipment should be designed using the Least Replacement Unit (LRU) principle whereby the repair of a fault merely involves the replacement of a faulty module.
- The design shall also minimize mean time to repair (MTTR) and costs throughout design life. MTTR is the ratio of cumulative time, including the access time

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expended during a time interval to the total number of relevant failures. The supplier shall specify the MTTR for the supplied components and assemblies.

- The subcontractor at his own cost, in Employer's depot, in coordination with BEML, shall demonstrate the periodic & intermediate overhaul, LRU replacement and corrective maintenance activities with/without car lifting.
- The procedures used in the demonstration shall be the same as those included in the maintenance manuals submitted.
- The subcontractor shall submit the list of required spares, consumable spares, tools etc. for such demonstration
- The subcontractor shall support an active supply for high availability.
- The subcontractor shall comply with procedure of BEML for fault rectification. If some failure needs the subcontractor's support, the subcontractor shall depute the engineer in the earliest possible time.
- The subcontractor shall provide training/requisite knowledge to BEML maintenance staff if any, needed at the time of maintenance.

20.6. Maintenance interval


The proposed Axle Bearing shall have obtained enough performance and durability to get the following inspection period without an additional maintenance & equipment change.

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

Preventive maintenance interval shall be compliant with the interval as specified in the table above.

20.7. Maintainability Target

The LRU replacement should be less than 30 minutes. MTTR in corrective

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maintenance operation that requires lifting of cars shall be less than 6 hours and 4 hours if lifting of car is not required (ERTS 2.12.12 table 2.5). Proposed MTTR for Axle Bearing is 3.5 hrs.

20.8. Master Maintenance Schedule


The master maintenance schedule shall be provided stating clearly the parts needing attention in service checks and major overhauls.

The subcontractor shall submit work instructions/manuals for all scheduled maintenance activities, fault finding and corrective maintenance of all faults likely to be found during maintenance and servicing.

The master maintenance schedule should be incorporated in maintenance manual and subcontractor shall provide the relevant chapter reference in maintenance manual against the each maintenance task in master maintenance schedule.

20.9. Maintenance

- The trains shall operate with minimum attention between the specified inspection periods, and shall, under the operating conditions specified, operate between overhaul periods without requiring replacement of components other than those on the agreed list of consumable parts to be proposed by the subcontractor and accepted by the contractor.
- Special tools shall be avoided for maintenance. If unavoidable, they shall be supplied by the subcontractor in requisite quantities in all the depots to meet the maintenance requirements.
- Equipment design shall be modular to minimise down time following failures of equipment and components. Provision for mechanical handling devices shall be provided for any single piece of equipment weighing more than 35kg and all such items shall be identified as a part of Final Design Review (FDR). Equipment covers shall be provided with secure, visible, latching arrangements easily inspectable from the side of trains.
- All bogie equipment which cannot be handled manually shall be configured such that it can be removed and replaced from track level using fork lift trucks or lift tables, with recognition being given to the confined environment of the pit and the rail level and underframe dimensions. All bogie equipment shall be arranged such

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that it is capable of being removed and replaced without disturbing any other equipment. All such items, that may be required to be accessed and worked upon (including operation) in the event of any unusual occurrence on line shall be such mounted that it shall be very easily accessible to the train operator from PF/track level.

- If any equipment mounted above the ceiling requires the use of lifting equipment for its removal or refitting this shall be readily achievable without the risk of damage to the vehicle interior.
- Removal and re-assembly of moving and wearing parts on bogies shall generally be carried out without the use of special tools.
- Bogies shall be capable of being disconnected and reconnected to vehicle bodies with a minimum of operations. All connections must be easily and safely accessible to personnel located in pits or alongside the bogie at rail level. It shall be easy to inspect for correct reconnection, from alongside the bogie where possible. Preference will be given to a design which permits release of the bogie to permit the raising of the car body, without the need for a pit in the Lifting Berth.
- Each vehicle shall be capable of being lifted complete with bogies without the need to attach extra restraints or supports for the bogies or wheels.
- Lubrication points shall have button head type grease nipples, and shall be easily accessible from rail level and shall, where possible, be grouped together.
- On-vehicle test equipment shall be used on a vehicle to discriminate between a fault on the main equipment and a fault on the control electronic equipment.


20.10. Life Cycle Costs (LCC)

The subcontractor shall provide equipment that has minimum total LCC. The subcontractor shall submit LCC calculation in accordance with ERTS 2.21. The LCC which contains preventive & corrective maintenance activities shall be in compliance with the maintenance manuals submitted by the subcontractor.

20.11. Reliability and Maintainability (R&M) Demonstrations

The reliability demonstration of each train will start after six months of that train in revenue service and will continue till the end of the DLP.

Reliability of the trains and of the identified major systems will be demonstrated on

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fleet basis. Accordingly, the subcontractor shall be required to demonstrate compliance with specified equipment reliability.

During DLP, the values of the R&M target shall be calculated from the records of all faults and service failures. In the event that the R&M target is not achieved, the subcontractor shall, at his own expense, take whatever corrective action(s) to meet the R&M target specified, either by way of change of design of the relevant equipment/ component or software modification.

The subcontractor shall analyze and submit detail report to BEML/Employer for each and every failure/defect of whether of component, sub-system or system to determine the cause of failure and to propose corrective measures, which would be reviewed by BEML/ Employer.

Correction shall be made to components or subsystems that either fail to attain predicted reliability levels or show Pattern Failure, at subcontractor's own cost.


At the subcontractor cost, in depot at Mumbai, in coordination with BEML, the subcontractors shall demonstrate the maintainability for Periodic Overhaul, Intermediate Overhaul, LRU Replacement and Corrective Maintenance with car lifting and without car lifting.

The procedures used in the demonstration shall be the same as those included in the manuals delivered and the subcontractor is required to submit the list of required spares, consumable spares and tools for the Maintainability Demonstration.

The subcontractor shall support an active supply for high availability. If some failure needs subcontractor's support, the subcontractor shall depute his engineer as soon as possible. The subcontractor shall provide requisite training to maintenance personnel of Employer/BEML team for the same if needed.

20.12. Safety Requirements

The subcontractor shall comply with ERGS 2.7 & ERTS 2.4 for system safety assurance. The safety assurance program for the axle box and bearing shall be consistent with the assurance program of the overall rolling stock and covers design, manufacture, testing & commissioning. The subcontractor shall indicate the magnitude and seriousness of events or malfunctions, which could result in injury to passengers and damage to the equipment but cannot be eliminated.

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To meet the safety requirement, the subcontractor shall submit the following documentations as a minimum:

System Safety assurance plan as per ERTS 2.4

Hazard analysis including preliminary & subsystem hazard analysis, operation & support hazard analysis and interface hazard analysis as per ERTS 2.5. The subcontractor shall comply with ERTS 2.5.

FMECA (Failure Mode, Effects and Criticality Analysis)

Quantitative Fault Tree Analysis (FTA) for Safety Critical Events

20.13. RAMS Deliverables

The subcontractor shall submit the following RAMS Deliverables.

RAMS Plan during preliminary design

Product breakdown structure during preliminary design stage

Reliability analysis with train withdrawal scenarios as per Appendix-TG of ERTS

Reliability block diagram & reliability prediction during both pre-final design stage

Hazard analysis including PHA, sub-system hazard analysis, operating & support hazard analysis and interface hazard analysis during pre-final design stage

Preventive and corrective maintenance analysis during pre-final design stage.

Master maintenance schedule during pre-final design stage

FMECA (Failure Mode, Effects and Criticality Analysis) during both Pre-final design Stage


LRU list during pre-final design stage

Safety FTA during Final design Stage

LCC Analysis during Final design Stage

21. Fire safety

The subcontractor shall comply with ERTS-2.19 for fire performance and fire safety.

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21.1. Material Properties

All non-metallic materials used in proposed system shall be selected so as to reduce to maximum extent practical heat load, rate of heat release, propensity to ignite, rate of flame spread, smoke, emission and toxicity of combustion gases.

All non-metallic materials used in proposed system shall conform to fire safety requirements of EN45545 Part 1 to 7 (Category 4-A, Hazard level HL3) latest edition.

The subcontractor shall submit a fire-safety plan providing the list of non-metallic material items that are used in proposed system with details of material, applied mass, fire safety compliance (flammability, smoke, toxicity and heat release rate etc) during preliminary design phase.

21.2. 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.


21.3. Fire Performance Deliverables

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

Sl. No.	Deliverables	Remarks	Submission Period
1	List of Non-Metallic Materials with details of material, mass & calorific value	As per EN45545 HL3	During Pre-Final Design stage
2	Fire Test Report	As per EN45545 HL3	During Pre-Final Design stage
3	Heat Release rate Test report	As per EN45545 HL3	During Pre-Final Design stage

22. Compliance for PTS, ERTS & ERGS

The subcontractor shall provide a valid and fully compliant proposal for the Axle Box and Bearing as detailed in the ERTS, ERGS and PTS.

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The subcontractor shall submit a detailed clause by clause commentary (CBC) on the relevant clauses of the ERTS, ERGS and PTS.

Subcontractor shall note that their comments in CBC shall only be of the following forms:

“Complied” shall be indicated by the subcontractor where the subcontractor is able to comply fully with the clause.

“Noted” where a clause merely provides information and no other comment is necessary, “Noted” will suffice.

Offers with non-compliance and deviations to any of PTS, ERTS & ERGS clauses are liable for rejection.

23. Attachments

MRS1 ERGS & ERTS

Drawing No. 525-81153

Drawing No. 525-81102

Drawing No. 525-81103

Drawing No. 525-81104

Drawing No. 525-81105

Drawing No. 525-81130

Drawing No. 525-81131

Annexure 1: Submittals Check sheets

Annexure 2: Vendor Approval Form

24. Offer Submissions

The subcontractor shall submit all the documents specified in Annexure 1 and Annexure 2 along with technical offer in format enclosed.