



BEML LIMITED BANGALORE

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MRS1 PROJECT
PROCUREMENT TECHNICAL SPECIFICATION
FOR
WHEEL FLANGE LUBRICATOR (WFL) SYSTEM

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1. Introduction

This document specifies the technical requirements of Wheel Flange Lubricator system (WFL) to be supplied for cars under the 'MRS1' contract (hereafter MRS1). The WFL shall comply in all respects with Employer's Requirements General Specifications (ERGS) and Employer's Requirements Technical Specifications (ERTS).

BEML will carry out all required works and activities as a *contractor* for MRS1 project, while the *supplier* shall be responsible for all works required in this PTS with regard to WFL and shall be responsible for supporting BEML activities.

2. General Specifications

The supplier shall supply Oil Type WFL with necessary subsidiary materials to ensure its functionality e.g. plug, protective coating/packing, sealant, etc. The supplier shall have responsibility for investigation & consideration of suitability of WFL for the environmental condition as 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 of WFL.

The supplier shall comply with GTC, ERGS, PTS, TCMS ICD requirements and all chapters of ERTS.

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)
 - *DM - T - M - M - T - DM* - (6 car train formation)
- For increase in quantity (If required)
- - T - M - - (2 car unit formation)
 - *DM - T - M - M - T - DM* - (6 car train formation)
 - *DM - T - M - T - M - M -T - DM* - (8 car train formation #)

In case of 8-car formation (if required), the performance features of extra 2 car unit (T-M) shall be suitably designed in line with ERTS sub clause 3.22.10.

2.2. Car weight

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

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Approximate car weights and train configuration are given in the below table:

	DMC	TC	MC
Tare	≤42,000 kg	≤41,000 kg	≤42,000 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 supplier shall use vehicle performance requirements as specified in section-3.22 of ERTS for designing of WFL as given below:

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 0 kmph to 60 kmph 0 kmph to 80 kmph		1.0 m/s ² 0.75 m/s ² 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 0 kmph to 60 kmph 0 kmph to 80 kmph		1.20 m/s ² 0.80 m/s ² 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
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
<i>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.</i>		

2.4. Wheel diameter

Wheel diameter (new)	860 mm
Wheel diameter (half worn)	820mm
Wheel diameter (full worn)	780mm

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2.5. Track parameters

The supplier shall use track parameters as specified in section-3.14 & 3.15 of ERTS for designing of WFL to be used for MRS1 project as given below:

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)	60 EI (UIC 60) 880/HH	60 EI (UIC 60) 1080/HH	60 EI (UIC 60) 1080/HH
Rail Profile	UIC 861-3		
Inclination Of Rail	1 in 20		
Sleeper Spacing (Main line)	600 mm ± 10mm	600 mm ± 10mm	700 mm ± 10mm
Sleeper Spacing (Depot)	650 mm ± 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	
Rail Panel Lengths	Longer than 200m		
Minimum Radius of Curvature	200m-Underground 110m-Elevated 100m-Depot		
Minimum Turn out Radius.- (Main line)	1 in 9 - 300m radius 1 in 7- 190m radius		
Minimum Turn Out Radius Depot	1 in 7 - 190m radius		
Maximum Cant Permissible	110 mm		
Maximum Cant Desirable	110 mm		
Maximum Cant Deficiency Permissible	85mm		
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

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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 supplier shall supply WFL to satisfy climatic & environmental conditions as specified in section- 3.10 & 3.11 of ERTS given below:

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
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.
SO ₂ level in atmosphere	80 – 120 micro gram/m ³
Suspended particulate matter in atmosphere (TSPM)	360 – 540 micro gram/m ³
Flood Proofing	The traction sub-systems mounted on the under-frame will be designed to permit propulsion of the train at 10 kmph through water up to a depth of 50mm 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:

- a. 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.
- b. Any moisture condensation shall not lead to any malfunction or failure.
- c. 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.

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2.7. Principal notional vehicle dimensions

Description		Dimension
Gauge		1,435 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 at Car Centre Line		4,048 mm
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	Maximum	2400 mm
	Minimum	2200 mm
Distance between bogie centers	Maximum	15,100 mm
	Minimum	14,400 mm
Wheel diameters	New	860 mm
	Fully worn	780 mm
Maximum axle load		17 Ton (including all tolerances as per IEC 1133-1992)

2.8. Unclear aspects

If any term/clause/definition is unclear in this PTS or there is any conflict among the requirements of particular clauses of the PTS, ERTS and ERGS, the supplier shall seek clarification from design team in BEML prior to making 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 supplier

- a. The supplier shall be responsible for design, manufacture, supply and performance of WFL supplied to BEML. The responsibility of BEML as a contractor for WFL in MRS1 project as per requirements of GCC, ERGS & ERTS shall be obligatory for supplier.
- b. The supplier shall seek information from BEML for all interfaces between WFL and related equipments of bogie required by supplier for meeting design & performance requirements.
- c. The supplier shall provide BEML with all interface related information in detail as requested by other system/equipment manufacturer for interface compatibility, as & when required and in a time bound manner.

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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. The complete requirements are those found in the aforesaid documents. It shall be the supplier's responsibility to ensure that 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

3. Definitions and Abbreviations

3.1. Definitions

The following definitions shall be used as applicable:

- "Employer" means Delhi Metro Rail Corporation Limited (DMRC), its legal successors and assignees.
- "Engineer" means any person nominated or appointed from time to time by the Employer to act as Engineer for the purpose of the Contract and notified as such in writing to the Contractor.
- "Engineer's Representative" means any Assistant of the Engineer appointed from time to time by the Engineer
- "BEML" means the contractor to procure the WFL for MRS1 project.
- "Supplier /Supplier" means the supplier of WFL to BEML.

3.2. Abbreviations

The following abbreviations shall be used as applicable:

- GTC: General Terms & Conditions of Contract of BEML
- ERGS: Employer's Requirement General Specifications
- ERTS: Employer's Requirement Technical Specifications
- PTS: Procurement Technical Specifications of BEML
- MMRDA: Mumbai Metro Rail Development Authority
- DMRC: Delhi Metro Rail Corporation
- RAMS: Reliability, Availability, Maintainability & Safety
- LCC: Life Cycle Cost

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4. Qualifying Criteria & Vendor Approval

- a. Supplier should be a reputed OEM of the proposed aggregate for Metro Railway Rolling stock and should have capability to design & manufacture and testing & commissioning. Company profile and the infrastructure details shall be submitted by the supplier along with technical bid submission.
- b. The supplier shall meet the qualification criteria mentioned in ERTS 3.2.2 for supply of WFL. Proposed WFL 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.
- c. The supplier shall submit certificate of satisfactory performance & reliability from metro operators/end-users for a period of 3 years or more along with technical offer for proposed aggregates.
- d. The supplier shall provide all the required documents for obtaining the vendor approval for WFL as per the ERTS 3.2.5.
- e. The submissions for vendor approval may require further modifications, additional documents & updates based on BEML/Employer feedback. The supplier shall provide the same within 5-7 working days to BEML/Employer.
- f. The vendor approval format is attached as an enclosure (Appendix-3) to this document.
- g. Vendor approval is mandatory for all suppliers by Employer. Only approved vendors shall be considered for supplies. The acceptance of technical offer by BEML submitted by supplier is subject to approval of Employer.
- h. The supplier 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 supplier shall submit detailed proposal in this regard.
- i. The supplier shall undertake to provide complete details & information to BEML, for all such items in his proposed equipments/aggregates for which he is not an OEM.
- j. The supplier should give an undertaking to supply spares for a minimum period of 10 years from the date of last car supplied by BEML to DMRC.

5. Technical Requirements

5.1. General

The supplier shall be responsible for meeting all the technical requirement in PTS and for requesting all the required data for the WFL System.

5.2. ERTS requirements for WFL

The supplier shall provide compliance, as a minimum for the following clauses of ERTS:

Relevant clauses of chapter 1, 2, 3, 5.14, 10, 14.1, 14.2, 14.4, 14.6, 14.17, 14.18, 14.19, 14.20, 14.21, 15.2, 15.3, 15.6, 15.8, 15.10, 15.25, 15.26.

5.3. Technical Specification of WFL

The supplier shall meet the technical requirements as per section 5.14 of ERTS & following requirements as a minimum:

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The system requirements of the Wheel flange lubricator system shall be met, but not be limited to, for the following;

(a) Oil type Wheel flange lubricators of a proven design in EMU/ metro application shall be provided only at both driving ends of each train or Dry type Wheel Flange Lubricators on 50% axles of each train. The final decision shall be taken during design stage. A suitable mechanism shall be provided to ensure that lubricators operate only in the leading position on the train actuate suitably during traversing of the curves automatically and shall be effective for all wheels, the purpose of the WFL shall be to reduce wear of wheel and track/rail and reduce noise in the curves.

(b) The design of WFL system shall ensure precise & cyclic application of lubricant on the flange of the wheel(s) so that the lubrication application is uniformly distributed on the flange surface without any excess deposition on the contact surface. There shall be no flow of lubricant on the tread/braking surface under any circumstance. The system shall be designed to minimize oil and air consumption. Single tube system shall be preferred. The nozzles shall be designed to protect against choking /clogging due to dust. There shall be no movable part in the nozzle. The design shall permit optimized control of oil spray in straight and curved track by suitably modulating the spraying cycles and quantity of oil in the spray. The spray cycle as above shall be programmable and shall be fine tuned during field trials and performance of wheels during DLP. The programming tools shall be supplied to Employer (one set each line).

(c) The spray of oil shall be time controlled as well as distance controlled. The actuation and spray cycle and quantity shall be decided by the location and degree of the curve which shall be communicated to the system by a centrifugal force sensor, coordinates and parameters of curves informed by the vehicle or/and through GPS. Status of WFL shall be available in TCMS. It shall be possible to isolate the equipment through TCMS in case of any defect/malfunctioning.

(d) Supplier to note that the provision will be made in bogies to permit fitment of dry type flange lubricator up to 50% axles in a train.

(e) Supplier shall also include lubrication of flange back of both side wheels to prevent wear of wheel flange back and check rail.

(f) Rolling stock will provide compressed air and electrical power (110VDC -30%, +25%) to the WFL. The supplier shall provide the technical description of functioning and drawings of WFL system.

(g) WFL system shall be mounted on the leading axle of the leading bogie of DM cars. Supplier shall provide confirmation of effective functioning of WFL system for this arrangement.

(h) The lubricant tank shall have a definite volume which can be decided at detailed design stage. The supplier recommendation is expected on installation w.r.t mechanical interface (Mounting, Orientation of the tank, easy access for refilling, Interface with air supply system and electrical system). Provision for automatic filling shall be provided through a filling connection (plug, industrial quick closing coupling). Provision for lubricant level checking shall be provided.

(i) The supplier shall provide the details, dimensions and material used for inlet/outlet pipes, connections and fittings along with the hardware required for the equipment

(j) The lubricant applied by the spray nozzles to the wheel flange shall form a fine film

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with good adhesive properties. This film shall be passed on to the other wheels via the rail side and should not flung off at high speeds.

(k) Spray nozzles shall ensure lubrication of the wheel flanges even at high speeds, without soiling other components. Nozzles are to be designed in such a way that they can be adjusted in axial and radial direction.

(l) The supplier to provide complete technical details of the supporting components of the system like functional description, Space requirements, orientation and location of mounting & Interface details (Mechanical/Electrical) The Control equipment & Distribution Panels shall be designed with better protection levels and supplier to provide the details thereof. Main and auxiliary contacts of contactors / relays & solenoid valves shall be with adequate protection against dust ingress.

(m) Single tube system shall be ensured

(n) The system shall be fully programmable (ERTS 5.14) permitting combination of the operating modes and the spraying cycle shall be determined by distance or time or curve. Continues spraying of lubricant is not appropriate and should be replaced by cyclic lubrication.

(o) The supplier shall be responsible for meeting all the technical requirement in PTS and requesting all required data for wheel flange lubricator.

5.4. Coating System

- a. WFL shall be protected using an internationally accepted painting system proven in railway applications, which will protect the WFL from damage by corrosion in climate conditions prevailing in MRS1 project, for at least the period between major bogie overhauls without maintenance. The supplier 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).
- b. 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
- c. The machined surfaces shall be covered with anti-corrosive coat. The anti-corrosive coating plan shall be submitted to BEML for approval
- d. Colour of finish coat shall be decided by BEML/Employer before painting process
- e. The painting of all surfaces except machining surface shall follow below requirements:

	Nominal Value	Min Value	Max Value	Max Allowed
Primer coat	50µm	40 µm	80 µm	120 µm
Finish coat	50µm	40 µm	80 µm	120 µm

6. Interface Data

The wheel flange lubricator is required to interface with many variables on the Rolling Stock. BEML will be responsible for interface arrangement. However supplier shall

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be responsible to support BEML for interface arrangement and take lead, time to time whenever needed.

The supplier will provide BEML with all kinds of information in order to verify the interface with regard to mechanical and electrical between vehicle and the supplier's scope of supply.

Interface document and drawing made by the supplier shall include, but not limited to, the following interface information;

6.1. Mechanical Interface

The location of the mounting points and the design of equipment installation shall be defined by the Supplier and approved by BEML, in order to avoid the mechanical interference with other equipment. Supplier shall be responsible for confirming the mounting method and providing all materials for mounting the wheel flange lubricator as specified in the drawings.

BEML shall be responsible for defining the technical and the design constraints and the technical requirements. The Supplier shall be responsible for the optimum design of the WFL, the submission of design information (drawings, technical documents and 3 dimensional modelling data) and the execution of test & inspection in a timely manner without any delay. BEML/DMRC reserves the rights for approval and supplier shall provide required alterations in a time-bound manner.

Any changes in design shall be submitted in a timely manner to BEML/DMRC for approval. The Supplier shall have full responsibility to request and clarify if there is any required information or data from rolling stock and/or running/operating conditions, to prevent any design defect under revenue service in the main line.

The brief requirements of Mechanical Interface are as mentioned below

- Outline dimension.
- Electrical connection position.
- Routing and layout of piping connections
- Compressed air inlet position
- Fasteners, Fittings and Hardware (Standard, Size, Tightening Torque).
- Demands, free space for installation and maintenance.
- Weight and centre of gravity.
- Earth position.

6.2. Electrical/Communication Interface

The supplier shall provide the interface specification of wheel flange lubrication system. Time to time BEML will facilitate direct face to face meeting between other sub-system either at supplier's works, BEML works, other sub-supplier works. Supplier is responsible to resolve the interface issues to achieve the ERGS and ERTS requirement.

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The following is a brief of requirements for Electrical Interface

- Technical specification.
- Block diagram / System Architecture
- Power requirements.
- Rated current, voltage characteristic and power consumption.
- Connector (male and female) with pin and socket part no.
- Signal input/output list and interface specification.
- Connector/ terminal arrangement
- WFL system's schematic, wiring diagram & pin configuration diagrams.

7. Scope of Supply and Work

7.1. General

- a. The supplier shall supply wheel flange lubricator system with necessary subsidiary materials to ensure its functionality e.g. plug, protective coating/packing, sealant, etc.
- b. The supplier shall provide necessary documentation and relevant/suitable test procedures & reports to establish the efficacy of WFL which shall include tests on mainline with and without the usage of WFL. The data should be able to illustrate the reduction in wheel wear and squealing noise providing a comparison statistically.
- c. The supplier shall be solely responsible for suitability of his proposed aggregate for the environmental conditions as specified in this PTS & ERTS 2.1.
- d. The scope of work covers design, development, manufacture, supply, support during testing & commissioning and training of operation & maintenance personnel of the Employer and includes all items of work which are 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.
- e. The scope also covers supply of spares, special tools, testing and diagnostic equipment, jigs and fixtures for maintenance, repair and overhaul of wheel flange lubricator in sufficient quantities to meet the maintenance requirements. The supplier shall submit a separate offer for the same to BEML/DMRC, if asked.
- f. The supplier shall provide all the documentation and support material associated with the operation and maintenance of the WFL system for all the corridors.
- g. The supplier shall provide technical support during Commissioning & DLP and Defects Liability coverage until the completion of the warranty period, and rectifying the defects and deficiencies as communicated by the GC/DMRC.
- h. The supplier shall seek details from BEML and/or provide necessary information, for interfacing with other Designated Contractors who have either physical, functional or design interfaces with WFL equipment.
- i. The supplier shall provide training to engineers, operations and maintenance staff including providing the training materials, training kits and demonstration of equipment, if asked.
- j. The supplier shall provide final drawings, design calculations and other documents including operations and maintenance manuals for review and

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acceptance by the BEML/DMRC.

- k. The supplier shall provide supporting information including samples for design development items such as studies and reports if required by BEML/DMRC.
- l. The supplier shall provide documents as required by BEML/DMRC for obtaining approvals from the appropriate statutory authorities like RDSO, CMRS etc.
- m. The supplier shall comply with GTC, ERGS, PTS, TCMS ICD requirements and clauses of ERTS mentioned in section 5.2 of this document.

7.2. Hardware

The supplier shall be responsible for supplying WFL system with all necessary hardware/accessories (if any) required for meeting design functionality but not to be limited to, as the followings:.

- a. Wheel Flange Lubricator System: Supplier to provide complete BOM for each WFL system.
- b. Spare parts – If necessary, it will be separately contracted.
- c. Special tools and testing equipment – If necessary, it will be separately contracted
 - a. Feeler Gauge for Nozzle
 - b. Pneumatic Filling Pump
 - c. Programming tool (Software, Adaptor)
 - d. Operating Panel to be used in workshop for maintenance
 - e. Nozzle Alignment tool
- d. All mating connectors, contacts/pins etc. for carbody side wiring and necessary tools for crimping/pin extraction of the same for WFL unit shall be provided by supplier.
- e. Supplier shall submit the list of cable requirement at car side connections. Supplier shall supply if any special cables are required for WFL system.
- f. Equipment side connectors for Di-electric test – supplier shall supply connectors and its contacts as mounted on the equipments for each car-type (DM cars) to carry out the vehicle level voltage withstand test at BEML factory. Details shall be decided and finalised before first supplies.
- g. Fire retardant heat shrinkable Cable markers shall be provided for the wiring in WFL control unit. Also fire retardant heat shrinkable Clear Sleeves shall be provided over the Cable marker by WFL supplier to avoid fading of the cable marking.
- h. All cable terminations shall be of the crimped type. Soldered connections shall not be used.
- i. Gold contacts shall be used / provided for the signal cables by WFL supplier.

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7.3. Software (Relevant to Microprocessor Equipment)

Supplier shall supply necessary Programming tool (Software, Adaptor etc.) and provide training for editing the parameters, configuring etc.

Additional Software update for each equipment due to Employer's requirements shall be made up to DLP of trains by Supplier.

Supplier shall comply all software related clauses ERGS 6 and ERTS 14.14 etc.

7.4. Spare Parts, Special tools & Testing Equipments:

The supplier shall provide the list of Spare Parts, Special Tools and Test Equipment in line with ERGS chapter: 8 along with the offer separately and the same shall be exercised on requirement basis from DMRC.

Supplier shall provide the break-up of each modules/equipment in technical offer and commercial portion in commercial offer.

7.5. WFL qty per car (in nos.)

SL	DRAWING	DESCRIPTION	Qty/ DM	Qty/ M	Qty/ T	UNIT
1	525-81096	Wheel Flange Lubrication System (WFL)	1	-	-	No's
Spares requirement - GA1						
2	525-81068	Distributor, Flange Lubricator		4		No's
3	525-81069	Nozzle Flange Lubricator		16		No's
4	525-81073	Hose, Lubricator Flexible		16		No's
Spares requirement - GA5						
5	525-81094	Assembly and disassembly tools for WFL		2		Set
Spares requirement - GA3 & GA4						
6	525-81095	Kit for consumables and recommended spares		1		Set

Pricing for SI no:6 shall be given with necessary split-up giving detailed line items of recommended spares and consumables.

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7.6. Split of Responsibilities

- a. The supplier shall be primarily responsible for design and fitment of WFL and its sub components.
- b. The supplier shall be responsible for any design change within his scope of supply. The design change shall be done only after technical meeting with BEML/Employer under original contract rates & delivery schedule.
- c. The supplier shall send its engineer to BEML/Employer's designated place for technical meetings
- d. 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.
- e. Finalization of drawings or design documents may take considerable time from Employer end. Hence the supplier 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.
- f. The procedure for assembly & installation shall be provided by supplier to BEML in order to avoid any mechanical interference with other equipments/systems of the vehicle
- g. The supplier shall be responsible for providing all design documents, conducting type test & routine test, assembly of WFL to axles, finish painting , technical documentation, training (if any) and warranty against defects.
- h. The WFL drawings shall be approved by BEML/Employer before mass production is started.

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

7.7. Supply and fit Responsibility

No.	DESCRIPTION	BEML			Supplier		
		Design	Supply	Fit	Design	Supply	Fit
1	WFL Assembly				X	X	X
2	Mounting WFL			X1	X	X	X2
3	Paint				X	X	X

NOTE:

X: Designer, i.e. responsible for the design activity required for the specified element of the scope of supply including all calculation, analysis, drawing, documentation and testing connected with the design.

X1: Design Leader, i.e. responsible for supporting the designer by supplying of any relevant information required by the designer to produce a satisfactory design

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

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7.8. Design Responsibility

The supplier shall be responsible for design responsibility as described below.

No	Description	Details	Scope		Remarks
			BEML	Supplier	
1	Design	According to PTS		X	
2	Calculation documents	According to PTS		X	
3	Technical documentation	According to PTS		X	
3	Approval of drawing	According to PTS	X1	X	
4	Type & routine test	According to PTS		X	
5	Manufacturing	According to PTS		X	
7	Commissioning test	According to PTS	X	X1	
8	Manuals (Operation & maintenance)	According to PTS	X1	X	
9	Warranty for each components	According to PTS		X	

NOTE:

X: Designer, i.e. responsible for the design activity required for the specified element of the scope of supply including all calculation, analysis, drawing, documentation and testing connected with the design.

X1: Design Leader, i.e. responsible for supporting the designer by supply of any relevant information required to produce a satisfactory design.

7.9. Design Information

The supplier shall provide BEML with all necessary drawings, reports, calculations, specifications, technical data and similar documents of design, system assurance, manufacturing, test and training with respect to PTS, ERTS and ERGS according to the time schedule defined by BEML.

These drawings and documents shall be delivered in English language with the data format of, respectively, AutoCAD 2000, 3D model 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 clause 3.6 of ERGS.

The supplier shall request the interface information, which possibly affects performance, fitting and form, from BEML. The supplier shall comply, but not be limited to, with the Chapter 3 of ERTS.

7.10. Design Documents

The supplier shall comply with all the applicable clauses of this PTS and ERTS & ERGS.

The supplier shall provide BEML with all necessary drawings, reports, calculations, specifications, technical data and similar documents of design, system assurance,

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manufacturing, test and training with respect to PTS, ERTS and ERGS according to the time schedule defined by BEML.

- a. 3D model (catia /stp file)
- b. Detailed drawing in both dwg and pdf format.
- c. Interface data
- d. Standards applied
- e. Analysis & Calculation data.
- f. Natural frequency of the WFL system/Components.
- g. EMC/ EMI compliance
- h. Type test procedure, record sheet and type test report
- i. Routine test procedure, record sheet and report
- j. System description
- k. Certificate of conformity for the life of WFL
- l. Material certification
- m. O/M manual & spare parts catalogue
- n. Training manual of special tools & test equipment
- o. Training manual of WFL
- p. Manufacturing standard list
- q. Inspection instructions
- r. Delivery history

7.11. Testing

- a. The supplier shall carry out the type test and routine test of the WFL System. BEML and/or DMRC Representatives shall have the right to witness any or all of these tests at any stage of testing.
- b. All test procedures, type test reports including all corrective actions and checklists shall be submitted by the supplier and approved by BEML and/or DMRC Representatives. Test procedure submitted shall show all the safety aspects related to facilities of the proposed aggregates.
- c. The supplier shall prepare a test plan listing all tests to be performed, acceptable limits, pass/fail criteria etc along with scope of each test. After testing, the supplier shall submit a test report for BEML/DMRC approval.
- d. Any design changes, adjustments etc that are required to meet performance requirements, shall be fully re-tested, documented and implement the corrective action at no additional cost to BEML. Design changes if any, shall be subject to prior approval by BEML/DMRC.
- e. The supplier shall conduct product conformity testing on every supply to ensure that the equipment is functioning correctly as per performance/design requirements. The supplier shall submit test procedure for the same to be approved by BEML/DMRC.
- f. The vehicle level type test shall be done by BEML at designated depots of DMRC. In case any problems are encountered during the testing for items supplied by supplier, the supplier shall depute their expert in reasonable time for identification & rectification of root cause and shall provide full support to BEML for successful completion of testing & commissioning. Any cost associated in this regard shall be borne by supplier.
- g. BEML and/or GC/DMRC reserves the rights to witness any or all the First Article Inspection (FAI) under supplier's responsibility.
- h. In the event that any test fails, the supplier at his own expense and responsibility shall take corrective action as deemed necessary, such as, rectification,

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readjustment or design modifications to the satisfaction of BEML and/or DMRC, in order to meet the testing requirements.

- i. Only with the written consent of BEML/DMRC will type test or certification requirements be waived off. Nevertheless, if the type test should be carried out, the supplier at his own expense shall perform the type test which shall be witnessed by BEML/DMRC.
- j. In case Supplier seeks to waive off type test for such aggregates which are already type tested or certified for other projects of identical design, the supplier 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.

The Work tests for the WFL shall include, but not limited to the followings:

	Items	Type Test	Routine Test	Type Testing Schedule	Remarks
Inspection	Visual check	○	○	Approved by BEML	100%
	Dimension check	○	○	Approved by BEML	100%
	Weight check	○	○	Approved by BEML	100%
Electrical related Tests	Wiring check	○	○	Approved by BEML	100%
	Operating check	○	○	Approved by BEML	100%
	Insulation Resistance Test	○	○	Approved by BEML	100%
	Dielectric Test	○	○	Approved by BEML	100%
	Earth Continuity Test	○	○	Approved by BEML	100%
	Shock & Vibration Test	○	-	Approved by BEML	100%
	Dust Proof Test	○	-	Approved by BEML	100%
	Water Proof Test	○	-	Approved by BEML	100%
	EMC / EMI Test	○	-	Approved by BEML	100%
	Dry Heat Test	○	-	Approved by BEML	100%
Fire Performance Test	○	-	Approved by BEML	100%	

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	Earth Continuity Test	○	○	Approved by BEML	100%
Production test	Oil leakage test of Oil tank	○	○	Approved by BEML	100%
	Checking Sprayed Grease quantity of Oil tank	○	○	Approved by BEML	100%
	Air pressure test of Valve box	○	○	Approved by BEML	100%
	Air leakage test of Valve box	○	○	Approved by BEML	100%
	Vibration test of controller	○		Approved by BEML	
	Temperature test of pneumatic pump	○		Approved by BEML	
Combination test	Checking sprayed oil quantity	○		Approved by BEML	
	Voltage test	○		Approved by BEML	

7.11.1. Type Testing

The supplier 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 test procedure prepared by the supplier and approved by BEML and/or the DMRC / their representative. In addition, the supplier 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 DMRC / their representative. BEML and/or the DMRC / their representative reserve the right to witness all qualification tests.

After testing, the supplier 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 supplier expense. Equipment design changes shall be subject to prior approval by BEML and/or the DMRC / their representative.

7.11.2. First Article Inspection (FAI)

All components and assemblies shall be subject to a First Article Inspection (FAI) at the place of manufacture by BEML and/or DMRC representative prior to the delivery.

7.11.3. Routine Test for WFL

The supplier shall be responsible for the routine test of the WFL system. During the test, the criteria shall be observed and recorded. Copies of the routine test records shall be submitted.

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Additional copies of records of all tests / inspections result shall also be held at the supplier work to be made available to BEML and/or DMRC/ their representative on demand.

This test basically shall include, visual inspection and dimensional inspection but not be limited. The details of the test shall be defined by the supplier.

7.12. Handing over of WFL

The supplier shall hand over the WFL system to BEML in accordance with the delivery schedule of BEML.

The supplier shall provide the instruction for proper storage, handling and logistic function of components supplied by him, two month before handing over the first shipment of the WFL.

The supplier shall comply, but not be limited to, with the Chapter 13 of ERGS.

7.13. Operation and Maintenance Manual & spare parts catalogue

The supplier shall provide all the requirements specified in the PTS with respect to Operation and Maintenance Manual (O&M manual) and spare parts catalogue.

The O&M manual and spare parts catalogue shall be provided for approval according to the time schedule defined by BEML in compliance with chapter 8 and 12 of ERGS respectively.

The supplier shall deliver one original and 5 coloured copy each of the final O&M manuals in English and two copies of electronic files.

The supplier shall comply, but not be limited to ERGS Chapter 6.

7.14. Material & Workmanship

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

The requirements for material and workmanship of the WFL system shall be met, but not be limited to the applicable clauses of Chapter 14 of ERTS.

8. Training Needs

The supplier shall meet training requirements as specified in this PTS and chapter-9 of ERGS.

9. Warranty

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

10. Delivery

- a. The supplier shall deliver proposed aggregates as per delivery schedule agreed by BEML.
- b. The supplier shall provide instructions for proper storage, handling and logistics of components two month before handing over the first shipment of the WFL.

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- c. The supplier shall pack & deliver the WFL suitably to avoid any damage during transit/transportation.
- d. The O&M manuals shall be supplied one month before the first supply of WFL to BEML.

11. Quality

All works for the WFL shall be executed and controlled by a quality management system, in accordance with relevant standard. The supplier shall comply with ERGS 2.6 & ERTS 2.3 to a minimum.

11.1. Quality System Requirements

The supplier shall have relevant quality certification and shall manufacture the product accordingly. The supplier shall maintain and perform his internal management plans for the following:

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

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

11.2. Quality Assurance Plan (QAP)

The supplier 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:

- a. Process Control
- b. Purchasing
- c. Quality Audit
- d. Inspection and Test Plan (ITP)
- e. Quality Record
- f. Design Control
- g. Nonconformity control
- h. Inspection and Test procedure

11.3. 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:

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

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- g. BEML will designate Witness/Hold point of BEML and/or Employer/his Representative and notify it to the Supplier.

11.4. Quality Audit

The supplier shall develop a quality audit program in accordance with the relevant Quality System and submit to BEML for information. The supplier 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.

12. Project Management Plan

Along with the technical offer, the supplier 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. A diagram showing the organisational 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 organisations 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.
- b. The names, qualifications, positions and current resumes of key executive, supervisory and engineering staff to be employed full-time for the works.
- c. A narrative describing the sequence, nature and inter-relationship of the main contract activities including timing for exchange of information.
- d. Procedure for documentation control.
- e. The supplier 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.
- f. The proposed project manager shall be the employee of the supplier. The CV of the Project Manager shall be submitted along with the technical offer.
- g. To fulfil the supplier's obligations during the testing and commissioning and the DLP, the supplier shall nominate experienced maintenance engineers and organise deployment before undertaking testing and commissioning in depots. Separate maintenance engineer shall be positioned in each depot.
- h. The supplier 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

13. RAMS Requirements

The supplier shall comply in every aspect with the requirements of RAMS as per section 2.7 to 2.13 of ERTS chapter-2 and section 2.8 of ERGS. During DLP, the values of the RAMS target shall be calculated from the records of all faults and service failures. In the event that the target is not achieved, the supplier shall, at his own expense, take whatever action necessary to meet the target specified. The supplier shall comply with, but not limited to, the following ERTS requirements:

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13.1. Reliability Requirements

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

- a. 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
- b. 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

13.2. Reliability Analysis

- a. The reliability data shall be based on actual operating information of the equipment.
- b. The supplier shall submit a list of typical train withdrawal scenarios for review and acceptance by BEML. The list shall include all anticipated failure scenarios, which can affect safety, punctuality and passenger comfort. Also, a list of typical train withdrawal scenarios should be based on the reliability analysis.
- c. The reliability block diagrams and prediction of reliability performance shall be submitted to BEML for acceptance in the format, parameters & units as desired by the Employer
- d. The reliability block diagrams shall include all elements essential for successful performance of the system and their inter-relationship & interface.
- e. The supplier shall submit reliability prediction to demonstrate by quantitative methods, the achievement of the specified levels of reliability for the scope of supply.

13.3. Reliability Target

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

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

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

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 WFL 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:

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

Where,

Mean Distance Between Component Failures (MDBCF): The MDBCF of a system is

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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.

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

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. 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:
- b. A fault in an equipment or sub-system while operating within its design and environmental specification limits;
- c. Improper operation, maintenance, or testing of the item as a result of the subcontractor supplied documentation.
- d. 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:

- a. 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:
- b. Non-availability of the train to start revenue service after successful completion of pre-departure checkout.
- c. Withdrawal of the train from revenue services.
- d. A delay equivalent to or exceeding 3 minutes from the Schedule / Time table as noted at the destination station for the one way trip.
- e. 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:

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

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13.4. Maintainability Requirements

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

- a. The design of all components will be such that maintenance is reduced to a minimum, substantially improving service intervals.
- b. 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.
- c. 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 expended during a time interval to the total number of relevant failures.
- d. The supplier 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.
- e. The procedures used in the demonstration shall be the same as those included in the maintenance manuals submitted.
- f. The supplier shall submit the list of required spares, consumable spares, tools etc for such demonstration
- g. The supplier shall support an active supply for high availability.
- h. The supplier shall comply with procedure of BEML for fault rectification. If some failure needs the supplier's support, the supplier shall depute the engineer in the earliest possible time.
- i. The supplier shall provide training/requisite knowledge to BEML maintenance staff if any, needed at the time of maintenance.

13.5. Maintenance interval

The proposed WFL shall have obtained enough performance and durability to achieve the following inspection period of train set without an additional maintenance & equipment change.

Maintenance Type	Maintenance Interval (Service time or Running Distance)
A Service Check	15 days or 6,000km
B1 Service Check	45 days or 18,000km
B4 Service Check	180 days or 72,000km
B8 Service Check	360 days or 150,000 km
Intermediate Overhaul	Minimum 4 years or 600,000km
Periodic Overhaul	Minimum 8 years or 1200,000 km

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

13.6. Maintainability Target

The LRU replacement should be less than 30 minutes. MTTR in corrective maintenance operation that requires lifting of cars shall be less than 6 hours and 4

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hours if lifting of car is not required (ERTS 2.12.12 table 2.5). Proposed MTTR for WFL & coupling is 4.2hrs.

13.7. Master Maintenance Schedule

- a. The master maintenance schedule shall be provided stating clearly the parts needing attention in service checks and major overhauls.
- b. The supplier 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.
- c. The master maintenance schedule should be incorporated in maintenance manual and supplier shall provide the relevant chapter reference in maintenance manual against the each maintenance task in master maintenance schedule.

13.8. Life Cycle Costs (LCC)

The supplier shall provide equipment that has minimum total LCC. The supplier 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 supplier.

13.9. Reliability and Maintainability (R&M) Demonstrations

- a. 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 defects liability period.
- b. Reliability of the trains and of the identified major systems will be demonstrated on fleet basis. Accordingly, the subcontractor shall be required to demonstrate compliance with specified equipment reliability.
- c. During Defects Liability Period, the values of the R&M target shall be calculated from the records of all faults and service failures. In the event that the R&M target is not achieved, the subcontractor shall, at his own expense, take whatever corrective action to meet the R&M target specified, either by way of change of design of the relevant equipment/ component or software modification.
- d. 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.
- e. Correction shall be made to components or subsystems that either fail to attain predicted reliability levels or show Pattern Failure, at supplier's own cost.
- f. At the supplier cost, in depot at Mumbai, in coordination with BEML, the suppliers shall demonstrate the maintainability for Periodic Overhaul, Intermediate Overhaul, LRU Replacement and Corrective Maintenance with car lifting and without car lifting.
- g. The procedures used in the demonstration shall be the same as those included in the manuals delivered and the supplier is required to submit the list of required spares, consumable spares and tools for the Maintainability Demonstration.
- h. The subcontractor shall support an active supply for high availability. If some failure needs supplier's support, the supplier shall depute his engineer as soon as possible. The supplier shall provide requisite training to maintenance personnel of Employer/BEML team for the same if needed.

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13.10. Safety Requirements

The supplier shall comply with ERGS 2.7 & ERTS 2.4 for system safety assurance. The safety assurance program for the WFL shall be consistent with the assurance program of the overall rolling stock and covers design, manufacture, testing & commissioning. The supplier 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 completely eliminated.

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

- a. System Safety assurance plan as per ERTS 2.4
- b. Hazard analysis including preliminary & sub-system hazard analysis, operation & support hazard analysis and interface hazard analysis as per ERTS 2.5.
- c. FMECA (Failure Mode, Effects and Criticality Analysis)
- d. Quantitative Fault Tree Analysis (FTA) for Safety Critical Events

13.11. RAMS Deliverables

The supplier shall submit the following RAMS Deliverables.

- a. RAMS Plan during preliminary design
- b. Product breakdown structure during preliminary design stage
- c. Reliability analysis with train withdrawal scenarios as per Appendix-TG of ERTS
- d. Reliability block diagram & reliability prediction during pre-final design stage
- e. Hazard analysis including PHA, sub-system hazard analysis, operating & support hazard analysis and interface hazard analysis during pre-final design stage
- f. Preventive and corrective maintenance analysis during pre-final design stage.
- g. Master maintenance schedule during pre-final design stage
- h. FMECA (Failure Mode, Effects and Criticality Analysis) during pre-final Design Stage
- i. LRU list during pre-final design stage
- j. Safety FTA during final design Stage
- k. Life Cycle Cost (LCC) Analysis during final design Stage

14. Fire safety

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

14.1. Material Properties

- a. 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
- b. 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.
- c. The supplier 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.

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14.2. Fire Load Calculation

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

14.3. Fire Performance Deliverables

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

Sl	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

15. Noise Requirement

- a. The supplier shall devote particular attention to the design of equipment to obtain quiet operation and shall ensure that he specified noise & vibration levels are not exceeded.
- b. Vibration isolators, enclosures or baffles (silencers), acoustical absorption and other appropriate noise & vibration reduction methods shall be incorporated into the equipment design to adequately attenuate noise & vibration.
- c. The resonant frequency of the suspension system shall be designed to avoid coupling with the vehicle structure.

15.1. Specified Levels

The specified levels are stated in decibel (dB) with following reference values:

- Sound pressure levels-20 μ Pa (micro-Pascal)
- Sound power levels-1pW (pico-Watt)
- Velocity levels-1nm/s (nano-meter per second)
- Mobility level-1m/Ns

15.2. Test Conditions & Methods

Test shall be carried out using following standards:

- a. ISO 3740:1980, ISO 3741:1988, ISO 3742:1988, ISO 3743:1988, ISO 3744:1981; Determination of sound power levels of noise sources
- b. ISO 9614: Part-1 & 2; Determination of sound power levels of noise sources using sound intensity
- c. ISO 5348:1987; Mechanical vibration and shock- Mechanical mounting of accelerometer.

15.3. Resilient Mount

- a. Suspensions for vibrating equipment are to be designed to provide at least 95% reduction for all modes of vibration.
- b. Resilient mounting systems must be designed to withstand without damage or

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interruption of equipment function, the periodic momentary impact loads specified in the ERTS & this PTS, as may be associated with the hard coupling of cars, impacting large rail debris etc.

- c. The resilient mounts shall be arranged in a manner such that the equipment will be retained safely on the vehicle and may continue operation under all specified conditions stated in this PTS and ERTS in the event of a complete failure of the elastomeric material. Under such circumstance, the equipment must remain within the kinematic envelope, maintaining minimum clearance requirements.
- d. The supplier shall prepare and provide noise & vibration data and information on equipment to control noise levels of the complete train ensuring that the noise & vibration levels of the completed vehicle will meet BEML/Employer requirements.

16. Compliance for PTS, ERTS, ERGS & TCMS ICD requirements

- a. The supplier shall provide a valid and fully compliant proposal for the WFL as detailed in the ERTS, ERGS, TCMS ICD requirements and PTS.
- b. The supplier shall submit a detailed clause by clause commentary (CBC) on the relevant clauses of the ERTS, ERGS and PTS.
- c. Any clause of ERTS, ERGS, PTS and GTC for which no comments have been provided in CBC by the supplier shall be construed favourable to BEML/Employer.
- d. Supplier shall note that their comments in CBC shall only be of the following forms:
 - e. ***“Complied” shall be indicated by the supplier where the supplier is able to comply fully with the clause.***
 - f. ***“Noted” where a clause merely provides information and no other comment is necessary, “Noted” will suffice.***
 - g. ***Offers with non-compliance and deviations to any of PTS, ERTS & ERGS clauses are liable for rejection.***

17. Attachments

- a. MRS1 ERGS & ERTS
- b. TCMS interface Document (ICD) with WFL