1.0 Pre-Qualification Criteria:

1.1 The bidder should be a manufacturer/supplier of Roof Mounted Saloon HVAC for MEMU/EMU/Metros in India or any Railway system in the World.

1.2 The bidder should have supplied TCMS controlled Roof Mounted Saloon HVAC unit of minimum 7TR for MEMU/EMU/Metros in India or any Railway system in the World. Performance certificate for the HVAC system in bidder's name from end user shall be submitted.

1.3 The offered HVAC controller should be field proven and should have been supplied earlier by vendor as part of TCMS controlled saloon HVAC system. HVAC controller should have been connected via Ethernet to TCMS and communication should be bi-directional. Proof regarding the same shall be submitted.

1.4 Performance certificate submitted against Cl 1.2 above should pertain to Saloon HVAC unit with controller as per Cl 1.3 above.

1.5 The bidder should have supplied Saloon HVAC with interlaced Evaporator coil system for MEMU/EMU/Metros in India or any Railway system in the World. Proof of the same shall be submitted by the bidder.

1.6 For supplies made in India, bidder should be approved vendor of Indian Railways /Metro/RRTS.

1.7 The product should have valid type test certificate complying to relevant latest IEC and other standards mentioned in the Reference Technical Specification PS4452978 for rolling stock application on the date of submission of the tender. The vendor shall fully comply with the type and routine test & inspection clause in 3.13 of the technical specification PS4452978. The Purchaser has the right to ask to repeat the type tests either partially or fully if required, without any price implication to BHEL.

1.8 Those bidder(s) who are registered with BHEL/Railways (as the case may be) shall be considered for evaluation.
Bidders who are not registered with BHEL/Railways (as the case may be) can also quote in the tender. However, their credentials will be assessed for consideration in the tender before price bid opening, subject to meeting above PQC clauses.

2.0 Documents to be submitted:

All the relevant documents proof for points referred in 1.0 shall be submitted along with the tender.

Rev. 01 **PQC Updated for Saloon HVAC**		**Approved: Devanand**		
		Prepared: Piyush Arora	**Checked: Jagdish Shukla**	**Date:** 01.04.2024

Bharat Heavy Electricals Limited, Electronics Division, Mysore Road, Bengaluru

Purchase Specification no - PS4452978,REV.01

Item - HVAC SALOON

Vendor name - M/s

Price Format for Vande Bharat Train Sets

Sl. No.	Material Code	Item Description	Applicability (Yes/No)	Qty [A1]	UOM	Unit Rate [A2]	Cost per Rake [A3=A1*A2]	Total No. of Rakes [A4]	Total Qty for Supply [A1*A4]	Total Cost [A5=A3*A4]	Remarks
1	**-**	**Equipment cost**		**Per rake**		**in INR**	**in INR**	**in Nos.**	**Nos. / Set**	**in INR**	
1.1	PR2900000246	Basic Price per Set HVAC SALOON One SET of HVAC shall consist of following: i) RMPU type air conditioning system with mounting frames, air dampers, connectors & glands, inverter drives, smoke detector, bacteria kill device, CO2 level monitoriung, anti vibration pads/mounts with fasteners etc. - **2 Nos** ii) Cable entry box with EPDM/Glands - **2 Nos** iii) Microprocessor based controller unit alongwith protective devices, relays/contactors with connectors etc, pre-wired and mounted on suitable SS plate.- **1 No**	Yes	16	Set		0	32	512	0	
1.2		Freight & Insurance	Yes	16	Set		0	32	512		
								Total of sl no 1		0	
2		**Maintenance & Spares cost**									
2.1		AOH (1.5 Yrs) Spare Kit with consumables considering 6 years' consumption	No	-	-	-	-	-	-	-	
2.2		IOH (3 Yrs) Spare Kit with consumables considering 6 years' consumption	No	-	-	-	-	-	-	-	
2.3		POH (6 Yrs) Spare Kit with consumables considering 6 years' consumption	No	-	-	-	-	-	-	-	
2.4		Special Tool Kit (One time)	No	-	-	-	-	-	-	-	
2.5		AMC (It includes Man Power,Tools,Consumables and Testing equipments) for 4 (four) years post warranty period	Yes	1	Rake		0	2	2	0	
2.6		Spares for above mentioned AMC (for four year)	Yes	1	Rake		0	2	2	0	
								Total of sl no 2			
3		**Commissioning & Supervision of Erection**									
3.1		Commissioning & Supervision of Erection of Prototype Rake	No	-	-	-	-	-	-	-	
3.2		Commissioning & Supervision of Erection of All Rakes (Including Prototype)	Yes	1	Rake			32	32	0	
							Total estimated Price				

Note -

1. Any item required for functional integrity and commisioning of the item/system and not considered above shall be provided by the bidder without any cost implication to BHEL.
2. Bidder shall quote as per the quantities mentioned in this table only. Quantities mentioned in the specification are for reference purpose.
3. Tender evaluation shall be done on the total of sl. no. 1, 2 & 3. Purchase Order for Items in sl. no. 2 may be placed separately.
4. Each rake consists of 16 coaches.

	BHARAT HEAVY ELECTRICALS LIMITED ELECTRONICS DIVISION TRACTION Mysore Road, Bangalore	DOC. NO: PS4452978 REV. NO: 01 PAGE: 1 OF 45

	CUSTOMER/ CONSULTANT	BHEL/INDIAN RAILWAYS
	PROJECT	Manufacturing cum Maintenance of Vande Bharat Trainsets_VB_80 Rakes

PURCHASE SPECIFICATION
SALOON HVAC_VANDE BHARAT

01	22.02.24	Piyush	Jagdish	V.Devanand	Doc. Updated as per corrigendum
Rev No. 00	**Date**	**Altered**	**Checked**	**Approved**	**REVISION DETAILS**

APPROVED
V.Devanand

Issued By:
Traction Engg. Dept
BHEL-EDN

PREPARED	CHECKED	DATE
Piyush Arora	Jagdish Shukla	18.01.2024

Table of Contents:

SECTION – 1

SCOPE, QUANTITIES & ELIGIBILITY

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Roof Mounted Heating, Ventilation & Air Conditioning (HVAC) System for trainset.

The equipment is required for the following project.

Name of the customer : BHEL/INDIAN RAILWAYS
Name of the Project : Manufacturing cum Maintenance of Vande Bharat Trainsets

The scope shall also include the followings:

The supply of complete documentation for approval of design, relevant drawings and calculations to the satisfaction of purchaser and RDSO / nominated agency and support documentation associated with the operation and maintenance of the equipment supplied.

The supplier shall submit list of equipment and facilities required for maintenance and overhaul of equipment offered.

1.2 Bill of material for Saloon AC system:

1 SET of HVAC will include following items:

Sl. No.	Description	Quantity (per Coach)	Remarks
1.	RMPU type AC system with mounting frames, air dampers, bellow less coupling with ducts, connectors & glands, Inverter drives, smoke detector, Bacteria kill device, CO_2 level monitoring, Anti vibration pads/mounts with fasteners etc.	02 No.	*The HVAC panel assembly shall be made of SS304*.
2.	Cable entry box with EPDM/Glands.	02 No.	*Box shall be of stainless steel material made of SS304 with IP 65 rating*.
3.	Microprocessor based controller unit along with protective devices, relays/contactors etc., pre-wired and mounted on suitable SS 304 plate.	1 No.	Dimension/mounting of plate to be finalized during detailed design stage.
4.	Complete mounting hardware.	1 set	All mounting hardware shall be

			Stainless steel (GRADE A2-70). Mounting details to be finalized during design stage in consultation with ICF/RDSO/Indian Railways.
5.	Other accessories, earth strips, set of mating electrical couplers/connections etc.	As reqd.	

For 16 car rake our requirement is 16 sets.

1.3 ELIGIBILITY CRITERIA

The Bidder should be a regular supplier to Indian Railway Projects and should have supplied the offered equipment for Indian Railways projects of 3 phase IGBT Based AC EMU/MEMU/ Metros/Trainsets operating in India.

1.4 CLAUSE BY CLAUSE COMPLIANCE

Vendor to submit clause by clause compliance to complete technical specification along with the technical bid.

1.5 REFERENCE SPECIFICATIONS

This purchase specification has the reference of Railway Specification No. ICF MD SPEC-398 Rev-01 dated: 05/11/2022.

SECTION – 2

TECHNICAL SPECIFICATION

2.1 TECHNICAL SPECIFICATION OF SALOON AC SYSTEM

(a) Technical Requirement:

1. All the Sleeper Cars including shall be air-conditioned. Two light weight roof mounted packaged unit (RMPU) type air conditioning units in each Car of train set shall be provided. Each packaged unit shall have two independent refrigerant circuits. The control of both the air-conditioning unit shall be performed by suitably designed single microprocessor controller.
2. It shall also be able to provide heating during winter through reverse cycle heating concept or alternate method based on suitability, proven technology, and better energy efficiency. The complete system shall have EER better than 7.0. No material shall be used in construction of air conditioning unit that is liable to be adversely affected by vibration, damp, rotting or growth of moulds. Only fire retardant material should be used.
3. The AC shall be provided with refrigeration system using R 407C refrigerant or any other eco-friendly HFC refrigerant having zero ozone depletion potential and A1 safety category as per ASHRAE standards.
4. One of the compressors in each RMPU shall have automatic capacity control through hot gas bypass system or through VVVF control to optimize the efficiency of RMPU. Reference list of Trains/Projects working in INDIA to be furnished for both the above system.
5. Type test protocol to be submitted by vendor for evaluation along with the offer.
6. The air conditioning units shall be fed from the 3 Phase 415 V AC supplied from auxiliary converter. Protective devices, relays/contactors shall be provided for protection against short circuit / overload / earth fault and to isolate the healthy air conditioning unit from the defective one.
7. The Air-conditioning package unit shall have adequate capacity to air condition the coach under the following conditions:

Summer condition	**Dry bulb**	**Wet bulb**	**% R.H**
Outside (dry summer)	50°C	25°C	-
Outside (wet summer)	40°C	28°C	-
Inside (dry and wet)	20-25°C	--	40-60%
Winter condition			
Outside	-10°C	--	--
Inside	17-21°C	--	--

The capacity of the RMPU shall be based on heat load calculation for the worst of the condition mentioned above.

8. The rating of RMPU shall however not to be less than 8 TR. However, vendor to perform the detailed thermal analysis/calculations and specify the tonnage of refrigeration (TR) to meet the cooling / heating requirements as per coach layouts (refer Annexure 1). Following tables shall be referred to perform the capacity calculations:

(a) Tentative Mechanical/dimensional details of the train car are indicated in table below.

Mechanical/Dimensional details	
Roof area (m2)	68.5
Sidewall area (each side) (m2)	41.9 (car with pantograph 40.48)
Sidewall area under windows (each side) (m2)	7.56
Floor area (m2)	68.5
Front area (both) (m2)	12.8
Gangway (right and left TOTAL) (m2)	4.7
Doors area (each side) (m2)	3.53
Windows area (each side)(m2)	10.4
Steel (Total) (m2)	15.09 (car with pantograph 14.25,10% of floor,5%roof and side walls are covered by steel).
Thermal details	
Roof k factor (W/m2.K)	0.772
Sidewall k factor (W/m2.K)	0.772
Floor k factor (W/m2.K)	0.957
Front k factor (W/m2.K)	0.772
Doors k factor (W/m2.K)	4.3
Windows k factor (W/m2.K)	2.25
Gangway k factor (W/m2.K)	5.0
Steel (W/m2.K)	5.82
Overall Train k factor	1.45-1.55

These values shall be validated during the performance trials.

600 CMH of Conditioned air per HVAC will be bleed into each vestibule area and will be exhausted through toilets with an extractor fan. Capacity of each extractor fan is 300 CMH.*There will be a pantry load of 7KW in each coach. Each coach will have four (4) toilet and one pantry in the vestibule area.*

(b) Approximate number of Passenger in each type of sleeper car coach *with electrical cabinet heat load and Coach light load (Cabinet in Vestibule Area) are indicated in table below.*

SL No.	Coach Type	No. of Passenger	*Electrical Cabinet Heat Load (KW)*	*Light load(KW)*
1	DTC (Driver Trailer Car), 3 Tier	34	*2*	*1*
2	MC1 (Motor Car), 2 Tier	48	*2*	*1*
3	MC2 (Motor Car), 3 Tier	70	*2*	*1*
4	TC (Trailer Car) (with Pantograph), 3 Tier	64	*2*	*1*
5	NDTC1 (Non Driver Trailer Car), 3 Tier	52	*2*	*1*
6	NDTC2 (Non Driver Trailer Car), 1st Class	24	*2*	*1*

9. RMPUs shall be capable of pre-cooling the coach up to 23°C without passenger, with fresh air dampers closed, lights and fans switched on after raising the inside temperature to 45°C in less than 45 minutes. Further, capacity should be adequate to cool the coach in extreme summer condition within 2 hours when the coach is fully occupied, which will be verified by conducting pull down test on prototype rake/ coach (RDSO test program No.: ELPS/TP/AC/01 may be referred for guidance).
10. In the event of failure of one RMPU, the second RMPU shall cater 60% of the total air-conditioning load of the Car.
11. The single RMPU shall be able to work even with one condenser fan and the cooling capacity so obtained shall not be less than 75% of the rated capacity of the said RMPU.
12. All the equipment shall be capable of continuous operations without detriment to the operation of cut-outs and circuit breaker or over load, as per the environmental conditions mentioned in Clause no. 3.5 of Section-3 of this Specification.
13. The minimum fresh air quantities shall not be less than 0.25 m^3 / minute /person for all types of Cars. The air-flow parameters shall be as per ASHRAE /EN13129:2016.
14. On all the cars (except TC), the HVAC shall be positioned at the end of the car. In TC Car one of the AC Unit shall be placed after HV Equipment.
15. Instead of the horizontal air entry/exits of the classical Vande Bharat Trains, the new configuration need vertical aeraulic interfaces for both supply air and recirculation. The HVAC unit shall have aeraulic interfaces directly above the air channel.The area of the interfaces shall be sized accordingly. (refer Annexure 2)
16. The air duct is system is composed of two supply air ducts on the side, and one central recirculation duct. Furthermore, there are 4 extractors fan on the 4 toilets and one on the pantry, that are used to extract the odour from the enclosed ambient.
17. Noise level inside the car (passenger area) shall not exceed 65 Db(A) when stationary and shall not exceed 70 db(A) at maximum service speed with HVAC operating at its greatest noise. The Supplier shall associate with Purchaser at the design stage with regard to the interface requirement to minimize the noise levels.
18. The compressors suitable for traction environment, shall only be used and it shall have adequate capacity at 55°C condensing temperature & 5°C evaporating temperature. One of the compressors in each RMPU shall have automatic capacity control through hot gas bypass system or through VVVF control to optimize the efficiency of RMPU. The refrigerant evaporator unit shall comprise of cooling unit with automatic thermostatic expansion valve. Suitable arrangement for drainage of condensate water shall be made so that water does not come inside the Car and does not fall on couplers, gangways, platforms or any other equipment.

19. Each air conditioning unit shall be constructed as an integral module to enable removal from the Car as single complete item without the necessity to break any refrigerant lines or any part of Car or unit itself. All electrical connections and condensate outlets shall be fitted with standard quick heavy duty disconnect fittings. The connectors should be so positioned to ensure that it is not damaged when the air conditioning unit is removed from the Car and placed on a flat surface. Connectors shall conform to DIN EN 175301-801.
20. All fresh air intake shall be filtered and the air filter elements shall be cleanable and shall not be of disposable type. The Supplier shall use a filtration system suitable for Indian conditions requiring minimum attention/cleaning/maintenance. Suitable device to indicate the pressure drop shall be installed so that filters can be replaced/cleaned after getting necessary indication for the same.
21. Thermal comfort based Microprocessor controller shall be used for air conditioning system. However, in case of failure of microprocessor-based controller, it shall be possible to run the system with full capacity in manual mode with all major protections intact. The link between the microprocessor and interfaced cards shall be established by means of serial bus system or any other superior means to ensure error free high speed data transmission. The control and monitoring function shall be implemented through software to reduce hardware and cables. The complete control panel along with microprocessor controller shall be accessible from inside the Car without any requirement of going on roof.
22. The microprocessor shall perform the task of fault diagnosis and display in addition to control task. It shall be a capable of monitoring the status of the equipment and faulty sensor/cables continuously and the occurrence of the faults. It shall also take appropriate action and wherever necessary, it shall shutdown the equipment. The faults shall be stored in the memory of microprocessor and it shall be possible to download the same using commercial available USB pen drive or laptop.
23. Various important parameters of the equipment as well as environmental data at the time of occurrence of the fault shall also be recorded. Application/diagnostic software tools as required for trouble shooting and analysis of the fault shall be provided. Adequate redundancy shall be built in the microprocessor.
24. In the event of failure of air-conditioning unit/units, harmful quantities of the refrigerant shall not be released inside the compartment.
25. In the event of the failure of air conditioning unit in a Car or failure of 415V power supply, an emergency ventilation shall operate automatically to admit fresh air directly into Car to maintain the required oxygen level in fully loaded Car, in accordance with ASHRAE. The fresh air intake shall not be less than 15 m^3 / hour / person under specified loading conditions. The emergency ventilation shall be fed from 110VDC supply with its dedicated inverter, which shall not employ 50 Hz transformer. As an alternative BLDC blower motors directly operating at 110 V DC will also be acceptable.
26. Superstructure shall be provided with ducting arrangement for discharge/exhaust of air. It shall be ensured that water does not enter in such arrangement during heavy rains striking at 45° opposite to the movement of the train running at 160 kmph or during Car washing. Design of connecting ducts along with outlets shall be developed in consultation with RDSO/ICF/IR.
27. The Blower shall be designed for pressure loss of 250 PA. CFD Analysis report for HVAC UNIT is to be provided by the vendor
28. The refrigeration system shall have two separate refrigerant circuit with interlaced Evaporator coils.

29. The HVAC will be on Ethernet network and shall be able to communicate with TCMS via TRDP protocol. *There shall be two Ethernet ports in the RMPU controller for dual homing communication with TCMS.The Vendor should provide ICD list of HVAC with reference to Safety, Healthiness and performance of the unit for communication with TCMS*
30. Outside smoke detection sensor, inside CO_2 level sensor and arrangement to provide bacteria free air into passenger area shall be provided by supplier.
31. Automatic control of fresh air and return air dampers of HVAC shall be provided.
32. Air conditioning of each coach and Fresh air and return air ducts should be controllable as per fire system requirement.
33. Suitable cable entry box with EPDM/glands for cable entries on roof shall be provided by supplier.
34. Suitable prewired control plate having microprocessor based controller along with protective devices (for short circuit / overload / earth fault and to isolate defective unit), relays/contactors shall be provided by vendor which shall be mounted in ECC panel. ECC (Electronic Control Cabinet) shall be available in each coach (except DTC cars). The Control plate shall get 415V 3phase supply and 110 DC supply from the ECC panel. Electrical scheme of Control plate shall also be submitted to BHEL by supplier. Dimension of prewired control plate shall be finalized during detail design stage.
35. Protection shall be designed in such a manner, that any fault in RMPU should not lead to fault in 415V 3phase supply and 110 DC supply obtained from ECC panel thereby avoiding tripping/damage of Aux converter (415 V)/battery Charger (DC Supply- 110V) or any other load connected to bus of 415 V 3 phase and 110 V DC supply of the train. Protection scheme in detail shall be submitted by supplier.
36. Required cables (Power and control) from Control panel to RMPU unit shall be provided by BHEL. However, all cable Glands/ Mating connectors (Harting or equivalent) and cable entry box shall be in supplier's scope.
37. In the event of detection of smoke outside the Train, an alarm shall be provided to the Driver/Guard. Damper for fresh air intake shall close automatically when outside smoke is detected. In the event of detection of a smoke/fire inside the car, the air conditioning system shall be controlled to minimize the spread of fire to promote the escape of passenger. Relevant interfacing between TCMS and RMPU shall be decided during detailed design engineering.
38. Design and manufacturing of RMPU type Air Conditioning System with complete assembly shall be in accordance with EN45545. The applicable Hazard level will be HL 3.
39. The design of RMPU shall facilitate easy maintenance even when rakes are placed for inspection/maintenance in washing lines.
40. Each Driving Car (Not in the driving cab) shall have provision for Centralized Coach Monitoring System (CCMS) (not in supplier's scope) for monitoring, recording and control of the air-conditioning and other faults e.g. power supply failure etc. CCMS shall monitor the following:

- Auto/bypassed mode working of Air Conditioning unit
- Temperature (return air, supply air temperature and ambient temperature)
- Pressure (Low pressure, High Pressure and Oil pressure in AC system)
- LP & HP tripping
- Compressor tripping
- AC motors tripping
- Other inputs and output information to be decided during design stage.

RMPU Supplier to ensure the availability of above details on the Train TCMS.

41. In Prototype rake, supervision of installation and commission shall be provided by supplier.
42. The vendor to furnish detailed description/procedure of the assembly, mounting and installation process of the Air Conditioning system. The vendor to also furnish any supporting circuit/block/connections diagram for placing Air Conditioning HVAC system in coach.
43. The offered HVAC unit shall be within the limits specified as per MMD of IRSOD-1D.
44. Mounting Arrangements:
    TENTATIVE OGA DRAWING IS UPDATED AND IS ATTACHED FOR REFERENCE AS PER ANNEXURE-A.

45. OTHER APPLICABLE STANDARDS
    In addition to the above mentioned technical requirements, the offered equipment must comply to relevant IECs/other applicable standards as per **Annexure-4**

46. TESTING AFTER COMMISSIONING
    Test on Air Conditioning system after commissioning on Car:
    (i) Verification of co-efficient of Performance
    (ii) Pre-cooling test.
    (iii) Pull down test

47. *The Air conditioning equipment should be tested according to the latest version of ANSI/ASHRAE standard 37 as per ASHRAE Guideline 23-20116.The Air conditioning equipment should be tested for shock and vibration as per IEC 61373 (latest version). Test shall be included in QAP*

2.1 EQUIPMENT TESTING

(1) Valid Type test report is to be submitted for the equipment along with offer, if the equipment is already type tested. In case, ultimate customer insists to repeat the type tests due to any reason, the type test shall be conducted again by the supplier, for which test procedure shall also be submitted by the supplier for approval before conducting the type test. In case ultimate customer desires to witness the type tests, the supplier shall have no objection. The supplier is required to quote for the type test charges if any, separately in commercial offer. These charges will be loaded in the equipment price at the time of final evaluation. If Type Test charges are not quoted separately in the commercial offer, then it will be presumed that offer is inclusive of type test charges and no extra payment will be done in case of type test conducted due to any reason.
(2) Supplier to submit Routine test certificates and inspection certificate of equipment as per QAP along with equipment.
(3) Type and routine test will also confirm to clause 3.11 of section 3 of technical specification.

2.2 DESIGN REQUIREMENTS TO BE PROVIDED BY SUPPLIER

Write-up/ description of each equipment	To be provided by Supplier
Datasheet of equipment	To be provided by Supplier
Circuit diagram, connection & wiring diagram, equipment drawing with mounting details, weights, center of gravity, etc. and any other relevant drawings.	To be provided by Supplier
Type test protocol & procedure/ Type test reports	Supplier to submit the complete reports of type test already conducted on the proposed/offered equipment. In case type test is required to be done, supplier to submit the detailed test procedures for approval.
Routine test protocol & procedure/ Routine test reports	Supplier to submit Routine test certificates and inspection certificate of equipment as per QAP along with equipment.
Details of proven design	To be provided by Supplier
Performance statement	To be provided by Supplier in the attached format.
Performance certificate	To be provided by Supplier in the attached format.
RDSO Approval letter (conforming to the latest RDSO spec as applicable)	To be provided by Supplier
Project specific AUTO CAD drawing-2D and 3D model	To be provided by Supplier after order placement
Project Specific Drawings in A3 size	To be provided by Supplier
Technical Manual	To be provided by Supplier
Installation, Operational and Maintenance Manual	To be provided by Supplier
MTBF/MDBF Values along with the method of calculation	To be provided by supplier
Quality assurance plan (QAP)	To be provided by supplier

SECTION – 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.1 GENERAL

This section stipulates the General Technical Requirements under the contract and forms an integral part of the Technical Specification. The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections and are not exclusive.

However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

The Train shall be Distributed Power type which shall have Driving Cabs on its both ends and shall be capable of running in either direction without the requirement for any change in its composition. Configuration of 16-car rake shall be two End Basic Units and two Middle Basic Units.

The configuration of Vande Bharat express (Trainsets) is as under (for reference):

DTC-MC-TC-MC-MC-TC-MC-NDTC-NDTC-MC-TC-MC-MC-TC-MC-DTC

Where,

DTC: Driving Trailer Coach

MC: Motor Coach

NDTC: Non-Driving Trailer Coach

TC: Trailer Coach

3.2 INSTRUCTION TO BIDDERS

The bidders shall submit the technical requirements, data and information as per the technical specification, provided in Section-2.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc. in English language, fully in conformity with the technical specification.

Whenever required, the bidder shall depute his technical experts to RDSO / nominated agency for design discussions and approval.

3.3 GENERAL DESIGN REQUIREMENTS

i) The stock fitted with the supplied equipment shall meet the operating, service conditions and performance requirements of this specification and shall be suitable for operating conditions on IR.

ii) All equipment shall be vandal proof and incorporate necessary anti-pilferage features without compromising aesthetics / maintainability.

iii) Notwithstanding the contents of this specification, the Supplier shall ensure that the equipment supplied by them is complete in all respect so as to achieve the efficient operation & optimum performance of the Train set.

iv) The equipment design shall incorporate all essential features necessary to yield high traffic use, low maintenance requirements, easy maintainability, high regeneration, high efficiency, light in weight, user & environment friendly and high reliability in train operation. The design shall also facilitate easy erection, inspection, maintenance and replacement of the sub-units/ assemblies of all the equipment.

v) The entire equipment shall be designed to ensure satisfactory and safe operation under the running conditions mentioned in this specification duly taking care of sudden variations in load, voltage etc. under abnormal working conditions due to faulty operation, short circuits & earth faults etc.

vi) Wherever applicable: Airflow inlet/ arrangement for forced cooled equipment shall be designed in such a way that cloth, polythene, papers etc., which may get sucked, either do not block the airflow or get removed during halts. Moreover, filter should be easily cleanable.

vii) All working parts of the control and auxiliary circuit specifically electronics and PCBs, shall be suitably covered to keep them free from moisture, mold growth and dust. The protection level shall be furnished by the Supplier during design approval.

viii) All the electrical equipment shall comply with the latest edition of governing IEC specifications unless otherwise specified. The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with the limits specified and the ambient conditions defined in the Specification.

ix) All equipment shall be adequately earthed, insulated, screened or enclosed. They shall be provided with essential interlocks & keys as may be adequate to ensure the protection of the equipment and the safety of those concerned with its operation and maintenance.

x) Wherever applicable: Supplier shall to the extent feasible employ the currently available lubricants/cooling oils in India. Full lubrication scheme and schedule for the equipment shall be submitted. If use of imported lubricants or cooling oil is inevitable, supplier shall furnish details of equivalent Indian lubricants/oil.

xi) Supplier shall submit 3D models of offered equipment including associated sub-assemblies, etc. in. stp formats.

xii) The design of the equipment shall be based on sound, proven and reliable engineering practices. The equipment used in different sub systems shall be of proven technology and design. The supplier shall submit the supportive document for each of the assembly/sub-assembly for its proven performance under the environmental conditions prevalent in India.

xiii) The supplier shall design the mounting arrangements suitable for coaches. The accessories for mounting the equipment shall be part of the scope of supply. The hardware for mounting, safety links for underslung equipment, the termination hardware also will be in the scope of supply for all equipment.

xiv) SOFTWARE (WHEREVER APPLICABLE)

a. Software shall be written in a structured manner and fully documented during all stages of its design and development. This shall meet the requirements of EN 50126-2: The specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 2, EN 50128: Railway Applications: Software for Railway Control and Protection Systems, and EN 50129: Safety-related Electronic Railway Control and Protection Systems.

b. The Supplier shall submit the values of parameters, list of fault messages, their environmental data, hierarchy of fault display, fault categorization, trouble shooting of each fault by way of Changes in parameters shall be demonstrated with their effect on the results.

c. Parametric changes shall be possible in the software in order to meet the future requirements. While listing out the values of various parameters, the Supplier must provide a range within which any change can be made without jeopardizing the functionality of the system. Supplier shall submit the licensed software to the purchaser.

d. Software shall be fine-tuned through simulations & real life working conditions based on the extensive trials, associating BHEL / user Railways before putting the rake in commercial services. As it requires, instrumentation and expertise of Software Design Professionals, software expert(s) of Supplier shall be based at the work place along with commissioning engineers so that all software related issues are expeditiously resolved before putting the rake into commercial service.

e. Quality and efficacy of trouble shooting manual, software tools and software documentation shall be validated during extensive field trials. Final version of these documents shall include the changes required based on the service trials, commercial service operation, experience of operating Railways.

f. All the changes, thereafter, in software shall be approved by RDSO / nominated agency in consultation with user Railways before actual implementation and the Supplier must give software release, which shall include brief description of the problem, earlier as well as modified logic, explanation, parametric changes etc. to the satisfaction of RDSO / nominated agency.

g. The Supplier shall submit Software Quality Plan for review before work commences on software design. The software quality plan shall clearly state the controls and practices used in the software life cycle from specification through to in-service operation.

h. Internal independent review, verification & testing, using real & synthetic data, shall be performed at the software module and system level. RDSO/ nominated agency / BHEL / user Railway may audit the Supplier against the **Software Quality Plan** at any stage during the Contract. The Supplier shall ensure that all software is fully de- bugged prior to the final review by RDSO/user Railway.

i. Sufficient software documentation shall be provided to give the full understanding of the software function, logics, parameters and operation. Documentation shall be complete, clear and concise, and include all modifications up to the final acceptance. Documentation shall clearly explain the software logics, associated parameters, include software block diagram showing signal flow, logic and hardware interfaces etc. A top level flow diagram and description of detailed operation shall be provided.

xv) Notwithstanding the contents of this specification, the supplier shall ensure that the equipment supplied by them is complete in all respect so as to enable the desired operation of the Train fitted with their equipment.

xvi) Supplier shall deliver the executable files of all developed software along with necessity tools to upload / download and carry out fault analysis.

3.4 INGRESS PROTECTION

i) All equipment shall be suitably protected from dust and water. As a minimum, equipment shall be sealed to the standards stated below:

Under frame & externally mounted equipment (other than traction/ auxiliary converter/Traction Motor)	IP65
Battery Box and Brake Chopper	IP20
Equipment mounted inside the Car body	IP54

ii) It may be necessary to protect some equipment to IP 67 in order to meet the requirements of Clause 3.5 of this Specification.

3.5 AMBIENT CONDITIONS / OPERATING CONDITIONS

The equipment shall be designed to work satisfactorily under following environmental conditions: -

Atmospheric temperature	Maximum temperature: 50 degrees Celsius Maximum touch temperature of metallic surface under the Sun: 75 degrees Celsius and in shade: 55 degrees Celsius Minimum temperature: - 10 degree Celsius
Humidity	100% saturation during rainy season
Solar radiation	1 kW/m2
Altitude	1000 meter above mean sea level
Rain fall	Very heavy and continuous rainfall in certain areas (up to 2500 mm during rainy season)
Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m3. In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system
Coastal area	Humid and salt laden atmosphere. The equipment shall function in accordance with this Specification when subjected continuously to a humid and salt laden atmosphere with maximum pH value as per IEC 60571, sulphate content of 7 mg per litre, maximum concentration of chlorine 6 mg per litres and maximum conductivity of 130 micro Siemens / cm.
Vibration	The vibration and shock levels recorded on various Sub-systems in existing Trains of IR are generally more than the limits given in IEC 61373 particularly at axle box, and traction motor. Accelerations over 50g have been recorded at axle box levels during run. Vibrations during wheel slips are of even higher magnitude. High level of vibrations above 30g have been measured at traction motor on IR's Trains, which increase up to 50g with worn gear- pinion.
Wind speed	High wind speed in certain areas, with wind pressure reaching 216 kg/m2 as per IS:875 Part 3(2015)
Flood level	The Train shall function in accordance with these Specifications and Standards in the event of flooding up to 203 mm above Rail Level as follows: • In the event of flooding at any level below Rail Level, the Train shall operate in full compliance with these Specifications and Standards.

	• In the event of flooding at a height between Rail Level and 203 mm above Rail Level, the Train shall operate in full compliance with these Specifications and Standards with the exception that it is permissible to restrict the operation of the Train to a maximum of 8 km/h. Allowance is to be made in addition for increase in the height of water level due to the "bow wave" effect of the Train passing through the water.
Flood Proofing of the under slung Equipment	Waterproofing test will be conducted on Traction and Auxiliary Converter by dipping them up to a height equivalent to 650 mm from rail level (under fully wheel worn condition) in stationary water for 12 hours. There should be no water ingress and Converters shall function normal after the test. Traction Motor with gearbox shall be tested for waterproofing as defined in clause 3.4.6.10.1 of specification ICF MD SPEC-398, issue status-01, rev 01. Other underslung equipment shall have IP protection as mentioned in clause 3.4 of this specification. However, even in case of flood levels more than the mentioned above, the equipment shall not get damaged and it should be possible to rejuvenate the equipment with minor attention without any adverse effect on their performance. Axle box shall be adequately flood proof.

3.6 STANDARDS

(a) The standards applicable and relevant to the complete Train and to the various Sub-systems and systems shall be:
- (i) IEC publications;
- (ii) EN;
- (iii) UIC;
- (iv) AAR;
- (v) IEEE;
- (vi) BS;
- (vii) RDSO specifications;
- (viii) ICF/RCF specifications;
- (ix) NF-F;
- (x) ORE;
- (xi) VDE;
- (xii) UL;
- (xiii) JIS
- (xiv) IS; and
- (xv) Any other standards referred to in this Schedule.

(b) In the event of any contradiction in the aforesaid standards, the following standards shall have priority in the order listed:

(i) Standards mentioned in these Specifications and Standards set forth herein;
(ii) EN/IEC/UIC/AAR and
(iii) IS.

(c) For avoidance of any doubt, in case of any conflict between the requirements of these standards, the stipulations of Specifications and Standards in this Schedule shall have precedence.

(d) The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with the limits specified and the ambient conditions defined in the Specification. Specified temperature rise of equipment shall be calculated after taking into account at least 25% choking of air filters and radiator fins etc.

3.7 ENGINEERING DATA

(a) The contactor shall necessarily submit all the drawings/ documents unless anything is waived. The contactor shall submit drawings/ design documents/ data/ test reports as may be required for the approval of the purchaser. All drawings submitted by the Manufacturer including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required, dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

(b) Each drawing submitted by the Manufacturer shall be clearly marked with the name of the Customer and Project, the unit designation, the specifications title, the specification number, date of revision (if any), duly signed by the concerned technical person. If standard catalogue pages are submitted, the applicable items shall be indicated therein and should be made project specific. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

(c) The title block of drawings shall contain the following information incorporated in all contract drawings

1. Customer : BHEL /Indian Railways
2. Project: Manufacturing cum Maintenance of Vande Bharat Trainsets
3.Contract No./LOA No./ Ref no.: 2022/RS(WTA)-527/Vande Bharat Trains/874/1 dated 14/06/23
4. Main Contractor : Bharat Heavy Electricals Limited

3.7.1 SIZE OF DRAWINGS

The drawings of the following parts shall be to the sizes indicated below

I. Equipment details – full size or half size
II. Motor Assemblies – 1:5
III. General Assemblies- 1:10

Further, the scaling of drawings should be as per applicable standards.

3.7.2 METHOD OF FILING OF DRAWINGS

To facilitate filing of drawings, it is essential that each drawing submitted for approval is marked so that it can be identified. The supplier is, therefore, required to ensure that all prints are marked legibly at the right hand bottom corner. The following information is required in respect of each drawing:

I. Supplier's drawing number.
II. Supplier's name and date of submission.
III. Contract no. given by the purchaser.
IV. Description of drawings.
V. Relevant Specifications

3.8 MARKING OF EQUIPMENT & RATING PLATE

(a) All main assemblies of the equipment shall bear serial number, year of manufacture and symbol/ identification of the purchaser. Where the sub- assemblies/components of the main assemblies are not inter-changeable, the sub-assemblies shall also be marked with the serial nos. of the main assembly of which they form a part.

(b) All equipment/cubicles shall contain non-detachable rating plates of anodized aluminium with embossed letters and fitted in a visible position. The rating plate will give detailed rating specification and identification of equipment.

3.9 INFRINGEMENT OF PATENT RIGHTS

BHEL and Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, components used in design, development and manufacturing of propulsion system & other equipment and any other factor which may be a cause such dispute. The responsibility to settle any issue lies with the manufacturer.

3.10 DOCUMENT SUBMISSIONS

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Purchaser would be discussed and finalized at the time of award. The following schedule shall be followed generally for approval:

Sl.no.	No. of copies	Schedule
i)	Initial Submission Drawings, Data sheets, Type test Reports	At the time of submission of offer.
ii)	Furnishing of drawings in hard / soft copy format	Approx 2 to 3 weeks from the date of award of contract.
iii)	Furnishing of type test reports in hard / soft copy format	Hard / soft copy to be submitted immediately after the completion of the test.
iv)	Furnishing of routine test reports	Hard / soft copy to be submitted immediately after the completion of the test.
v)	All documents including Installation, Operation & Maintenance manuals.	Approx 2 to 3 weeks from the date of award of contract.

3.11 QUALITY ASSURANCE PROGRAMME

(a) To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Manufacturer's Works or at his Sub-manufacturer's premises or at the Purchaser's site or at any other place of Work, are in accordance with the specifications, the Manufacturer shall adopt a suitable quality assurance program to control such activities at all points, as necessary. Such program shall be outlined by the Manufacturer and shall be finally accepted by the Purchaser

(b) A quality assurance program of the manufacturer shall generally cover the following:

I. Manufacturer's organization structure for the management and implementation of the proposed quality assurance program:
II. Documentation control system;
III. Qualification data of bidder's key personnel;
IV. The procedure for purchases of materials, parts components and selection of sub-Manufacturer's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
V. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
VI. Control of non-conforming items and system for corrective actions;
VII. Inspection and test procedure both for manufacture and field activities;
VIII. Control of calibration and testing of measuring instruments and field activities;
IX. System for indication and appraisal of inspection status;
X. System for quality audits;
XI. System for authorizing release of manufactured product to the Purchaser

XII. System for maintenance of records;

XIII. System for handling storage and delivery; and

XIV. A quality plan detailing out the specific quality control measures and Procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

(c) The Purchaser or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Manufacturer/'his vendor's quality management and control activities.

3.12 QUALITY ASSURANCE DOCUMENTS

The Manufacturer shall be required to submit the Quality Assurance Documents as stipulated in the quality plan at the time of purchaser's inspection of equipment/ material.

3.13 TYPE AND ROUTINE TESTING & INSPECTION

1. The individual prototype equipment, systems and sub- systems shall be type and routine tested in accordance with the relevant IEC/UIC/EN publications inclusive of the mandatory and optional tests along with the special tests as specified.

2. All type tests shall be conducted by Supplier or such other agency or person agreed by RDSO / Nominated Agency at the Supplier's cost where ever performed in presence of and to the satisfaction of RDSO/ Nominated Agency, who reserves the right to witness any or all of the tests. All tests set forth in this specification shall be conducted by the Supplier or other agency or competent person as agreed by the purchaser/ RDSO/ Nominated Agency.

3. RDSO / Nominated Agency may waive some of these tests in case of equipment/ sub-assemblies where the manufacturer can establish to the satisfaction of RDSO that such tests have already been carried out earlier. In such a case, manufacturer shall submit complete test reports along with necessary certification.

4. Wherever any equipment, system, sub system is not specifically covered by an international recognized specification or test procedure, the tests which are acceptable to both to Supplier and to the IR's representative shall be devised.

5. Without prejudice to any provisions of the contract, the purchaser reserves the right to witness any or all of the type tests and to require submission of any or all test specification and reports.

6. In case any bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

7. The Purchaser, his duly authorized representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractors premises or Works and shall have the power, at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Manufacturer shall obtain for the Engineer and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Manufacturer's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site as the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

8. Supplier to depute qualified person for supervision of installation and commissioning of the equipment in the prototype rake. During the prototype tests/trials of train, if a technical problem arises with the equipment, qualified supplier representative should be deputed to attend the same.

9. During the prototype tests/trials or service of train, if any problems arise or feedback information is obtained, which warrants a re-check of the design/manufacture/quality of the equipment and components, action will be taken as may be necessary by the Supplier to carry out the required investigations and to incorporate the improvements considered most appropriate to reach compliance with the specification without any extra costs to the Purchaser and in a manner approved by the RDSO/Nominated Agency on equipment/components already supplied as well as those to be supplied later.

10. The prototype rakes fitted with the supplied equipment, shall be subjected to pre-revenue service trials. Service trials are intended to prove the satisfactory running performance of the supplied Train set equipment and evaluate their reliability in service, ease of maintenance and operations. The performance of the equipment shall be assessed based on the experience gained during the service trials. Necessary modification as required and also as desired by the RDSO/ Nominated Agency / Indian Railway shall be implemented in the series production without any extra costs to the Purchaser.

11. **Type tests on electronic equipment and control electronics**

    The electronic equipment and Control Electronics shall be tested as per IEC 60571/EN50155, IEC 60068, EN 50121, IEC 60721-2-5 and IEC 61373 including both compulsory and optional tests. Dry heat test, as specified in IEC 60571, shall be conducted for testing power and control electronic equipment at 80 degrees Celsius. LCD display units shall be tested at 70°C.

3.14 MATERIALS AND WORKMANSHIP

Equipment materials and components shall be new, of high grade and good quality and be to the latest engineering practice. The material and workmanship throughout shall be in accordance with the purpose for which they are intended. Each component shall be designed to be consistent with its duty.

3.15 PACKING, STORAGE AND HANDLING INSTRUCTIONS

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. The manufacturer shall also submit packing details/ associated drawing for any equipment/ material before equipment dispatch.

All coated surfaces shall be protected against abrasions, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device.

Storage requirements shall be clearly defined by the supplier. Packing shall be such that if required, long time storage at site should not deteriorate the performance of the equipment.

3.16 FIRE PREVENTION

i) The design of equipment shall incorporate all measures to prevent fire, and will be such that should any fire take place, the effects shall be minimized and no spread of fire should take place. Materials that are not fire retardant shall not be used.

ii) Materials used in the manufacture of equipment shall be selected to reduce the heat load, rate of heat release, propensity to ignite, rate of flame spread, smoke emission and toxicity of combustion gases.

iii) The fire protection on Train shall be designed and constructed in accordance with EN 45545.The applicable Hazard level will be HL3.

iv) Contractor shall furnish the relevant data, fire load calculations, certifications etc. of the items considered in fire load calculations separately for Above & Below the floor level. The calculations and validation shall conform to the standard adopted by the contractor for fire strategy.

v) Relevant provisions stipulated in Central Electricity Authority (Measures related to Safety and Electric Supply) Regulations, 2010, shall be followed in the interest of safety of passenger/staff as well as for equipment / instruments provided in the coaches.

SECTION – 4
RELIABILITY, AVAILABILITY, MAINTAINABILITY AND SAFETY (RAMS)

4.1 KEY PERFORMANCE INDICATORS

Performance indicators comprises of Availability, Reliability and upkeep of Cars. The bidder must ensure RAMS parameters for the offered equipment and its sub-assemblies supplied to at least maintain the overall fleet availability and reliability targets given below. In case, fleet reliability drops on account of poor reliability of subassemblies supplied, the supplier will be required to improve the quality of subassemblies to match the availability & reliability targets.

a) Availability

Sum of Available Hours as a proportion of the total hours (Available Hours + Non-Available Hours) in the Fleet in any Accounting Year, shall be considered as “Availability”. Guaranteed Availability in every Accounting Year shall be at least 95%.

b) Reliability

Average Mean distance travelled between two Failures for the fleet in any Accounting Year shall be considered as “Reliability”. Guaranteed Reliability shall not be less than 200,000 km.

c) Upkeep

For the offered equipment, there shall be no such conditions during the operation of trains that affects the reliability, safety and passenger amenities. Any maintenance shall be conterminous with the train maintenance schedules as given in Cl 4.5 of this section.

List of Conditions affecting Upkeep (As applicable) is enclosed as Annexure-A of this section.

4.2 RELIABILITY AVAILABILITY MAINTAINABILITY AND SAFETY (RAMS)

a) The supplier shall ensure that, Guaranteed Reliability, Guaranteed Availability and High Degree of Safety in order to provide a dependable service, forms an integral element of the offered products.

b) The plan for Reliability, Availability, Maintainability and Safety shall conform to EN 50126/ IEC 61709/ IEC 62278. Reliability of electronic components shall conform to IEC 61709.

c) The supplier shall develop and provide RAMS targets (MTBF/MDBF/MTBSF) for the offered equipment both for the complete system and for the major Sub-systems at ambient temperature up to 50°C.

d) After rectification of any failure / fault, the concerned equipment / system should resume its original performance / function.

e) Components critical for safety shall fall into safe operating mode in case of malfunctioning. The system safety plan shall identify and list safety critical components and this list shall be updated periodically and intimate to the purchaser.

f) Supplier shall submit the basic maintenance schedules of the proposed equipment. Minimum interval between two maintenance schedules in the depot for the equipment supplied should not be less than 90 days except for activities which can be done outside the base depot (such as cleaning of filters mounted in the under-frame, for which the periodicity shall not be less than 15 days) and 3 years for major works in workshop/major depot. Average running distance of a rake may be considered as 2000 kilometer per day. Please refer Cl 4.5 below in respective planning of maintenance schedule for the supplied equipment.

g) All systems, components and structural areas serviced as part of inspection or periodic preventive maintenance shall be conveniently accessible for service and inspection.

4.3 RAMS DOCUMENTATION

Vendor shall agree to submit following documents pertaining to RAMS analysis:

- Functional breakdown + inherent failure analysis
- Mission critical failures Analysis (Fault Tree Analysis)
- FMECA (Failure Mode Effects and Criticality Analysis)
- System/Sub-Systems Hazard Analysis
- Hazard Log + SIL data (if applicable)
- List of critical components
- Preventive Maintenance Analysis
- Corrective Maintenance Analysis

4.4 SERVICE LIFE OF EQUIPMENT/SYSTEM

Vendor shall specify the service life of the offered equipment / system based on life cycle calculations after which the equipment / system shall call for complete replacement to maintain the required reliability & availability of fleet.

Annexure-A

List of Conditions affecting Upkeep of Trains.

S.No.	System name	Condition
1	Windscreen Wiper and Washer System	- Rainy weather, defective wiper in any cab.
2	Couplers (any type)	- Any mechanical/electrical/pneumatic fault and/or any dimensional misalignment and/or any damage to any part which does not allow the coupler to guarantee the fulfilment to its assigned mission, in accordance to the technical requirements, performance and safety set out in this specification.
3	Suspension	- Any defect in primary / secondary suspension resulting in passenger safety, comfort or performance.
4	Wheel	- If wheel flat is > 40 mm or as finalised in design. - Any abnormal hammering as reported by the TO.
5	Pantograph	- Isolation of any pantograph
6	Transformer	- Isolation of any one main transformer.
7	Battery charger	- Battery Charger of one unit isolated.
8	Mechanical drive system	- Any defect resulting in high temperature / isolation
9	Traction Motors	- Isolation of more than 25%motors.
10	Traction converters	- As per the consequential effect as defined in Item 10 above.
11	Main compressor unit	- Isolation of any Main Compressor Unit
12	Auxiliary converter-inverter	- Isolation of any Auxiliary Converter-Inverter unit.
13	Brake system (mechanical)	- If isolation of an additional bogie (mechanical) leads to speed restriction.
14	Exterior lights	- Failure of any head light / marker/tail light.
15	Driver's desk	- If master controller prevents the train from moving. - Any defect in master controller even if no delays are reported. - Any defective cab switch leading to unsafe operation.

16	TCMS & Vehicle circuits	- If HMI display fails & functionality is not transferred to redundant HMI. - Any failure in TCMS component / equipment /circuit element / software/communication system etc. resulting in loss of intended function. - Further cases will be included based on TCMS redundancy and configuration.
17	PIS & CCTV	- If both automatic and manual announcements fail - If announcements in Car is not audible - if ≥ 1 unit exterior side view CCTV not working - If >1 PEA in any car is defective - One saloon CCTV, including its backup if any, is isolated. - If ≥ 1 unit for rear cab and front cab camera, cameras on the roof
18	Passenger doors	- If ≥ 1 (one) door per train side is isolated.
19	HVAC (passenger area)	- Failure of any one HVAC in any car leading to increase in inside temperature ≥28^{0}C - Failure of two HVAC's in one car. - Noisy Air Conditioner: Interior Noise >+2dB than the one recorded and validated during the type test at standstill)
20	Ground fault in DC Circuit	- Train to be withdrawn in case of single ground fault if it leads to unsafe operation as per the design.
21	A failure or symptom which may endanger safe and/or normal operation of train	- Failure in safety interlock or protection circuit such as door loop - Abnormal noise in underframe - Wheel flat - Arcing in pantograph - Failure of emergency equipment - Failure which may disable train's push out duty. - Train which that requires more than 2 instances of reset within 30 minutes - Jerky movement (The details shall be finalized in design stage). - Others to be decided during design stage

Note: *The above list shall be further reviewed and updated during design stage.*

4.5 TRAIN MAINTENANCE SCHEDULE (TENTATIVE)

Sl. No.	Schedule	Place of maintenance	Permissible time per schedule	Periodicity
1	Minor maintenance	Light maintenance at Depot	8 hours	3 months
2	AOH	Light maintenance at Depot	7 days	18 months
3	IOH	Heavy maintenance at Depot	10 days	36 months
4	POH	Heavy maintenance at Depot	20 days	72 months

SECTION -5

SPARES AND CONSUMABLES FOR MAINTENANCE

5.1 SPARES AND CONSUMABLES

i) Supplier shall provide complete list of items/materials which get consumed during normal course of operation of the Train as applicable for the equipment/system (the **"Consumables"**).

ii) Supplier shall provide complete list of parts or equipment/system ensuring fleet availability of 95% or better, which would be necessary for efficient operation and maintenance of the (the **"Spares")**.

iii) Supplier shall provide detailed spare parts catalogue / data-sheet listing all components manufactured or purchased by the supplier along with their rating, source, type / model no., schematic, position, etc.

iv) Price for above spares and consumables to be shared separately as part of commercial offer.

5.2 SCHEDULED MAINTENANCE

a) Scheduled (Preventive) maintenance consists of operations to maintain an assembly/subassembly or components in its specific operating conditions by performing:

   i) periodical inspection and diagnostic tests for prevention of malfunctioning.
   ii) scheduled replacement of components.
   iii) checks to be performed at specified time intervals, whose outcome determines whether or not replacements will be required.
   iv) routine operations, such as filling, topping up, change oil, greasing, adjustments, etc.
   v) general overhaul of systems and subsystems.

b) The preventive maintenance schedules required to keep the supplied system in good fettle with requisite reliability and availability would be coterminous with the train maintenance schedules and it should be possible to comfortably complete such maintenance during the time provided for respective train maintenance schedule and in the facility provided (refer Chapter Reliability, Availability, Maintainability and Safety).

c) Details of Schedule of Periodic / preventive maintenance (the **"Scheduled maintenance")** shall be submitted in following sample format:

Nature of inspection / maintenance	Periodicity / Interval	Items to be replaced

d) Scheduled Maintenance shall ordinarily not be required before a travel of 40,000 km (forty thousand kilometres).
e) Supplier shall provide plan / activities for periodical inspection and diagnostic test for prevention of malfunctioning
f) List of facilities including tools & tackles required for carrying out all scheduled maintenance activities to be provided by vendor.
g) All systems, components and structural areas serviced as part of inspection or periodic preventive maintenance shall be conveniently accessible for service and inspection.

5.3 UNSCHEDULED MAINTENANCE

Unscheduled (Corrective) maintenance consists of maintenance operation which is not scheduled (part of preventive maintenance) as a result of an in-service failure.

The supplier shall be required to provide repair & maintenance instructions to put back the equipment / system back in service.

List of facilities including tools & tackles required for carrying out all unscheduled maintenance activities to be provided by vendor.

5.4 EPIDEMIC DEFECT WARRANTY

(a) If any identical defect or deficiency affecting Safety, Reliability and Availability of the trains on more than 20% (twenty per cent) of equipment or parts in any rolling period of 36 (thirty-six) months commencing from the second Year of the Supply Period, such defect or deficiency shall be deemed to be an epidemic defect (the "Epidemic Defect") and the supplier shall cover such Epidemic Defect under an epidemic defect warranty.

(b) In case, the Government (Railways) notifies an Epidemic Defect on account of the supplied assembly, the supplier shall remedy such Epidemic Defect on all such Trains where equipment or parts of that particular design or lot are provided, subject to limitation of period elapsed since commissioning as mentioned above in this para.

5.5 OPERATION AND MAINTENANCE MANUAL

i) Supplier shall provide an operation manual (the "Operation Manual") for the offered equipment / system in soft copy format in English and Hindi language. The Operation Manual shall include (but not limited to):

a) Instructions for troubleshooting;
b) Rating and layout of equipment;
c) Operating limits of installed systems;
d) Control and safety features of the Equipment/System;
e) Instructions to Loco Pilots for operation of the Train (if applicable);
f) Do's and don'ts for Loco Pilots (if applicable);
g) Safety precautions to be taken by the Loco Pilots (if applicable);

ii) The Maintenance Manual to be provided by supplier shall include:

(a) All maintenance activities and their periodicities that are required to keep the Train safe and ensure that the prescribed tolerances of systems and components are not exceeded at any time, including any systems relevant to the maximum moving dimensions;
(b) The inspection program for regularly checking that the Train is safe to continuing in service;
(c) Assembly & disassembly sequences for the supplies with pictorial playbook guide
(d) The engineering facilities (such as pit facilities, special tools etc.) necessary for the mandated maintenance;
(e) Minimum competencies required by staff for the maintenance activities.

iii) The Maintenance Manual shall ensure that safety critical systems and components on the Train are identified specifically and the minimum testing requirements that must be invoked in the event of their disturbance at examination or repair are defined.

iv) Preparation of the Maintenance Manual shall give consideration to inspections, tests and maintenance of the following that have a bearing on safety:

(a) inter-vehicular couplers.
(b) fire prevention system including safe working of pantry/ sub pantry equipment.
(c) Auxiliary electrical machines: Integrity and security, earthing condition and integrity, condition of safety labelling.
(d) Passenger Information System
(e) Cleaning: Ventilation ducts, filters, bogies and underframe equipment
(f) Power systems (including protection systems): Integrity and security earthing condition and integrity, condition of safety labelling.
(g) Pantographs: Integrity and security - dimensions and condition of pantograph head, over-height protection, earthing condition and integrity, condition of safety labelling.
(h) Train structures and underframes: Integrity and condition of all load bearing members or panels, integrity, operation and security of doors, openable and removable panels, integrity and security of all body mounted equipment, alignment, gangway.
(i) Safety systems (e.g. Vigilance control device): Functional tests;
(j) Hydraulic and pneumatic systems: Condition and integrity of hoses, pipework, valves, etc.
(k) Fire protection systems: Integrity and condition.
(l) Lighting Systems & Visibility: Headlight, flasher and marker lights, adjustment, intensity
(m) Speedometers; headlights and marker lights; horn; doors; cattle guard; and bio-vacuum toilets

(v) The instructions within the Maintenance Manuals shall be such as to protect staff working on the Trains, with particular reference to safety precautions and implementing a specified safety condition of the Train prior to starting work.

5.6 OBSOLESCENCE MANAGEMENT

Supplier is required to manage obsolescence of all equipment, spares and consumables to enable the trains to continue in service for 35 years. This obsolescence management service must include:
i) Timely identification of any obsolete items of equipment;
ii) Development of mitigation strategies to minimize the impact of the imminent obsolescence of any item within the offered equipment / system including:

- Establishing alternative supply paths;
- Provision of equivalent or interchange parts or equipment
- Development of replacement products or design modifications to accept market available alternatives.

5.7 TRAINING ON MAINTENACE ASPECTS

Suppler to provide training to undertake scheduled and unscheduled maintenance to purchaser and its designated persons to handle the maintenance of train for 35 years. The duration of training shall be 12 man days.

REVISION HISTORY

Rev No.	Date	Description/Update
01	22.02.24	DOCUMENTS UPDATED AS PER CORRIGRNDUM FOR PS4452978

PERFORMA FOR PERFORMANCE CERTIFICATE

Name of firm: .....

TO WHOMSOEVER IT MAY CONCERN

Sub : Confirmation letter for service performance

Dear Sir,

We hereby confirm that We ..... have manufactured _____ number of sets of .....(Name of Equipment with Model No.) for 3 Phase IGBT based EMUs/MEMUs/Metros/trainsets/LOCOs.
We further confirm that …… number of sets of .....(Name of Equipment with Model No.) for 3 Phase IGBT based EMUs/ MEMUs/Metros/trainsets/Locos are in satisfactory operation for railway rolling stock application.
Proforma for performance statement confirming above is also attached.

Yours faithfully

For (Name of Firm)

PERFORMA FOR PERFORMANCE STATEMENT

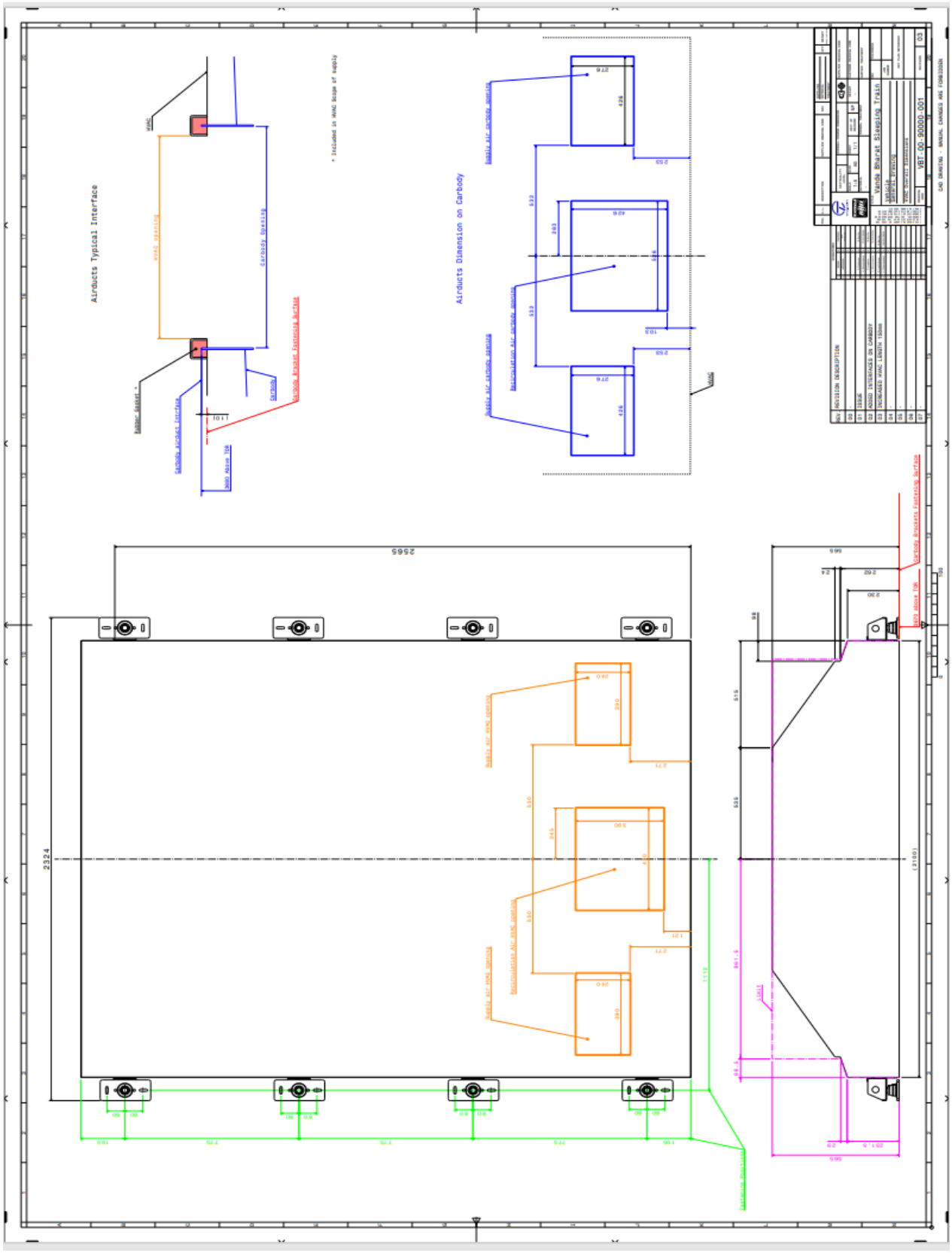
IGBT BASED 3-PHASE DRIVE TRAINSETS
PROFORMA FOR PERFORMANCE STATEMENT

Name of the Equipment:
Name of Firm :

S. No.	Order placed by (full address of Purchaser)	Order No. and Date	Description of Quantity of ordered equipment	Details of System for which equipment was supplied at Sr. No. 4 above to be given as follows			Value of Order	Date of Completion of Delivery		Remarks indicating Reasons for late Delivery, if any	Qty. in Satisfactory Service on 3 Phase IGBT based EMU's/MEMUs/ Locos/Trainsets /Metros
				Supply System	Unit Formation	Speed Potential		As per Contract	Actual		
(1)	(2)	(3)	(4)	(5)			(6)	(7)	(8)	(9)	(10)

ANNEXURE – A

Tentative SALOON HVAC OGA



FOR AERAULIC INTERFACE REFER ANNEXURE 2

ANNEXURE – B

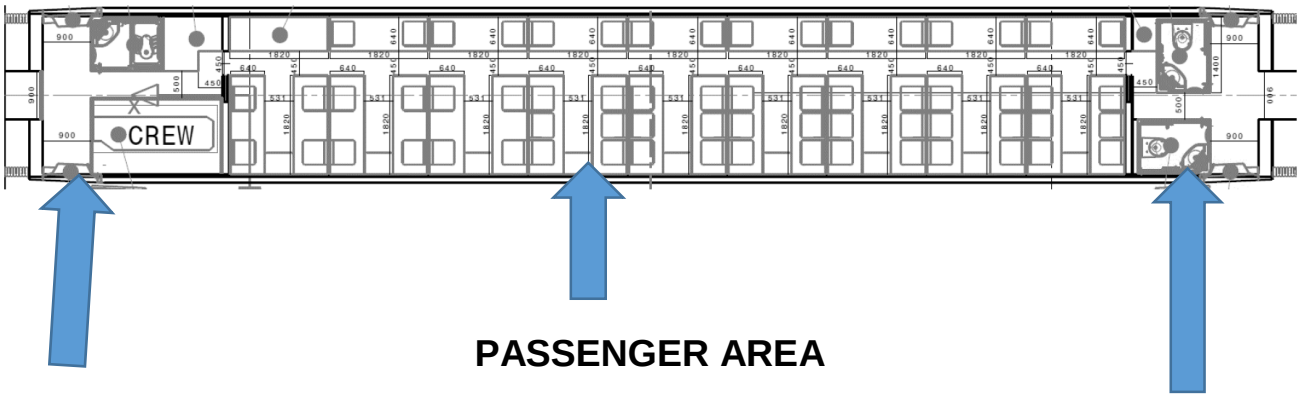
LIST OF STANDARDS FOR TESTING OF EQUIPMENTS

1.	Electric traction – rolling stock – test methods for electric and thermal /electric rolling stock on completion of construction and before entry into service	IEC 61133
2.	Electronic equipment used on rail vehicles	IEC-61287
3.	Specific rules concerning the electronic control part of converters	IEC-60571
4.	Electric traction - Electronic converter-fed alternating current motors	IEC 60349
5.	Railway application – rolling stock – Part 1: combined testing of inverter fed alternative current motors and their control system	IEC 61377
6.	Guide for the evaluation and identification of insulation systems of electrical equipment	IEC 60505
7.	Electric railway equipment-train communication network	IEC 61375
8.	Rotating electrical machines: Functional evaluation of insulation systems	IEC 60034-18
9.	Railway applications – electromagnetic compatibility – Part 3-2: rolling stock – Apparatus	EN 50121-3-2 / IEC 62236-3-2
10.	Railway applications – electromagnetic compatibility – Part 2: emission of the whole railway system to the outside world	EN 50121-2/ IEC 62236-2
11.	Railway applications – electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle	IEC 62236-3-1 / EN 501213-1
12.	Railway applications – compatibility between rolling stock and train detection system	EN 50238

13.	Transformer and chokes	IEC 60310
14.	High voltage AC circuit breaker	IEC 60077-4
15.	Rules for pantograph of electric rolling stock	IEC: 60494-1
16.	Relays, contactors and switches	IS 3231, IEC 60947
17.	Cables	IEC 60228, IS 10810**,** EN 50264
18.	Lightning arrestor	IEC 60099-4, IS 3070 Pt III
19.	Railway applications – rolling stock equipment – shock and vibration test	IEC 61373
20.	Programming languages for PLC	IEC 61131
21.	Railway applications – electric equipment for rolling stock	IEC 60077
22.	Electronic equipment used on rail vehicles	IEC 60571
23.	Power converter installed on board rolling stock – Part 1: Characteristics and test methods	IEC 61287-1
24.	Power converter installed on board rolling stock– Part 2: Additional technical information	IEC 61287-2
25.	Railway application – rolling stock protective provisions against electrical hazards	IEC 61991
26.	Auxiliary machines	IEC 60034
27.	Power factor correction	IEC 60871
28.	Environmental testing	IEC 60068
29.	Battery	Relevant IECs
30.	Degree of protection provided by enclosures	IEC 60529
31.	Rules for installation of cabling	EN 50343
32.	Railway applications, welding of railway vehicles and components. Inspection, testing and documentation.	EN15085

33.	Schedule of Dimension for broad gauge	IR Schedule Of Dimension for Broad Gauge, revision 2004 with latest amendment
34.	Reliability of electronic component	IEC 61709
35.	RAMS	EN 50126/ IEC 62278
36.	Metallized carbon strip for pantograph	RDSO's specification no. RDSO/2009/EL/SPEC/0097 Rev. 1 or latest
37.	Lighting arrestor	IEC 60099
38.	Capacitors	IEC 61881
39.	Railway applications: Fire protection on Railway vehicles	EN45545
40.	Railway applications: Body side entrance systems for rolling stock	EN 14752
41.	Railway applications: Air conditioning for urban and suburban rolling stock. Comfort parameters	EN 14750 EN13129

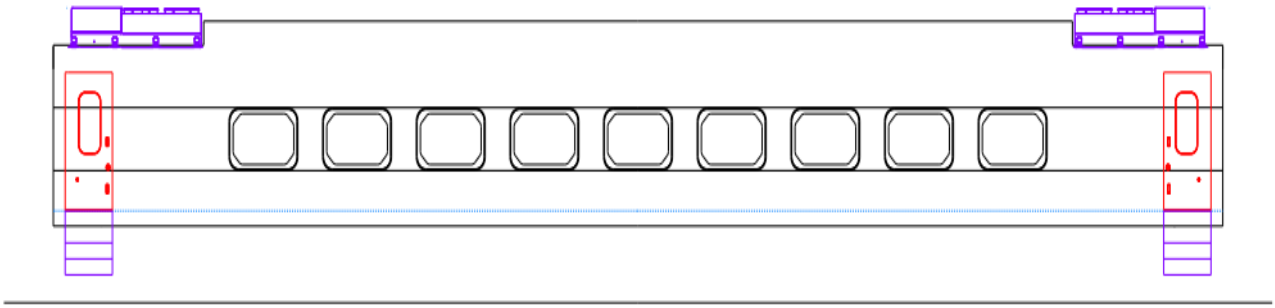
ANNEXURE –1
TENTATIVE GENERAL COACH LAYOUT

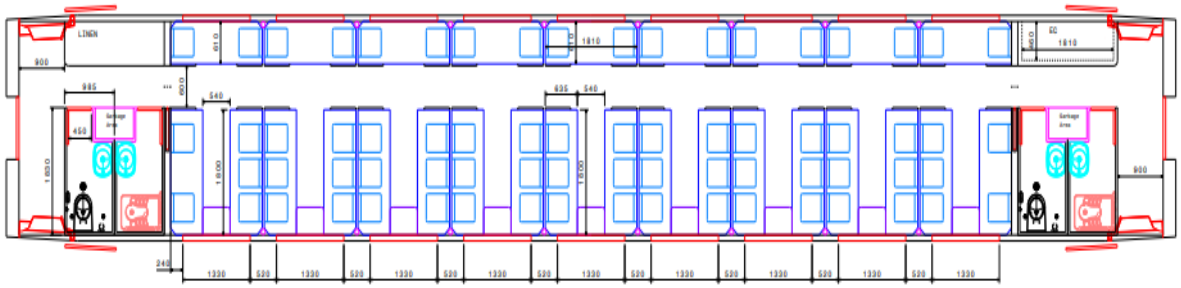


PASSENGER AREA

VESTIUBLE AREA-1 **VESTIUBLE AREA-2**

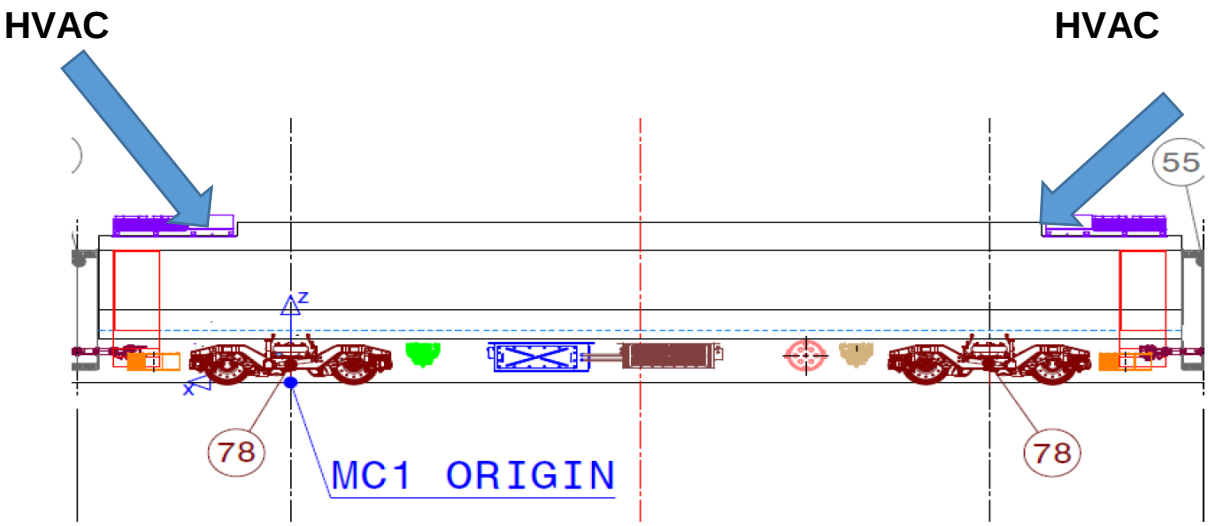
600 CMH OF AIR WILL BLEED IN EACH VESTIUBLE AREA

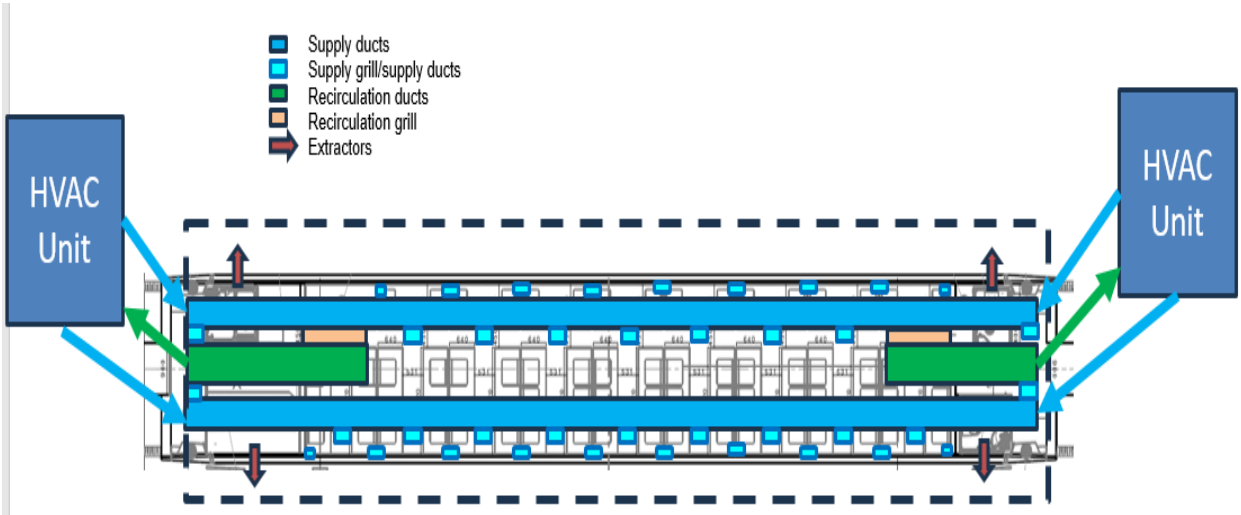




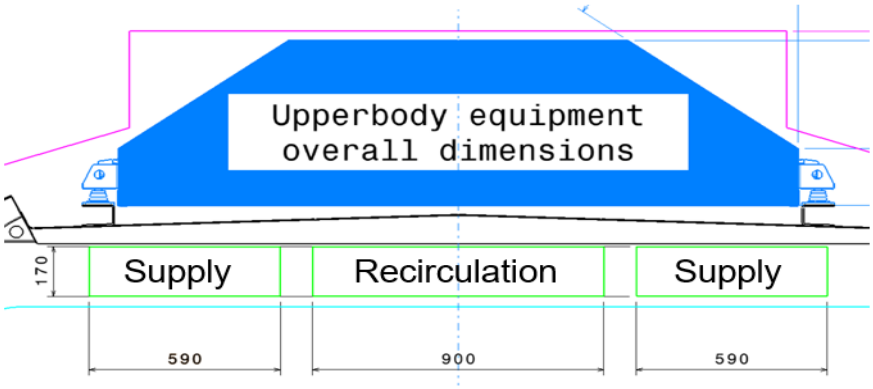
ANNEXURE –2

TENTATIVE RMPU POSITIONING/LAYOUT, RMPU VIEW, DUCTING LAYOUT TENTATIVE





The air duct is system is composed by two supply air ducts on the side, and one central recirculation duct.

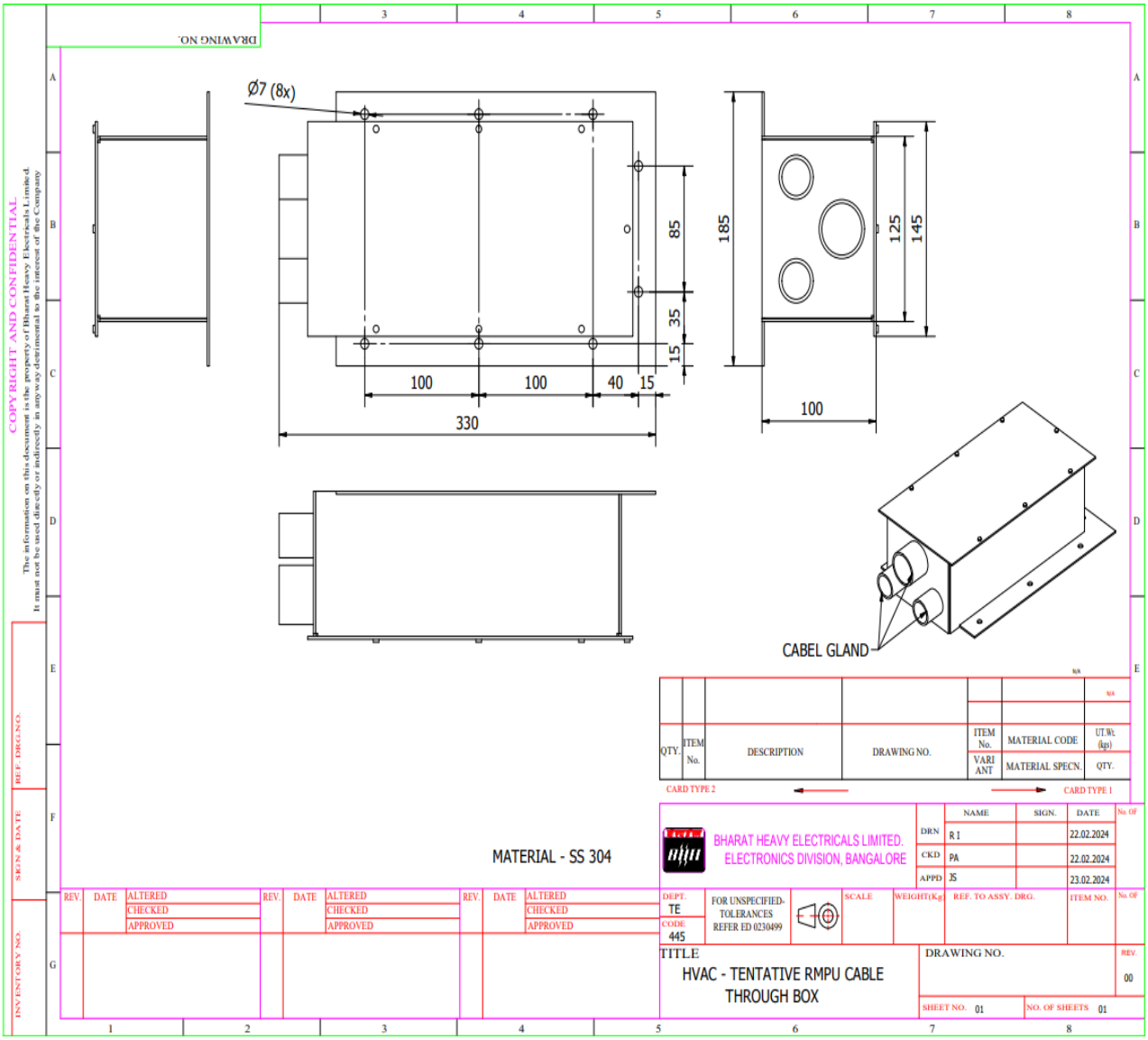


The preliminary aid duct shape is shown in the figure above. The HVAC unit shall have aeraulic interfaces directly above the air channel. According to our experience, the maximum velocity of air exiting from the HVAC should be below 10m/s, so the area of the interfaces shall be sized accordingly.

DUCTING SIZE FOR HVAC

ANNEXURE –3

TENTATIVE ROOF TERMINAL BOX DETAILS DRAWING



IP RATING OF BOX WILL BE IP65

ANNEXURE –4

List of Standards

i.	Electric traction – rolling stock – test methods for electric and thermal /electric rolling stock on completion of construction and before entry into service	IEC 61133
ii.	Electronic equipment used on rail vehicles	IEC-61287
iii.	Specific rules concerning the electronic control part of converters	IEC-60571
iv.	Electric traction - electronic converter-fed alternating current motors	IEC 60349 –2
v.	Railway application – rolling stock – Part 1: Combined testing of inverter fed alternative current motors and their control system	IEC 61377-1
vi.	Guide for the evaluation and identification of insulation systems of electrical equipment	IEC 60505
vii.	Electric railway Equipment-Train communication network	IEC 61375-1
viii.	Rotating electrical machines: Functional evaluation of insulation systems	IEC 60034-18
ix.	Railway applications – electromagnetic compatibility – Part 3-2: rolling stock – apparatus	EN 50121-3-2/ IEC 62236-3-2
x.	Railway applications – electromagnetic compatibility – Part 2: emission of the whole railway system to the outside world	EN 50121-2/ IEC 62236-2
xi.	Railway applications – compatibility between rolling stock and train detection system	EN 50238 IEC 62427
xii.	Transformer and chokes	IEC 60310
xiii.	Transformer oil	BS 148 -1984
xiv.	High voltage AC circuit breaker	IEC 60077-4
xv.	Rules for pantograph of electric rolling stock	IEC: 60494-1
xvi.	Relays, contactors and switches	IS 3231, IEC 60947
xvii.	Cables	IEC 60228, IS 10810, EN 50264
xviii.	Lightning arrestor	IEC 60099-4, IS 3070 Pt III
xix.	Railway applications – rolling stock equipment – shock and vibration test	IEC 61373
xx.	Programming languages for PLC	IEC 61131
xxi.	Railway applications – electric equipment for rolling stock	IEC 60077
xxii.	Electronic equipment used on rail vehicles	IEC 60571
xxiii.	Power converter installed on board rolling stock – Part 1: Characteristics and test methods	IEC 61287-1
xxiv.	Power converter installed on board rolling stock– Part 2: Additional technical information	IEC 61287-2

xxv.	Railway application – rolling stock protective provisions against electrical hazards	IEC 61991
xxvi.	Auxiliary machines	IEC 60034
xxvii.	Power factor Correction	IEC60871
xxviii.	Environmental testing	IEC 60068
xxix.	Batteries	IEC60871
xxx.	Degree of protection provided by enclosures	IEC 60529
xxxi.	Rules for installation of cabling	EN 50343
xxxii.	Railway applications, welding of railway vehicles and components. Inspection, testing and documentation (The Supplier shall, no later than the 5th(fifth) anniversary of the Appointed Date, demonstrate compliance to the EN 15085)	EN15085
xxxiii.	Schedule of Dimension	IR Schedule of dimension for Broad Gauge, revision 2022 with latest amendment/ Correction Slips
xxxiv.	Reliability of electronic component	IEC 61709
xxxv.	RAMS	EN 50126/ IEC 62278
xxxvi.	Metallized carbon strip for pantograph	RDSO's specification no. RDSO/2009/EL/SPEC/0097 Rev. 1 or latest
xxxvii.	Track Geometry	Indian Railway Permanent Way Manual
xxxviii.	Railway applications —Current collection systems - Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line	BS EN 50317
xxxix.	Railway applications —Current collection systems — Validation of simulation of the dynamic interaction between pantograph and overhead contact line	BS EN 50318
xl.	Railway applications — Current collection systems — Technical criteria for the interaction between pantograph and overhead line (to achieve free access)	BS EN 50367
xli.	Railway Applications – Air conditioning for main line rolling stock. Comfort parameters and type tests.	BS EN 13129

	BHARAT HEAVY ELECTRICALS LIMITED ELECTRONICS DIVISION TRACTION Mysore Road, Bangalore	DOC. NO: PS4452978 REV. NO: 01 PAGE: 1 OF 45

CUSTOMER/ CONSULTANT	BHEL/INDIAN RAILWAYS
PROJECT	Manufacturing cum Maintenance of Vande Bharat Trainsets_VB_80 Rakes

TECHNICAL SPECIFICATION
SALOON HVAC_VANDE BHARAT

Rev No. 00	Date	Altered	Checked	Approved	REVISION DETAILS
01	22.02.24	Piyush	Jagdish	V.Devanand	Doc. Updated as per corrigendum

Issued By:
Traction Engg. Dept
BHEL-EDN

APPROVED
V.Devanand

PREPARED	CHECKED	DATE
Piyush Arora	Jagdish Shukla	18.01.2024

Table of Contents:

SECTION – 1

SCOPE, QUANTITIES & ELIGIBILITY

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Roof Mounted Heating, Ventilation & Air Conditioning (HVAC) System for trainset.

The equipment is required for the following project.

Name of the customer : BHEL/INDIAN RAILWAYS
Name of the Project : Manufacturing cum Maintenance of Vande Bharat Trainsets

The scope shall also include the followings:

The supply of complete documentation for approval of design, relevant drawings and calculations to the satisfaction of purchaser and RDSO / nominated agency and support documentation associated with the operation and maintenance of the equipment supplied.

The supplier shall submit list of equipment and facilities required for maintenance and overhaul of equipment offered.

1.2 Bill of material for Saloon AC system:

1 SET of HVAC will include following items:

Sl. No.	Description	Quantity (per Coach)	Remarks
1.	RMPU type AC system with mounting frames, air dampers, bellow less coupling with ducts, connectors & glands, Inverter drives, smoke detector, Bacteria kill device, CO_2 level monitoring, Anti vibration pads/mounts with fasteners etc.	02 No.	*The HVAC panel assembly shall be made of SS304*.
2.	Cable entry box with EPDM/Glands.	02 No.	*Box shall be of stainless steel material made of SS304 with IP 65 rating*.
3.	Microprocessor based controller unit along with protective devices, relays/contactors etc., pre-wired and mounted on suitable SS 304 plate.	1 No.	Dimension/mounting of plate to be finalized during detailed design stage.
4.	Complete mounting hardware.	1 set	All mounting hardware shall be

			Stainless steel (GRADE A2-70). Mounting details to be finalized during design stage in consultation with ICF/RDSO/Indian Railways.
5.	Other accessories, earth strips, set of mating electrical couplers/connections etc.	As reqd.	

For 16 car rake our requirement is 16 sets.

1.3 ELIGIBILITY CRITERIA

The Bidder should be a regular supplier to Indian Railway Projects and should have supplied the offered equipment for Indian Railways projects of 3 phase IGBT Based AC EMU/MEMU/ Metros/Trainsets operating in India.

1.4 CLAUSE BY CLAUSE COMPLIANCE

Vendor to submit clause by clause compliance to complete technical specification along with the technical bid.

1.5 REFERENCE SPECIFICATIONS

This purchase specification has the reference of Railway Specification No. ICF MD SPEC-398 Rev-01 dated: 05/11/2022.

SECTION – 2

TECHNICAL SPECIFICATION

2.1 TECHNICAL SPECIFICATION OF SALOON AC SYSTEM

(a) Technical Requirement:

1. All the Sleeper Cars including shall be air-conditioned. Two light weight roof mounted packaged unit (RMPU) type air conditioning units in each Car of train set shall be provided. Each packaged unit shall have two independent refrigerant circuits. The control of both the air-conditioning unit shall be performed by suitably designed single microprocessor controller.
2. It shall also be able to provide heating during winter through reverse cycle heating concept or alternate method based on suitability, proven technology, and better energy efficiency. The complete system shall have EER better than 7.0. No material shall be used in construction of air conditioning unit that is liable to be adversely affected by vibration, damp, rotting or growth of moulds. Only fire retardant material should be used.
3. The AC shall be provided with refrigeration system using R 407C refrigerant or any other eco-friendly HFC refrigerant having zero ozone depletion potential and A1 safety category as per ASHRAE standards.
4. One of the compressors in each RMPU shall have automatic capacity control through hot gas bypass system or through VVVF control to optimize the efficiency of RMPU. Reference list of Trains/Projects working in INDIA to be furnished for both the above system.
5. Type test protocol to be submitted by vendor for evaluation along with the offer.
6. The air conditioning units shall be fed from the 3 Phase 415 V AC supplied from auxiliary converter. Protective devices, relays/contactors shall be provided for protection against short circuit / overload / earth fault and to isolate the healthy air conditioning unit from the defective one.
7. The Air-conditioning package unit shall have adequate capacity to air condition the coach under the following conditions:

Summer condition	**Dry bulb**	**Wet bulb**	**% R.H**
Outside (dry summer)	50°C	25°C	-
Outside (wet summer)	40°C	28°C	-
Inside (dry and wet)	20-25°C	--	40-60%
Winter condition			
Outside	-10°C	--	--
Inside	17-21°C	--	--

The capacity of the RMPU shall be based on heat load calculation for the worst of the condition mentioned above.

8. The rating of RMPU shall however not to be less than 8 TR. However, vendor to perform the detailed thermal analysis/calculations and specify the tonnage of refrigeration (TR) to meet the cooling / heating requirements as per coach layouts (refer Annexure 1). Following tables shall be referred to perform the capacity calculations:

(a) Tentative Mechanical/dimensional details of the train car are indicated in table below.

Mechanical/Dimensional details	
Roof area (m2)	68.5
Sidewall area (each side) (m2)	41.9 (car with pantograph 40.48)
Sidewall area under windows (each side) (m2)	7.56
Floor area (m2)	68.5
Front area (both) (m2)	12.8
Gangway (right and left TOTAL) (m2)	4.7
Doors area (each side) (m2)	3.53
Windows area (each side)(m2)	10.4
Steel (Total) (m2)	15.09 (car with pantograph 14.25,10% of floor,5%roof and side walls are covered by steel).
Thermal details	
Roof k factor (W/m2.K)	0.772
Sidewall k factor (W/m2.K)	0.772
Floor k factor (W/m2.K)	0.957
Front k factor (W/m2.K)	0.772
Doors k factor (W/m2.K)	4.3
Windows k factor (W/m2.K)	2.25
Gangway k factor (W/m2.K)	5.0
Steel (W/m2.K)	5.82
Overall Train k factor	1.45-1.55

These values shall be validated during the performance trials.

600 CMH of Conditioned air per HVAC will be bleed into each vestibule area and will be exhausted through toilets with an extractor fan. Capacity of each extractor fan is 300 CMH.*There will be a pantry load of 7KW in each coach. Each coach will have four (4) toilet and one pantry in the vestibule area.*

(b) Approximate number of Passenger in each type of sleeper car coach *with electrical cabinet heat load and Coach light load (Cabinet in Vestibule Area) are indicated in table below.*

SL No.	Coach Type	No. of Passenger	*Electrical Cabinet Heat Load (KW)*	*Light load(KW)*
1	DTC (Driver Trailer Car), 3 Tier	34	*2*	*1*
2	MC1 (Motor Car), 2 Tier	48	*2*	*1*
3	MC2 (Motor Car), 3 Tier	70	*2*	*1*
4	TC (Trailer Car) (with Pantograph), 3 Tier	64	*2*	*1*
5	NDTC1 (Non Driver Trailer Car), 3 Tier	52	*2*	*1*
6	NDTC2 (Non Driver Trailer Car), 1st Class	24	*2*	*1*

9. RMPUs shall be capable of pre-cooling the coach up to 23°C without passenger, with fresh air dampers closed, lights and fans switched on after raising the inside temperature to 45°C in less than 45 minutes. Further, capacity should be adequate to cool the coach in extreme summer condition within 2 hours when the coach is fully occupied, which will be verified by conducting pull down test on prototype rake/ coach (RDSO test program No.: ELPS/TP/AC/01 may be referred for guidance).
10. In the event of failure of one RMPU, the second RMPU shall cater 60% of the total air-conditioning load of the Car.
11. The single RMPU shall be able to work even with one condenser fan and the cooling capacity so obtained shall not be less than 75% of the rated capacity of the said RMPU.
12. All the equipment shall be capable of continuous operations without detriment to the operation of cut-outs and circuit breaker or over load, as per the environmental conditions mentioned in Clause no. 3.5 of Section-3 of this Specification.
13. The minimum fresh air quantities shall not be less than 0.25 m^3 / minute /person for all types of Cars. The air-flow parameters shall be as per ASHRAE /EN13129:2016.
14. On all the cars (except TC), the HVAC shall be positioned at the end of the car. In TC Car one of the AC Unit shall be placed after HV Equipment.
15. Instead of the horizontal air entry/exits of the classical Vande Bharat Trains, the new configuration need vertical aeraulic interfaces for both supply air and recirculation. The HVAC unit shall have aeraulic interfaces directly above the air channel.The area of the interfaces shall be sized accordingly. (refer Annexure 2)
16. The air duct is system is composed of two supply air ducts on the side, and one central recirculation duct. Furthermore, there are 4 extractors fan on the 4 toilets and one on the pantry, that are used to extract the odour from the enclosed ambient.
17. Noise level inside the car (passenger area) shall not exceed 65 Db(A) when stationary and shall not exceed 70 db(A) at maximum service speed with HVAC operating at its greatest noise. The Supplier shall associate with Purchaser at the design stage with regard to the interface requirement to minimize the noise levels.
18. The compressors suitable for traction environment, shall only be used and it shall have adequate capacity at 55°C condensing temperature & 5°C evaporating temperature. One of the compressors in each RMPU shall have automatic capacity control through hot gas bypass system or through VVVF control to optimize the efficiency of RMPU. The refrigerant evaporator unit shall comprise of cooling unit with automatic thermostatic expansion valve. Suitable arrangement for drainage of condensate water shall be made so that water does not come inside the Car and does not fall on couplers, gangways, platforms or any other equipment.

19. Each air conditioning unit shall be constructed as an integral module to enable removal from the Car as single complete item without the necessity to break any refrigerant lines or any part of Car or unit itself. All electrical connections and condensate outlets shall be fitted with standard quick heavy duty disconnect fittings. The connectors should be so positioned to ensure that it is not damaged when the air conditioning unit is removed from the Car and placed on a flat surface. Connectors shall conform to DIN EN 175301-801.
20. All fresh air intake shall be filtered and the air filter elements shall be cleanable and shall not be of disposable type. The Supplier shall use a filtration system suitable for Indian conditions requiring minimum attention/cleaning/maintenance. Suitable device to indicate the pressure drop shall be installed so that filters can be replaced/cleaned after getting necessary indication for the same.
21. Thermal comfort based Microprocessor controller shall be used for air conditioning system. However, in case of failure of microprocessor-based controller, it shall be possible to run the system with full capacity in manual mode with all major protections intact. The link between the microprocessor and interfaced cards shall be established by means of serial bus system or any other superior means to ensure error free high speed data transmission. The control and monitoring function shall be implemented through software to reduce hardware and cables. The complete control panel along with microprocessor controller shall be accessible from inside the Car without any requirement of going on roof.
22. The microprocessor shall perform the task of fault diagnosis and display in addition to control task. It shall be a capable of monitoring the status of the equipment and faulty sensor/cables continuously and the occurrence of the faults. It shall also take appropriate action and wherever necessary, it shall shutdown the equipment. The faults shall be stored in the memory of microprocessor and it shall be possible to download the same using commercial available USB pen drive or laptop.
23. Various important parameters of the equipment as well as environmental data at the time of occurrence of the fault shall also be recorded. Application/diagnostic software tools as required for trouble shooting and analysis of the fault shall be provided. Adequate redundancy shall be built in the microprocessor.
24. In the event of failure of air-conditioning unit/units, harmful quantities of the refrigerant shall not be released inside the compartment.
25. In the event of the failure of air conditioning unit in a Car or failure of 415V power supply, an emergency ventilation shall operate automatically to admit fresh air directly into Car to maintain the required oxygen level in fully loaded Car, in accordance with ASHRAE. The fresh air intake shall not be less than 15 m^3 / hour / person under specified loading conditions. The emergency ventilation shall be fed from 110VDC supply with its dedicated inverter, which shall not employ 50 Hz transformer. As an alternative BLDC blower motors directly operating at 110 V DC will also be acceptable.
26. Superstructure shall be provided with ducting arrangement for discharge/exhaust of air. It shall be ensured that water does not enter in such arrangement during heavy rains striking at 45° opposite to the movement of the train running at 160 kmph or during Car washing. Design of connecting ducts along with outlets shall be developed in consultation with RDSO/ICF/IR.
27. The Blower shall be designed for pressure loss of 250 PA. CFD Analysis report for HVAC UNIT is to be provided by the vendor
28. The refrigeration system shall have two separate refrigerant circuit with interlaced Evaporator coils.

29. The HVAC will be on Ethernet network and shall be able to communicate with TCMS via TRDP protocol. *There shall be two Ethernet ports in the RMPU controller for dual homing communication with TCMS.The Vendor should provide ICD list of HVAC with reference to Safety, Healthiness and performance of the unit for communication with TCMS*
30. Outside smoke detection sensor, inside CO_2 level sensor and arrangement to provide bacteria free air into passenger area shall be provided by supplier.
31. Automatic control of fresh air and return air dampers of HVAC shall be provided.
32. Air conditioning of each coach and Fresh air and return air ducts should be controllable as per fire system requirement.
33. Suitable cable entry box with EPDM/glands for cable entries on roof shall be provided by supplier.
34. Suitable prewired control plate having microprocessor based controller along with protective devices (for short circuit / overload / earth fault and to isolate defective unit), relays/contactors shall be provided by vendor which shall be mounted in ECC panel. ECC (Electronic Control Cabinet) shall be available in each coach (except DTC cars). The Control plate shall get 415V 3phase supply and 110 DC supply from the ECC panel. Electrical scheme of Control plate shall also be submitted to BHEL by supplier. Dimension of prewired control plate shall be finalized during detail design stage.
35. Protection shall be designed in such a manner, that any fault in RMPU should not lead to fault in 415V 3phase supply and 110 DC supply obtained from ECC panel thereby avoiding tripping/damage of Aux converter (415 V)/battery Charger (DC Supply- 110V) or any other load connected to bus of 415 V 3 phase and 110 V DC supply of the train. Protection scheme in detail shall be submitted by supplier.
36. Required cables (Power and control) from Control panel to RMPU unit shall be provided by BHEL. However, all cable Glands/ Mating connectors (Harting or equivalent) and cable entry box shall be in supplier's scope.
37. In the event of detection of smoke outside the Train, an alarm shall be provided to the Driver/Guard. Damper for fresh air intake shall close automatically when outside smoke is detected. In the event of detection of a smoke/fire inside the car, the air conditioning system shall be controlled to minimize the spread of fire to promote the escape of passenger. Relevant interfacing between TCMS and RMPU shall be decided during detailed design engineering.
38. Design and manufacturing of RMPU type Air Conditioning System with complete assembly shall be in accordance with EN45545. The applicable Hazard level will be HL 3.
39. The design of RMPU shall facilitate easy maintenance even when rakes are placed for inspection/maintenance in washing lines.
40. Each Driving Car (Not in the driving cab) shall have provision for Centralized Coach Monitoring System (CCMS) (not in supplier's scope) for monitoring, recording and control of the air-conditioning and other faults e.g. power supply failure etc. CCMS shall monitor the following:

- Auto/bypassed mode working of Air Conditioning unit
- Temperature (return air, supply air temperature and ambient temperature)
- Pressure (Low pressure, High Pressure and Oil pressure in AC system)
- LP & HP tripping
- Compressor tripping
- AC motors tripping
- Other inputs and output information to be decided during design stage.

RMPU Supplier to ensure the availability of above details on the Train TCMS.

41. In Prototype rake, supervision of installation and commission shall be provided by supplier.
42. The vendor to furnish detailed description/procedure of the assembly, mounting and installation process of the Air Conditioning system. The vendor to also furnish any supporting circuit/block/connections diagram for placing Air Conditioning HVAC system in coach.
43. The offered HVAC unit shall be within the limits specified as per MMD of IRSOD-1D.
44. Mounting Arrangements:
    TENTATIVE OGA DRAWING IS UPDATED AND IS ATTACHED FOR REFERENCE AS PER ANNEXURE-A.

45. OTHER APPLICABLE STANDARDS
    In addition to the above mentioned technical requirements, the offered equipment must comply to relevant IECs/other applicable standards as per **Annexure-4**

46. TESTING AFTER COMMISSIONING
    Test on Air Conditioning system after commissioning on Car:
    (i) Verification of co-efficient of Performance
    (ii) Pre-cooling test.
    (iii) Pull down test

47. *The Air conditioning equipment should be tested according to the latest version of ANSI/ASHRAE standard 37 as per ASHRAE Guideline 23-20116.The Air conditioning equipment should be tested for shock and vibration as per IEC 61373 (latest version). Test shall be included in QAP*

2.1 EQUIPMENT TESTING

(1) Valid Type test report is to be submitted for the equipment along with offer, if the equipment is already type tested. In case, ultimate customer insists to repeat the type tests due to any reason, the type test shall be conducted again by the supplier, for which test procedure shall also be submitted by the supplier for approval before conducting the type test. In case ultimate customer desires to witness the type tests, the supplier shall have no objection. The supplier is required to quote for the type test charges if any, separately in commercial offer. These charges will be loaded in the equipment price at the time of final evaluation. If Type Test charges are not quoted separately in the commercial offer, then it will be presumed that offer is inclusive of type test charges and no extra payment will be done in case of type test conducted due to any reason.
(2) Supplier to submit Routine test certificates and inspection certificate of equipment as per QAP along with equipment.
(3) Type and routine test will also confirm to clause 3.11 of section 3 of technical specification.

2.2 DESIGN REQUIREMENTS TO BE PROVIDED BY SUPPLIER

Write-up/ description of each equipment	To be provided by Supplier
Datasheet of equipment	To be provided by Supplier
Circuit diagram, connection & wiring diagram, equipment drawing with mounting details, weights, center of gravity, etc. and any other relevant drawings.	To be provided by Supplier
Type test protocol & procedure/ Type test reports	Supplier to submit the complete reports of type test already conducted on the proposed/offered equipment. In case type test is required to be done, supplier to submit the detailed test procedures for approval.
Routine test protocol & procedure/ Routine test reports	Supplier to submit Routine test certificates and inspection certificate of equipment as per QAP along with equipment.
Details of proven design	To be provided by Supplier
Performance statement	To be provided by Supplier in the attached format.
Performance certificate	To be provided by Supplier in the attached format.
RDSO Approval letter (conforming to the latest RDSO spec as applicable)	To be provided by Supplier
Project specific AUTO CAD drawing-2D and 3D model	To be provided by Supplier after order placement
Project Specific Drawings in A3 size	To be provided by Supplier
Technical Manual	To be provided by Supplier
Installation, Operational and Maintenance Manual	To be provided by Supplier
MTBF/MDBF Values along with the method of calculation	To be provided by supplier
Quality assurance plan (QAP)	To be provided by supplier

SECTION – 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.1 GENERAL

This section stipulates the General Technical Requirements under the contract and forms an integral part of the Technical Specification. The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections and are not exclusive.

However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

The Train shall be Distributed Power type which shall have Driving Cabs on its both ends and shall be capable of running in either direction without the requirement for any change in its composition. Configuration of 16-car rake shall be two End Basic Units and two Middle Basic Units.

The configuration of Vande Bharat express (Trainsets) is as under (for reference):

DTC-MC-TC-MC-MC-TC-MC-NDTC-NDTC-MC-TC-MC-MC-TC-MC-DTC

Where,

DTC: Driving Trailer Coach

MC: Motor Coach

NDTC: Non-Driving Trailer Coach

TC: Trailer Coach

3.2 INSTRUCTION TO BIDDERS

The bidders shall submit the technical requirements, data and information as per the technical specification, provided in Section-2.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc. in English language, fully in conformity with the technical specification.

Whenever required, the bidder shall depute his technical experts to RDSO / nominated agency for design discussions and approval.

3.3 GENERAL DESIGN REQUIREMENTS

i) The stock fitted with the supplied equipment shall meet the operating, service conditions and performance requirements of this specification and shall be suitable for operating conditions on IR.

ii) All equipment shall be vandal proof and incorporate necessary anti-pilferage features without compromising aesthetics / maintainability.

iii) Notwithstanding the contents of this specification, the Supplier shall ensure that the equipment supplied by them is complete in all respect so as to achieve the efficient operation & optimum performance of the Train set.

iv) The equipment design shall incorporate all essential features necessary to yield high traffic use, low maintenance requirements, easy maintainability, high regeneration, high efficiency, light in weight, user & environment friendly and high reliability in train operation. The design shall also facilitate easy erection, inspection, maintenance and replacement of the sub-units/ assemblies of all the equipment.

v) The entire equipment shall be designed to ensure satisfactory and safe operation under the running conditions mentioned in this specification duly taking care of sudden variations in load, voltage etc. under abnormal working conditions due to faulty operation, short circuits & earth faults etc.

vi) Wherever applicable: Airflow inlet/ arrangement for forced cooled equipment shall be designed in such a way that cloth, polythene, papers etc., which may get sucked, either do not block the airflow or get removed during halts. Moreover, filter should be easily cleanable.

vii) All working parts of the control and auxiliary circuit specifically electronics and PCBs, shall be suitably covered to keep them free from moisture, mold growth and dust. The protection level shall be furnished by the Supplier during design approval.

viii) All the electrical equipment shall comply with the latest edition of governing IEC specifications unless otherwise specified. The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with the limits specified and the ambient conditions defined in the Specification.

ix) All equipment shall be adequately earthed, insulated, screened or enclosed. They shall be provided with essential interlocks & keys as may be adequate to ensure the protection of the equipment and the safety of those concerned with its operation and maintenance.

x) Wherever applicable: Supplier shall to the extent feasible employ the currently available lubricants/cooling oils in India. Full lubrication scheme and schedule for the equipment shall be submitted. If use of imported lubricants or cooling oil is inevitable, supplier shall furnish details of equivalent Indian lubricants/oil.

xi) Supplier shall submit 3D models of offered equipment including associated sub-assemblies, etc. in. stp formats.

xii) The design of the equipment shall be based on sound, proven and reliable engineering practices. The equipment used in different sub systems shall be of proven technology and design. The supplier shall submit the supportive document for each of the assembly/sub-assembly for its proven performance under the environmental conditions prevalent in India.

xiii) The supplier shall design the mounting arrangements suitable for coaches. The accessories for mounting the equipment shall be part of the scope of supply. The hardware for mounting, safety links for underslung equipment, the termination hardware also will be in the scope of supply for all equipment.

xiv) SOFTWARE (WHEREVER APPLICABLE)

a. Software shall be written in a structured manner and fully documented during all stages of its design and development. This shall meet the requirements of EN 50126-2: The specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 2, EN 50128: Railway Applications: Software for Railway Control and Protection Systems, and EN 50129: Safety-related Electronic Railway Control and Protection Systems.

b. The Supplier shall submit the values of parameters, list of fault messages, their environmental data, hierarchy of fault display, fault categorization, trouble shooting of each fault by way of Changes in parameters shall be demonstrated with their effect on the results.

c. Parametric changes shall be possible in the software in order to meet the future requirements. While listing out the values of various parameters, the Supplier must provide a range within which any change can be made without jeopardizing the functionality of the system. Supplier shall submit the licensed software to the purchaser.

d. Software shall be fine-tuned through simulations & real life working conditions based on the extensive trials, associating BHEL / user Railways before putting the rake in commercial services. As it requires, instrumentation and expertise of Software Design Professionals, software expert(s) of Supplier shall be based at the work place along with commissioning engineers so that all software related issues are expeditiously resolved before putting the rake into commercial service.

e. Quality and efficacy of trouble shooting manual, software tools and software documentation shall be validated during extensive field trials. Final version of these documents shall include the changes required based on the service trials, commercial service operation, experience of operating Railways.

f. All the changes, thereafter, in software shall be approved by RDSO / nominated agency in consultation with user Railways before actual implementation and the Supplier must give software release, which shall include brief description of the problem, earlier as well as modified logic, explanation, parametric changes etc. to the satisfaction of RDSO / nominated agency.

g. The Supplier shall submit Software Quality Plan for review before work commences on software design. The software quality plan shall clearly state the controls and practices used in the software life cycle from specification through to in-service operation.

h. Internal independent review, verification & testing, using real & synthetic data, shall be performed at the software module and system level. RDSO/ nominated agency / BHEL / user Railway may audit the Supplier against the **Software Quality Plan** at any stage during the Contract. The Supplier shall ensure that all software is fully de- bugged prior to the final review by RDSO/user Railway.

i. Sufficient software documentation shall be provided to give the full understanding of the software function, logics, parameters and operation. Documentation shall be complete, clear and concise, and include all modifications up to the final acceptance. Documentation shall clearly explain the software logics, associated parameters, include software block diagram showing signal flow, logic and hardware interfaces etc. A top level flow diagram and description of detailed operation shall be provided.

xv) Notwithstanding the contents of this specification, the supplier shall ensure that the equipment supplied by them is complete in all respect so as to enable the desired operation of the Train fitted with their equipment.

xvi) Supplier shall deliver the executable files of all developed software along with necessity tools to upload / download and carry out fault analysis.

3.4 INGRESS PROTECTION

i) All equipment shall be suitably protected from dust and water. As a minimum, equipment shall be sealed to the standards stated below:

Under frame & externally mounted equipment (other than traction/ auxiliary converter/Traction Motor)	IP65
Battery Box and Brake Chopper	IP20
Equipment mounted inside the Car body	IP54

ii) It may be necessary to protect some equipment to IP 67 in order to meet the requirements of Clause 3.5 of this Specification.

3.5 AMBIENT CONDITIONS / OPERATING CONDITIONS

The equipment shall be designed to work satisfactorily under following environmental conditions: -

Atmospheric temperature	Maximum temperature: 50 degrees Celsius Maximum touch temperature of metallic surface under the Sun: 75 degrees Celsius and in shade: 55 degrees Celsius Minimum temperature: - 10 degree Celsius
Humidity	100% saturation during rainy season
Solar radiation	1 kW/m2
Altitude	1000 meter above mean sea level
Rain fall	Very heavy and continuous rainfall in certain areas (up to 2500 mm during rainy season)
Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m3. In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system
Coastal area	Humid and salt laden atmosphere. The equipment shall function in accordance with this Specification when subjected continuously to a humid and salt laden atmosphere with maximum pH value as per IEC 60571, sulphate content of 7 mg per litre, maximum concentration of chlorine 6 mg per litres and maximum conductivity of 130 micro Siemens / cm.
Vibration	The vibration and shock levels recorded on various Sub-systems in existing Trains of IR are generally more than the limits given in IEC 61373 particularly at axle box, and traction motor. Accelerations over 50g have been recorded at axle box levels during run. Vibrations during wheel slips are of even higher magnitude. High level of vibrations above 30g have been measured at traction motor on IR's Trains, which increase up to 50g with worn gear- pinion.
Wind speed	High wind speed in certain areas, with wind pressure reaching 216 kg/m2 as per IS:875 Part 3(2015)
Flood level	The Train shall function in accordance with these Specifications and Standards in the event of flooding up to 203 mm above Rail Level as follows: • In the event of flooding at any level below Rail Level, the Train shall operate in full compliance with these Specifications and Standards.

	• In the event of flooding at a height between Rail Level and 203 mm above Rail Level, the Train shall operate in full compliance with these Specifications and Standards with the exception that it is permissible to restrict the operation of the Train to a maximum of 8 km/h. Allowance is to be made in addition for increase in the height of water level due to the "bow wave" effect of the Train passing through the water.
Flood Proofing of the under slung Equipment	Waterproofing test will be conducted on Traction and Auxiliary Converter by dipping them up to a height equivalent to 650 mm from rail level (under fully wheel worn condition) in stationary water for 12 hours. There should be no water ingress and Converters shall function normal after the test. Traction Motor with gearbox shall be tested for waterproofing as defined in clause 3.4.6.10.1 of specification ICF MD SPEC-398, issue status-01, rev 01. Other underslung equipment shall have IP protection as mentioned in clause 3.4 of this specification. However, even in case of flood levels more than the mentioned above, the equipment shall not get damaged and it should be possible to rejuvenate the equipment with minor attention without any adverse effect on their performance. Axle box shall be adequately flood proof.

3.6 STANDARDS

(a) The standards applicable and relevant to the complete Train and to the various Sub-systems and systems shall be:
- (i) IEC publications;
- (ii) EN;
- (iii) UIC;
- (iv) AAR;
- (v) IEEE;
- (vi) BS;
- (vii) RDSO specifications;
- (viii) ICF/RCF specifications;
- (ix) NF-F;
- (x) ORE;
- (xi) VDE;
- (xii) UL;
- (xiii) JIS
- (xiv) IS; and
- (xv) Any other standards referred to in this Schedule.

(b) In the event of any contradiction in the aforesaid standards, the following standards shall have priority in the order listed:

(i) Standards mentioned in these Specifications and Standards set forth herein;
(ii) EN/IEC/UIC/AAR and
(iii) IS.

(c) For avoidance of any doubt, in case of any conflict between the requirements of these standards, the stipulations of Specifications and Standards in this Schedule shall have precedence.

(d) The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with the limits specified and the ambient conditions defined in the Specification. Specified temperature rise of equipment shall be calculated after taking into account at least 25% choking of air filters and radiator fins etc.

3.7 ENGINEERING DATA

(a) The contactor shall necessarily submit all the drawings/ documents unless anything is waived. The contactor shall submit drawings/ design documents/ data/ test reports as may be required for the approval of the purchaser. All drawings submitted by the Manufacturer including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required, dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

(b) Each drawing submitted by the Manufacturer shall be clearly marked with the name of the Customer and Project, the unit designation, the specifications title, the specification number, date of revision (if any), duly signed by the concerned technical person. If standard catalogue pages are submitted, the applicable items shall be indicated therein and should be made project specific. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

(c) The title block of drawings shall contain the following information incorporated in all contract drawings

1. Customer : BHEL /Indian Railways
2. Project: Manufacturing cum Maintenance of Vande Bharat Trainsets
3.Contract No./LOA No./ Ref no.: 2022/RS(WTA)-527/Vande Bharat Trains/874/1 dated 14/06/23
4. Main Contractor : Bharat Heavy Electricals Limited

3.7.1 SIZE OF DRAWINGS

The drawings of the following parts shall be to the sizes indicated below

I. Equipment details – full size or half size
II. Motor Assemblies – 1:5
III. General Assemblies- 1:10

Further, the scaling of drawings should be as per applicable standards.

3.7.2 METHOD OF FILING OF DRAWINGS

To facilitate filing of drawings, it is essential that each drawing submitted for approval is marked so that it can be identified. The supplier is, therefore, required to ensure that all prints are marked legibly at the right hand bottom corner. The following information is required in respect of each drawing:

I. Supplier's drawing number.
II. Supplier's name and date of submission.
III. Contract no. given by the purchaser.
IV. Description of drawings.
V. Relevant Specifications

3.8 MARKING OF EQUIPMENT & RATING PLATE

(a) All main assemblies of the equipment shall bear serial number, year of manufacture and symbol/ identification of the purchaser. Where the sub- assemblies/components of the main assemblies are not inter-changeable, the sub-assemblies shall also be marked with the serial nos. of the main assembly of which they form a part.

(b) All equipment/cubicles shall contain non-detachable rating plates of anodized aluminium with embossed letters and fitted in a visible position. The rating plate will give detailed rating specification and identification of equipment.

3.9 INFRINGEMENT OF PATENT RIGHTS

BHEL and Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, components used in design, development and manufacturing of propulsion system & other equipment and any other factor which may be a cause such dispute. The responsibility to settle any issue lies with the manufacturer.

3.10 DOCUMENT SUBMISSIONS

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Purchaser would be discussed and finalized at the time of award. The following schedule shall be followed generally for approval:

Sl.no.	No. of copies	Schedule
i)	Initial Submission Drawings, Data sheets, Type test Reports	At the time of submission of offer.
ii)	Furnishing of drawings in hard / soft copy format	Approx 2 to 3 weeks from the date of award of contract.
iii)	Furnishing of type test reports in hard / soft copy format	Hard / soft copy to be submitted immediately after the completion of the test.
iv)	Furnishing of routine test reports	Hard / soft copy to be submitted immediately after the completion of the test.
v)	All documents including Installation, Operation & Maintenance manuals.	Approx 2 to 3 weeks from the date of award of contract.

3.11 QUALITY ASSURANCE PROGRAMME

(a) To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Manufacturer's Works or at his Sub-manufacturer's premises or at the Purchaser's site or at any other place of Work, are in accordance with the specifications, the Manufacturer shall adopt a suitable quality assurance program to control such activities at all points, as necessary. Such program shall be outlined by the Manufacturer and shall be finally accepted by the Purchaser

(b) A quality assurance program of the manufacturer shall generally cover the following:

I. Manufacturer's organization structure for the management and implementation of the proposed quality assurance program:
II. Documentation control system;
III. Qualification data of bidder's key personnel;
IV. The procedure for purchases of materials, parts components and selection of sub-Manufacturer's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
V. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
VI. Control of non-conforming items and system for corrective actions;
VII. Inspection and test procedure both for manufacture and field activities;
VIII. Control of calibration and testing of measuring instruments and field activities;
IX. System for indication and appraisal of inspection status;
X. System for quality audits;
XI. System for authorizing release of manufactured product to the Purchaser

XII. System for maintenance of records;

XIII. System for handling storage and delivery; and

XIV. A quality plan detailing out the specific quality control measures and Procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

(c) The Purchaser or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Manufacturer/'his vendor's quality management and control activities.

3.12 QUALITY ASSURANCE DOCUMENTS

The Manufacturer shall be required to submit the Quality Assurance Documents as stipulated in the quality plan at the time of purchaser's inspection of equipment/ material.

3.13 TYPE AND ROUTINE TESTING & INSPECTION

1. The individual prototype equipment, systems and sub- systems shall be type and routine tested in accordance with the relevant IEC/UIC/EN publications inclusive of the mandatory and optional tests along with the special tests as specified.

2. All type tests shall be conducted by Supplier or such other agency or person agreed by RDSO / Nominated Agency at the Supplier's cost where ever performed in presence of and to the satisfaction of RDSO/ Nominated Agency, who reserves the right to witness any or all of the tests. All tests set forth in this specification shall be conducted by the Supplier or other agency or competent person as agreed by the purchaser/ RDSO/ Nominated Agency.

3. RDSO / Nominated Agency may waive some of these tests in case of equipment/ sub-assemblies where the manufacturer can establish to the satisfaction of RDSO that such tests have already been carried out earlier. In such a case, manufacturer shall submit complete test reports along with necessary certification.

4. Wherever any equipment, system, sub system is not specifically covered by an international recognized specification or test procedure, the tests which are acceptable to both to Supplier and to the IR's representative shall be devised.

5. Without prejudice to any provisions of the contract, the purchaser reserves the right to witness any or all of the type tests and to require submission of any or all test specification and reports.

6. In case any bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

7. The Purchaser, his duly authorized representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractors premises or Works and shall have the power, at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Manufacturer shall obtain for the Engineer and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Manufacturer's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site as the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

8. Supplier to depute qualified person for supervision of installation and commissioning of the equipment in the prototype rake. During the prototype tests/trials of train, if a technical problem arises with the equipment, qualified supplier representative should be deputed to attend the same.

9. During the prototype tests/trials or service of train, if any problems arise or feedback information is obtained, which warrants a re-check of the design/manufacture/quality of the equipment and components, action will be taken as may be necessary by the Supplier to carry out the required investigations and to incorporate the improvements considered most appropriate to reach compliance with the specification without any extra costs to the Purchaser and in a manner approved by the RDSO/Nominated Agency on equipment/components already supplied as well as those to be supplied later.

10. The prototype rakes fitted with the supplied equipment, shall be subjected to pre-revenue service trials. Service trials are intended to prove the satisfactory running performance of the supplied Train set equipment and evaluate their reliability in service, ease of maintenance and operations. The performance of the equipment shall be assessed based on the experience gained during the service trials. Necessary modification as required and also as desired by the RDSO/ Nominated Agency / Indian Railway shall be implemented in the series production without any extra costs to the Purchaser.

11. **Type tests on electronic equipment and control electronics**

    The electronic equipment and Control Electronics shall be tested as per IEC 60571/EN50155, IEC 60068, EN 50121, IEC 60721-2-5 and IEC 61373 including both compulsory and optional tests. Dry heat test, as specified in IEC 60571, shall be conducted for testing power and control electronic equipment at 80 degrees Celsius. LCD display units shall be tested at 70°C.

3.14 MATERIALS AND WORKMANSHIP

Equipment materials and components shall be new, of high grade and good quality and be to the latest engineering practice. The material and workmanship throughout shall be in accordance with the purpose for which they are intended. Each component shall be designed to be consistent with its duty.

3.15 PACKING, STORAGE AND HANDLING INSTRUCTIONS

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. The manufacturer shall also submit packing details/ associated drawing for any equipment/ material before equipment dispatch.

All coated surfaces shall be protected against abrasions, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device.

Storage requirements shall be clearly defined by the supplier. Packing shall be such that if required, long time storage at site should not deteriorate the performance of the equipment.

3.16 FIRE PREVENTION

i) The design of equipment shall incorporate all measures to prevent fire, and will be such that should any fire take place, the effects shall be minimized and no spread of fire should take place. Materials that are not fire retardant shall not be used.

ii) Materials used in the manufacture of equipment shall be selected to reduce the heat load, rate of heat release, propensity to ignite, rate of flame spread, smoke emission and toxicity of combustion gases.

iii) The fire protection on Train shall be designed and constructed in accordance with EN 45545.The applicable Hazard level will be HL3.

iv) Contractor shall furnish the relevant data, fire load calculations, certifications etc. of the items considered in fire load calculations separately for Above & Below the floor level. The calculations and validation shall conform to the standard adopted by the contractor for fire strategy.

v) Relevant provisions stipulated in Central Electricity Authority (Measures related to Safety and Electric Supply) Regulations, 2010, shall be followed in the interest of safety of passenger/staff as well as for equipment / instruments provided in the coaches.

SECTION – 4
RELIABILITY, AVAILABILITY, MAINTAINABILITY AND SAFETY (RAMS)

4.1 KEY PERFORMANCE INDICATORS

Performance indicators comprises of Availability, Reliability and upkeep of Cars. The bidder must ensure RAMS parameters for the offered equipment and its sub-assemblies supplied to at least maintain the overall fleet availability and reliability targets given below. In case, fleet reliability drops on account of poor reliability of subassemblies supplied, the supplier will be required to improve the quality of subassemblies to match the availability & reliability targets.

a) Availability

Sum of Available Hours as a proportion of the total hours (Available Hours + Non-Available Hours) in the Fleet in any Accounting Year, shall be considered as “Availability”. Guaranteed Availability in every Accounting Year shall be at least 95%.

b) Reliability

Average Mean distance travelled between two Failures for the fleet in any Accounting Year shall be considered as “Reliability”. Guaranteed Reliability shall not be less than 200,000 km.

c) Upkeep

For the offered equipment, there shall be no such conditions during the operation of trains that affects the reliability, safety and passenger amenities. Any maintenance shall be conterminous with the train maintenance schedules as given in Cl 4.5 of this section.

List of Conditions affecting Upkeep (As applicable) is enclosed as Annexure-A of this section.

4.2 RELIABILITY AVAILABILITY MAINTAINABILITY AND SAFETY (RAMS)

a) The supplier shall ensure that, Guaranteed Reliability, Guaranteed Availability and High Degree of Safety in order to provide a dependable service, forms an integral element of the offered products.

b) The plan for Reliability, Availability, Maintainability and Safety shall conform to EN 50126/ IEC 61709/ IEC 62278. Reliability of electronic components shall conform to IEC 61709.

c) The supplier shall develop and provide RAMS targets (MTBF/MDBF/MTBSF) for the offered equipment both for the complete system and for the major Sub-systems at ambient temperature up to 50°C.

d) After rectification of any failure / fault, the concerned equipment / system should resume its original performance / function.

e) Components critical for safety shall fall into safe operating mode in case of malfunctioning. The system safety plan shall identify and list safety critical components and this list shall be updated periodically and intimate to the purchaser.

f) Supplier shall submit the basic maintenance schedules of the proposed equipment. Minimum interval between two maintenance schedules in the depot for the equipment supplied should not be less than 90 days except for activities which can be done outside the base depot (such as cleaning of filters mounted in the under-frame, for which the periodicity shall not be less than 15 days) and 3 years for major works in workshop/major depot. Average running distance of a rake may be considered as 2000 kilometer per day. Please refer Cl 4.5 below in respective planning of maintenance schedule for the supplied equipment.

g) All systems, components and structural areas serviced as part of inspection or periodic preventive maintenance shall be conveniently accessible for service and inspection.

4.3 RAMS DOCUMENTATION

Vendor shall agree to submit following documents pertaining to RAMS analysis:

- Functional breakdown + inherent failure analysis
- Mission critical failures Analysis (Fault Tree Analysis)
- FMECA (Failure Mode Effects and Criticality Analysis)
- System/Sub-Systems Hazard Analysis
- Hazard Log + SIL data (if applicable)
- List of critical components
- Preventive Maintenance Analysis
- Corrective Maintenance Analysis

4.4 SERVICE LIFE OF EQUIPMENT/SYSTEM

Vendor shall specify the service life of the offered equipment / system based on life cycle calculations after which the equipment / system shall call for complete replacement to maintain the required reliability & availability of fleet.

Annexure-A

List of Conditions affecting Upkeep of Trains.

S.No.	System name	Condition
1	Windscreen Wiper and Washer System	- Rainy weather, defective wiper in any cab.
2	Couplers (any type)	- Any mechanical/electrical/pneumatic fault and/or any dimensional misalignment and/or any damage to any part which does not allow the coupler to guarantee the fulfilment to its assigned mission, in accordance to the technical requirements, performance and safety set out in this specification.
3	Suspension	- Any defect in primary / secondary suspension resulting in passenger safety, comfort or performance.
4	Wheel	- If wheel flat is > 40 mm or as finalised in design. - Any abnormal hammering as reported by the TO.
5	Pantograph	- Isolation of any pantograph
6	Transformer	- Isolation of any one main transformer.
7	Battery charger	- Battery Charger of one unit isolated.
8	Mechanical drive system	- Any defect resulting in high temperature / isolation
9	Traction Motors	- Isolation of more than 25%motors.
10	Traction converters	- As per the consequential effect as defined in Item 10 above.
11	Main compressor unit	- Isolation of any Main Compressor Unit
12	Auxiliary converter-inverter	- Isolation of any Auxiliary Converter-Inverter unit.
13	Brake system (mechanical)	- If isolation of an additional bogie (mechanical) leads to speed restriction.
14	Exterior lights	- Failure of any head light / marker/tail light.
15	Driver's desk	- If master controller prevents the train from moving. - Any defect in master controller even if no delays are reported. - Any defective cab switch leading to unsafe operation.

16	TCMS & Vehicle circuits	- If HMI display fails & functionality is not transferred to redundant HMI. - Any failure in TCMS component / equipment /circuit element / software/communication system etc. resulting in loss of intended function. - Further cases will be included based on TCMS redundancy and configuration.
17	PIS & CCTV	- If both automatic and manual announcements fail - If announcements in Car is not audible - if ≥ 1 unit exterior side view CCTV not working - If >1 PEA in any car is defective - One saloon CCTV, including its backup if any, is isolated. - If ≥ 1 unit for rear cab and front cab camera, cameras on the roof
18	Passenger doors	- If ≥ 1 (one) door per train side is isolated.
19	HVAC (passenger area)	- Failure of any one HVAC in any car leading to increase in inside temperature ≥28^{0}C - Failure of two HVAC's in one car. - Noisy Air Conditioner: Interior Noise >+2dB than the one recorded and validated during the type test at standstill)
20	Ground fault in DC Circuit	- Train to be withdrawn in case of single ground fault if it leads to unsafe operation as per the design.
21	A failure or symptom which may endanger safe and/or normal operation of train	- Failure in safety interlock or protection circuit such as door loop - Abnormal noise in underframe - Wheel flat - Arcing in pantograph - Failure of emergency equipment - Failure which may disable train's push out duty. - Train which that requires more than 2 instances of reset within 30 minutes - Jerky movement (The details shall be finalized in design stage). - Others to be decided during design stage

Note: *The above list shall be further reviewed and updated during design stage.*

4.5 TRAIN MAINTENANCE SCHEDULE (TENTATIVE)

Sl. No.	Schedule	Place of maintenance	Permissible time per schedule	Periodicity
1	Minor maintenance	Light maintenance at Depot	8 hours	3 months
2	AOH	Light maintenance at Depot	7 days	18 months
3	IOH	Heavy maintenance at Depot	10 days	36 months
4	POH	Heavy maintenance at Depot	20 days	72 months

SECTION -5

SPARES AND CONSUMABLES FOR MAINTENANCE

5.1 SPARES AND CONSUMABLES

i) Supplier shall provide complete list of items/materials which get consumed during normal course of operation of the Train as applicable for the equipment/system (the **"Consumables"**).

ii) Supplier shall provide complete list of parts or equipment/system ensuring fleet availability of 95% or better, which would be necessary for efficient operation and maintenance of the (the **"Spares")**.

iii) Supplier shall provide detailed spare parts catalogue / data-sheet listing all components manufactured or purchased by the supplier along with their rating, source, type / model no., schematic, position, etc.

iv) Price for above spares and consumables to be shared separately as part of commercial offer.

5.2 SCHEDULED MAINTENANCE

a) Scheduled (Preventive) maintenance consists of operations to maintain an assembly/subassembly or components in its specific operating conditions by performing:

   i) periodical inspection and diagnostic tests for prevention of malfunctioning.
   ii) scheduled replacement of components.
   iii) checks to be performed at specified time intervals, whose outcome determines whether or not replacements will be required.
   iv) routine operations, such as filling, topping up, change oil, greasing, adjustments, etc.
   v) general overhaul of systems and subsystems.

b) The preventive maintenance schedules required to keep the supplied system in good fettle with requisite reliability and availability would be coterminous with the train maintenance schedules and it should be possible to comfortably complete such maintenance during the time provided for respective train maintenance schedule and in the facility provided (refer Chapter Reliability, Availability, Maintainability and Safety).

c) Details of Schedule of Periodic / preventive maintenance (the **"Scheduled maintenance")** shall be submitted in following sample format:

Nature of inspection / maintenance	Periodicity / Interval	Items to be replaced

d) Scheduled Maintenance shall ordinarily not be required before a travel of 40,000 km (forty thousand kilometres).
e) Supplier shall provide plan / activities for periodical inspection and diagnostic test for prevention of malfunctioning
f) List of facilities including tools & tackles required for carrying out all scheduled maintenance activities to be provided by vendor.
g) All systems, components and structural areas serviced as part of inspection or periodic preventive maintenance shall be conveniently accessible for service and inspection.

5.3 UNSCHEDULED MAINTENANCE

Unscheduled (Corrective) maintenance consists of maintenance operation which is not scheduled (part of preventive maintenance) as a result of an in-service failure.

The supplier shall be required to provide repair & maintenance instructions to put back the equipment / system back in service.

List of facilities including tools & tackles required for carrying out all unscheduled maintenance activities to be provided by vendor.

5.4 EPIDEMIC DEFECT WARRANTY

(a) If any identical defect or deficiency affecting Safety, Reliability and Availability of the trains on more than 20% (twenty per cent) of equipment or parts in any rolling period of 36 (thirty-six) months commencing from the second Year of the Supply Period, such defect or deficiency shall be deemed to be an epidemic defect (the "Epidemic Defect") and the supplier shall cover such Epidemic Defect under an epidemic defect warranty.

(b) In case, the Government (Railways) notifies an Epidemic Defect on account of the supplied assembly, the supplier shall remedy such Epidemic Defect on all such Trains where equipment or parts of that particular design or lot are provided, subject to limitation of period elapsed since commissioning as mentioned above in this para.

5.5 OPERATION AND MAINTENANCE MANUAL

i) Supplier shall provide an operation manual (the "Operation Manual") for the offered equipment / system in soft copy format in English and Hindi language. The Operation Manual shall include (but not limited to):

a) Instructions for troubleshooting;
b) Rating and layout of equipment;
c) Operating limits of installed systems;
d) Control and safety features of the Equipment/System;
e) Instructions to Loco Pilots for operation of the Train (if applicable);
f) Do's and don'ts for Loco Pilots (if applicable);
g) Safety precautions to be taken by the Loco Pilots (if applicable);

ii) The Maintenance Manual to be provided by supplier shall include:

(a) All maintenance activities and their periodicities that are required to keep the Train safe and ensure that the prescribed tolerances of systems and components are not exceeded at any time, including any systems relevant to the maximum moving dimensions;
(b) The inspection program for regularly checking that the Train is safe to continuing in service;
(c) Assembly & disassembly sequences for the supplies with pictorial playbook guide
(d) The engineering facilities (such as pit facilities, special tools etc.) necessary for the mandated maintenance;
(e) Minimum competencies required by staff for the maintenance activities.

iii) The Maintenance Manual shall ensure that safety critical systems and components on the Train are identified specifically and the minimum testing requirements that must be invoked in the event of their disturbance at examination or repair are defined.

iv) Preparation of the Maintenance Manual shall give consideration to inspections, tests and maintenance of the following that have a bearing on safety:

(a) inter-vehicular couplers.
(b) fire prevention system including safe working of pantry/ sub pantry equipment.
(c) Auxiliary electrical machines: Integrity and security, earthing condition and integrity, condition of safety labelling.
(d) Passenger Information System
(e) Cleaning: Ventilation ducts, filters, bogies and underframe equipment
(f) Power systems (including protection systems): Integrity and security earthing condition and integrity, condition of safety labelling.
(g) Pantographs: Integrity and security - dimensions and condition of pantograph head, over-height protection, earthing condition and integrity, condition of safety labelling.
(h) Train structures and underframes: Integrity and condition of all load bearing members or panels, integrity, operation and security of doors, openable and removable panels, integrity and security of all body mounted equipment, alignment, gangway.
(i) Safety systems (e.g. Vigilance control device): Functional tests;
(j) Hydraulic and pneumatic systems: Condition and integrity of hoses, pipework, valves, etc.
(k) Fire protection systems: Integrity and condition.
(l) Lighting Systems & Visibility: Headlight, flasher and marker lights, adjustment, intensity
(m) Speedometers; headlights and marker lights; horn; doors; cattle guard; and bio-vacuum toilets

(v) The instructions within the Maintenance Manuals shall be such as to protect staff working on the Trains, with particular reference to safety precautions and implementing a specified safety condition of the Train prior to starting work.

5.6 OBSOLESCENCE MANAGEMENT

Supplier is required to manage obsolescence of all equipment, spares and consumables to enable the trains to continue in service for 35 years. This obsolescence management service must include:
i) Timely identification of any obsolete items of equipment;
ii) Development of mitigation strategies to minimize the impact of the imminent obsolescence of any item within the offered equipment / system including:

- Establishing alternative supply paths;
- Provision of equivalent or interchange parts or equipment
- Development of replacement products or design modifications to accept market available alternatives.

5.7 TRAINING ON MAINTENACE ASPECTS

Suppler to provide training to undertake scheduled and unscheduled maintenance to purchaser and its designated persons to handle the maintenance of train for 35 years. The duration of training shall be 12 man days.

REVISION HISTORY

Rev No.	Date	Description/Update
01	22.02.24	DOCUMENTS UPDATED AS PER CORRIGRNDUM FOR PS4452978

PERFORMA FOR PERFORMANCE CERTIFICATE

Name of firm: .....

TO WHOMSOEVER IT MAY CONCERN

Sub : Confirmation letter for service performance

Dear Sir,

We hereby confirm that We ..... have manufactured _____ number of sets of .....(Name of Equipment with Model No.) for 3 Phase IGBT based EMUs/MEMUs/Metros/trainsets/LOCOs.
We further confirm that …… number of sets of .....(Name of Equipment with Model No.) for 3 Phase IGBT based EMUs/ MEMUs/Metros/trainsets/Locos are in satisfactory operation for railway rolling stock application.
Proforma for performance statement confirming above is also attached.

Yours faithfully

For (Name of Firm)

PERFORMA FOR PERFORMANCE STATEMENT

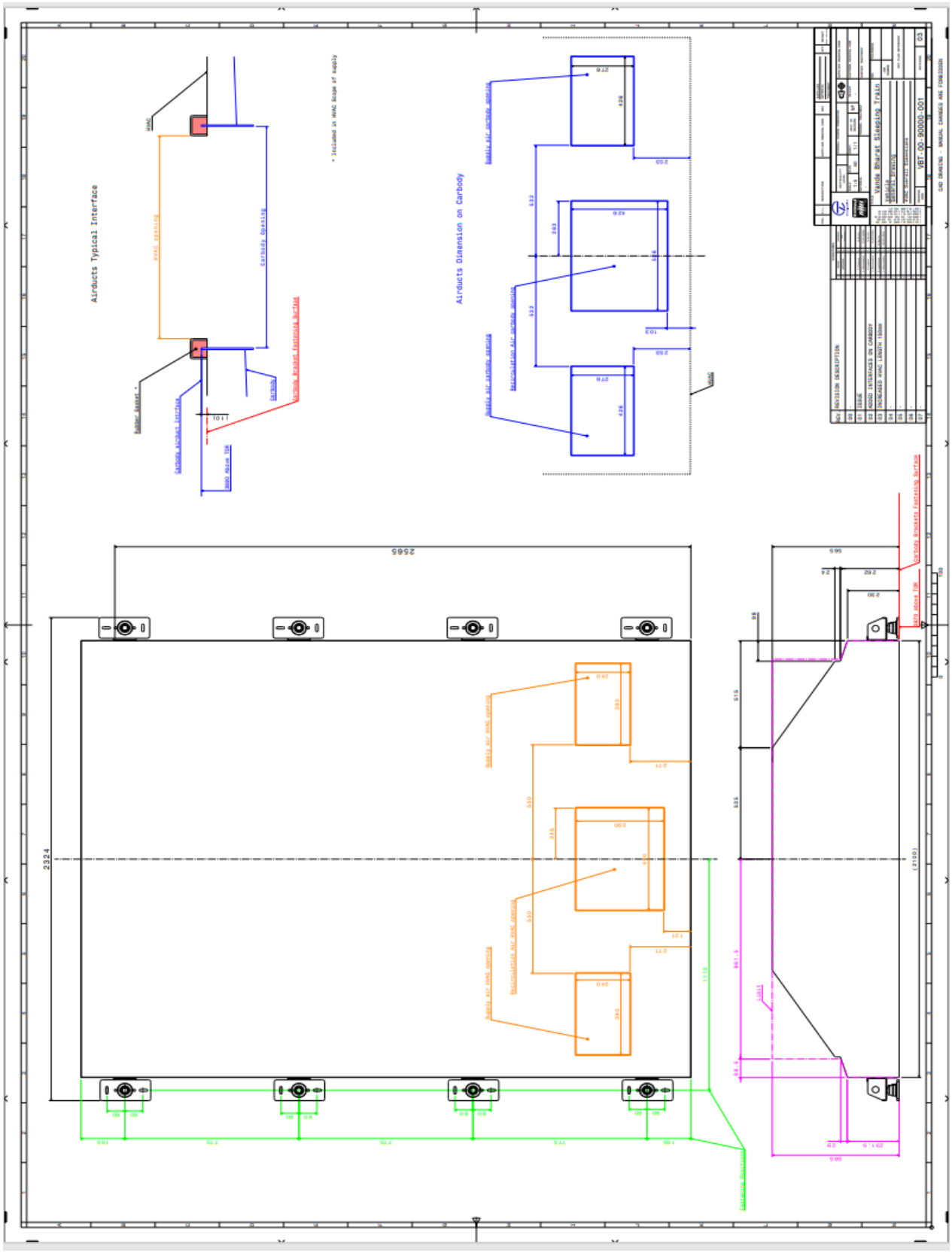
IGBT BASED 3-PHASE DRIVE TRAINSETS
PROFORMA FOR PERFORMANCE STATEMENT

Name of the Equipment:
Name of Firm :

S. No.	Order placed by (full address of Purchaser)	Order No. and Date	Description of Quantity of ordered equipment	Details of System for which equipment was supplied at Sr. No. 4 above to be given as follows			Value of Order	Date of Completion of Delivery		Remarks indicating Reasons for late Delivery, if any	Qty. in Satisfactory Service on 3 Phase IGBT based EMU's/MEMUs/ Locos/Trainsets /Metros
				Supply System	Unit Formation	Speed Potential		As per Contract	Actual		
(1)	(2)	(3)	(4)	(5)			(6)	(7)	(8)	(9)	(10)

ANNEXURE – A

Tentative SALOON HVAC OGA



FOR AERAULIC INTERFACE REFER ANNEXURE 2

ANNEXURE – B

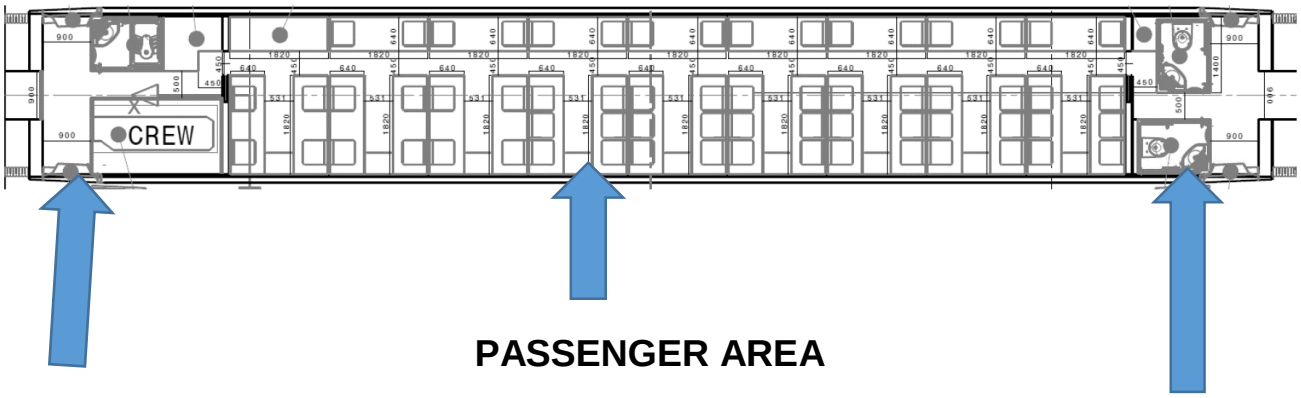
LIST OF STANDARDS FOR TESTING OF EQUIPMENTS

1.	Electric traction – rolling stock – test methods for electric and thermal /electric rolling stock on completion of construction and before entry into service	IEC 61133
2.	Electronic equipment used on rail vehicles	IEC-61287
3.	Specific rules concerning the electronic control part of converters	IEC-60571
4.	Electric traction - Electronic converter-fed alternating current motors	IEC 60349
5.	Railway application – rolling stock – Part 1: combined testing of inverter fed alternative current motors and their control system	IEC 61377
6.	Guide for the evaluation and identification of insulation systems of electrical equipment	IEC 60505
7.	Electric railway equipment-train communication network	IEC 61375
8.	Rotating electrical machines: Functional evaluation of insulation systems	IEC 60034-18
9.	Railway applications – electromagnetic compatibility – Part 3-2: rolling stock – Apparatus	EN 50121-3-2 / IEC 62236-3-2
10.	Railway applications – electromagnetic compatibility – Part 2: emission of the whole railway system to the outside world	EN 50121-2/ IEC 62236-2
11.	Railway applications – electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle	IEC 62236-3-1 / EN 501213-1
12.	Railway applications – compatibility between rolling stock and train detection system	EN 50238

13.	Transformer and chokes	IEC 60310
14.	High voltage AC circuit breaker	IEC 60077-4
15.	Rules for pantograph of electric rolling stock	IEC: 60494-1
16.	Relays, contactors and switches	IS 3231, IEC 60947
17.	Cables	IEC 60228, IS 10810**,** EN 50264
18.	Lightning arrestor	IEC 60099-4, IS 3070 Pt III
19.	Railway applications – rolling stock equipment – shock and vibration test	IEC 61373
20.	Programming languages for PLC	IEC 61131
21.	Railway applications – electric equipment for rolling stock	IEC 60077
22.	Electronic equipment used on rail vehicles	IEC 60571
23.	Power converter installed on board rolling stock – Part 1: Characteristics and test methods	IEC 61287-1
24.	Power converter installed on board rolling stock– Part 2: Additional technical information	IEC 61287-2
25.	Railway application – rolling stock protective provisions against electrical hazards	IEC 61991
26.	Auxiliary machines	IEC 60034
27.	Power factor correction	IEC 60871
28.	Environmental testing	IEC 60068
29.	Battery	Relevant IECs
30.	Degree of protection provided by enclosures	IEC 60529
31.	Rules for installation of cabling	EN 50343
32.	Railway applications, welding of railway vehicles and components. Inspection, testing and documentation.	EN15085

33.	Schedule of Dimension for broad gauge	IR Schedule Of Dimension for Broad Gauge, revision 2004 with latest amendment
34.	Reliability of electronic component	IEC 61709
35.	RAMS	EN 50126/ IEC 62278
36.	Metallized carbon strip for pantograph	RDSO's specification no. RDSO/2009/EL/SPEC/0097 Rev. 1 or latest
37.	Lighting arrestor	IEC 60099
38.	Capacitors	IEC 61881
39.	Railway applications: Fire protection on Railway vehicles	EN45545
40.	Railway applications: Body side entrance systems for rolling stock	EN 14752
41.	Railway applications: Air conditioning for urban and suburban rolling stock. Comfort parameters	EN 14750 EN13129

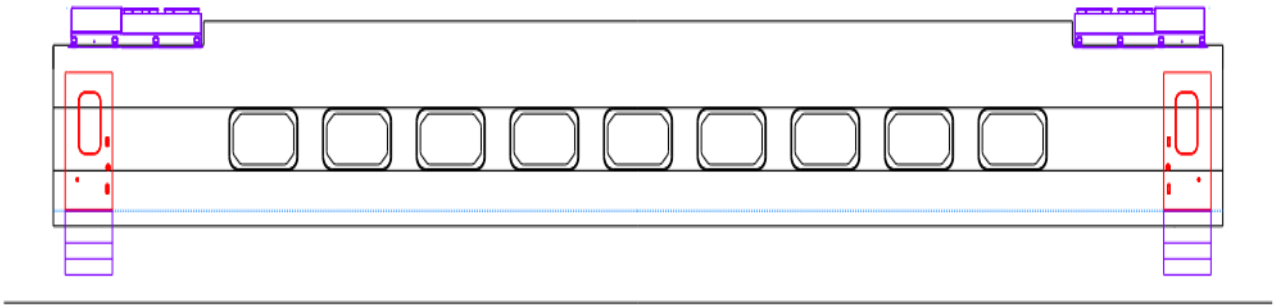
ANNEXURE –1
TENTATIVE GENERAL COACH LAYOUT

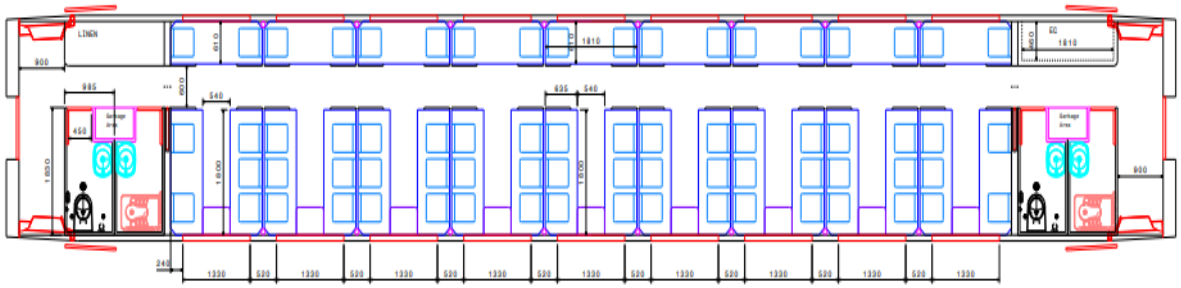


PASSENGER AREA

VESTIUBLE AREA-1 **VESTIUBLE AREA-2**

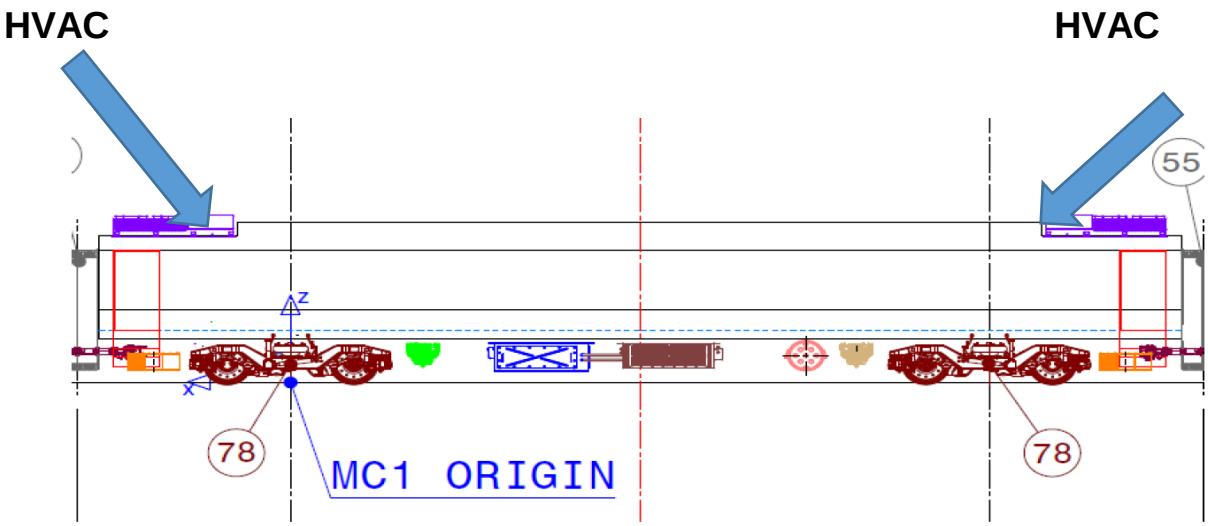
600 CMH OF AIR WILL BLEED IN EACH VESTIUBLE AREA

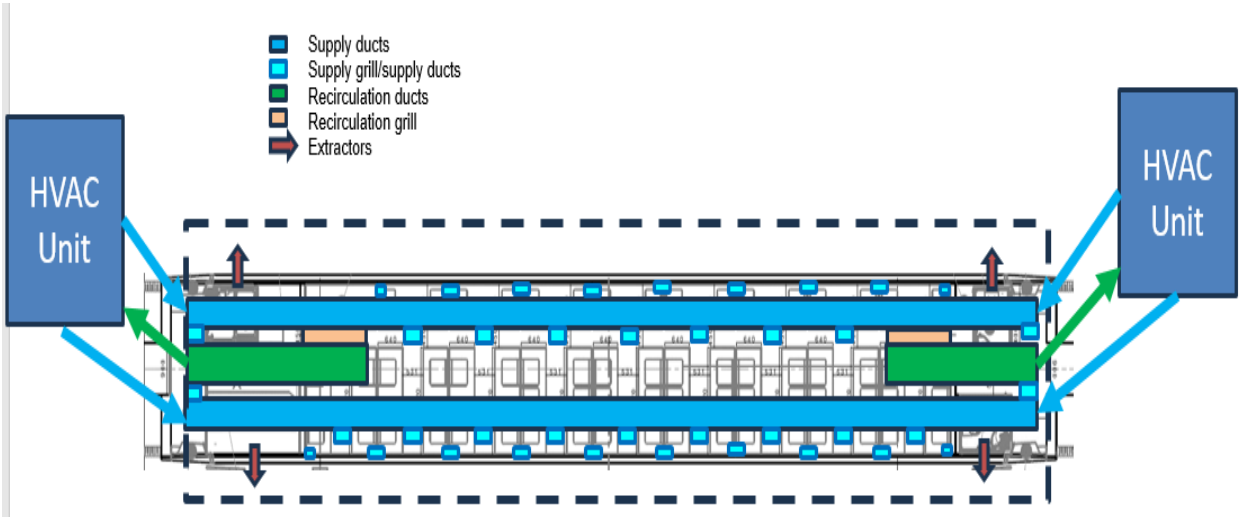




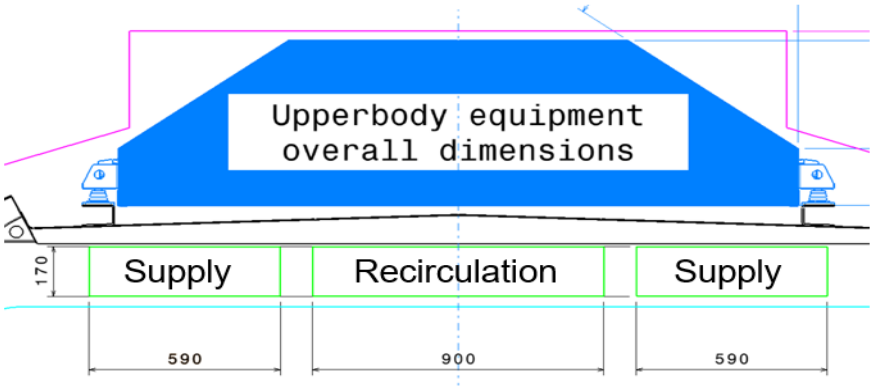
ANNEXURE –2

TENTATIVE RMPU POSITIONING/LAYOUT, RMPU VIEW, DUCTING LAYOUT TENTATIVE





The air duct is system is composed by two supply air ducts on the side, and one central recirculation duct.

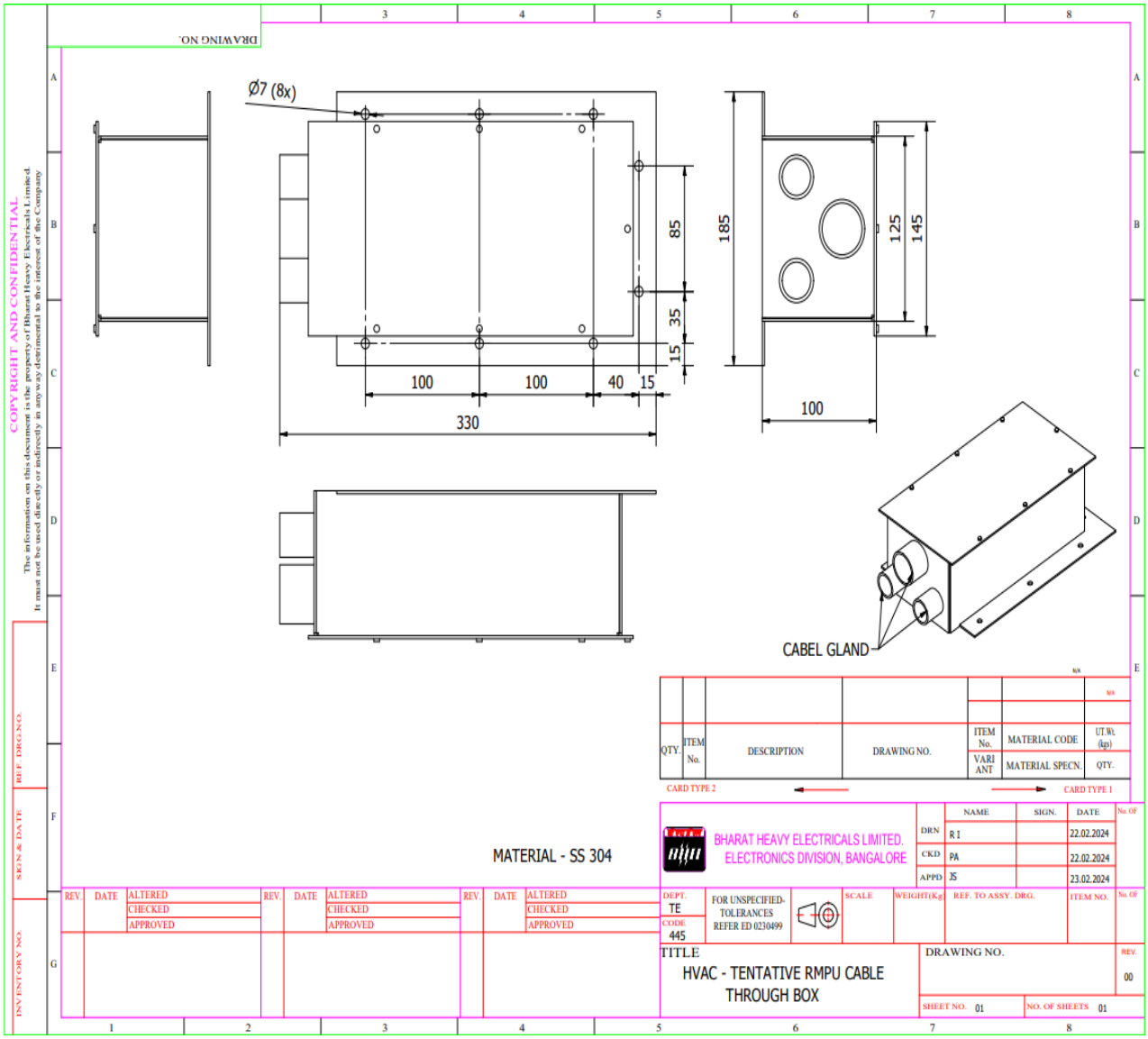


The preliminary aid duct shape is shown in the figure above. The HVAC unit shall have aeraulic interfaces directly above the air channel. According to our experience, the maximum velocity of air exiting from the HVAC should be below 10m/s, so the area of the interfaces shall be sized accordingly.

DUCTING SIZE FOR HVAC

ANNEXURE –3

TENTATIVE ROOF TERMINAL BOX DETAILS DRAWING



IP RATING OF BOX WILL BE IP65

ANNEXURE –4

List of Standards

i.	Electric traction – rolling stock – test methods for electric and thermal /electric rolling stock on completion of construction and before entry into service	IEC 61133
ii.	Electronic equipment used on rail vehicles	IEC-61287
iii.	Specific rules concerning the electronic control part of converters	IEC-60571
iv.	Electric traction - electronic converter-fed alternating current motors	IEC 60349 –2
v.	Railway application – rolling stock – Part 1: Combined testing of inverter fed alternative current motors and their control system	IEC 61377-1
vi.	Guide for the evaluation and identification of insulation systems of electrical equipment	IEC 60505
vii.	Electric railway Equipment-Train communication network	IEC 61375-1
viii.	Rotating electrical machines: Functional evaluation of insulation systems	IEC 60034-18
ix.	Railway applications – electromagnetic compatibility – Part 3-2: rolling stock – apparatus	EN 50121-3-2/ IEC 62236-3-2
x.	Railway applications – electromagnetic compatibility – Part 2: emission of the whole railway system to the outside world	EN 50121-2/ IEC 62236-2
xi.	Railway applications – compatibility between rolling stock and train detection system	EN 50238 IEC 62427
xii.	Transformer and chokes	IEC 60310
xiii.	Transformer oil	BS 148 -1984
xiv.	High voltage AC circuit breaker	IEC 60077-4
xv.	Rules for pantograph of electric rolling stock	IEC: 60494-1
xvi.	Relays, contactors and switches	IS 3231, IEC 60947
xvii.	Cables	IEC 60228, IS 10810, EN 50264
xviii.	Lightning arrestor	IEC 60099-4, IS 3070 Pt III
xix.	Railway applications – rolling stock equipment – shock and vibration test	IEC 61373
xx.	Programming languages for PLC	IEC 61131
xxi.	Railway applications – electric equipment for rolling stock	IEC 60077
xxii.	Electronic equipment used on rail vehicles	IEC 60571
xxiii.	Power converter installed on board rolling stock – Part 1: Characteristics and test methods	IEC 61287-1
xxiv.	Power converter installed on board rolling stock– Part 2: Additional technical information	IEC 61287-2

xxv.	Railway application – rolling stock protective provisions against electrical hazards	IEC 61991
xxvi.	Auxiliary machines	IEC 60034
xxvii.	Power factor Correction	IEC60871
xxviii.	Environmental testing	IEC 60068
xxix.	Batteries	IEC60871
xxx.	Degree of protection provided by enclosures	IEC 60529
xxxi.	Rules for installation of cabling	EN 50343
xxxii.	Railway applications, welding of railway vehicles and components. Inspection, testing and documentation (The Supplier shall, no later than the 5th(fifth) anniversary of the Appointed Date, demonstrate compliance to the EN 15085)	EN15085
xxxiii.	Schedule of Dimension	IR Schedule of dimension for Broad Gauge, revision 2022 with latest amendment/ Correction Slips
xxxiv.	Reliability of electronic component	IEC 61709
xxxv.	RAMS	EN 50126/ IEC 62278
xxxvi.	Metallized carbon strip for pantograph	RDSO's specification no. RDSO/2009/EL/SPEC/0097 Rev. 1 or latest
xxxvii.	Track Geometry	Indian Railway Permanent Way Manual
xxxviii.	Railway applications —Current collection systems - Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line	BS EN 50317
xxxix.	Railway applications —Current collection systems — Validation of simulation of the dynamic interaction between pantograph and overhead contact line	BS EN 50318
xl.	Railway applications — Current collection systems — Technical criteria for the interaction between pantograph and overhead line (to achieve free access)	BS EN 50367
xli.	Railway Applications – Air conditioning for main line rolling stock. Comfort parameters and type tests.	BS EN 13129

	Vande Bharat Project
	RAMS TEMPLATES
	CONTENTS
1	**Breakdown + Inherent Failure Reliability Prediction**
2	**Critical failures analysis**
3	**Failure Mode Effects and Criticality Analysis (FMECA)**
4	**System/Sub-Systems Hazard Analysis (SHA)**
5	**Hazard Log + SIL**
	Note All table are in accordance to the EN 50126-1-2-3 used as guideline. Refer to above standard for definition and meaning of contents. Minor differences may exist due to application of specific requirement from Railway Administration or final User

Breakdown + Inherent Failure Reliability Prediction

Project:															**Document No/Rev:**		
System:										**System Supplier:**					**Issue date:**		
Sub-System:																	
Drawing no:																	

RAMS code				Equipment /System Breakdown	Part number	Data Input	DTC	MC	TC	NDTC		λ unit. BASIC (FPMH)	Duty Cycle %	λ Effett. BASIC (FPMH)	λ Train Level (FPMH)	λ Train Level LEVEL 1 (FPMH) (16 CarTrain)	λ Train Level LEVEL 2 (FPMH) (Sub System)
				Equipment /System												Sum of Subsytems	
1	**1**			**Sub System 1**													**0.00**
1	**1**	1		Item 1													
1	**1**	2		Item 2													
1	**1**	3		Item (n)													
1	**2**			**Sub System 2**													**0.00**
1	**2**	1		Item 1													
1	**2**	2		Item 2													
1	**2**	3		Item (n)													
1	**3**			**Sub System (n)**													**0.00**
1	**3**	1		Item 1													
1	**3**	2		Item 2													
1	**3**	3		Item (n)													
				66													

Critical Failures Analysis

Project:			**Document No/Rev:**
System:		**System Supplier:**	**Issue date:**
Sub-System:			
Drawing no:			

TOP EVENT description:

Pos. No	Event Id. Number	Part/LRU Code	Description	Part Number	Coach type	Failure mode	Failure rate [1/(E-6 hrs)	FPMK	MTTR (h)	Failure rate source	Ref. to FMECA	Remarks	Action required

Failure Mode Effects and Criticality Analysis (FMECA)

Project:			**Document No/Rev:**
System:	**System Supplier:**		**Issue date:**
Sub-System:			
Drawing no:			

Position No	Part/LRU Code	Description	P/N	Coach type	Function	Phase	Failure mode		Cause of Failure Mode	Failure rate (FPMH)	Failure effect			Criticality		Failure identification /detection	Preventive and compensating measures	Remarks
							Fail. Mode index	Failure Mode			Local	System	Train	Service	Safety			

System/Sub-Systems Hazard Analysis (SHA)

:		Document No/Rev:
:	System Supplier:	Issue date:
stem:		
g no:		

Main System ID	Hazard Category	Hazard description (general)	Hazard Identification (detailed)	Hazard description (detailed)	Sequential Numbering	Phase / Operation mode	System / Sub-Sytem / Component	Causes	Consequence Potential accident/ damage	Severity Level	Probability	Risk Category	Preventive/compensating actions (Design, Maintenance, Operational Safeguards)	Target risk category	Remarks / Documents reference	Comments
Code that univocally identifies the system object of SHA	*Numbering for each hazard of the correspondin g "hazard type category"*	*Hazard category in accoding with Hazard List*	*Numbering for each hazard of the corresponding "hazard type"*	*Specific description of the generic hazard*	*Progressive number associated to previous column*	*- Running / Normal operation - Running / Degraded operation - Running / Multiple operation - Running / Emergency operation - Standstill / Parking - Standstill / Stabling - Standstill /Driver cab change - Depot / Manoeuvre - Depot / Maintenance*	*System/ subsystem /component from which the hazard originates*	*Description of the cause that originate the correspondin g hazard*	*Description of the consequences that could occour in case of the corresponding hazard. The subject of the consequences shall be identified.*	*Severity level category*	*Estimed Frequency of Hazard*	*Risk category and acceptance criteria*	*The preventive and mitigation measures identified in order to reach the Target risk Objective.All the useful Design, Maintenance, Operational safeguards shall be taken into account, and where available, a reference to applicable standards or regulation shall be reported.*	*Desired risk category and acceptance criteria*	*Reference to drawings or specification or documents*	*Any useful comments for a better understanding. For example it shall be highlighted If an hazard needs to be exported to the vehicle builder / train operator*

Hazard Log + SIL

Project:										Document No/Rev:			
System:							System Supplier:			Issue date:			
Sub-System:													
Drawing no:													

No.	Main Sys. Id.	Hazard Type	Hazard category	Hazard ID	Hazard Description	System / Sub-system/ Component	Cause	Exposed to the Hazard				Effects	Phase / Operation mode	Initial Risk Evaluation			Safety Function Code [A]	Description of Safety Function [B]	SIL [C]	Software (Safety Function) [D]	Preventive and mitigative measures	Final Risk Evaluation			STATUS	Responsibility				Remarks
								Driver	Crew	Passenger	Maintainer			Severity	Frequency	Risk						Severity	Frequency	Residual Risk		Car builder	Supplier	Maintainer	Operator	
1																													
2																													
3																													
4																													
5																													
.																													
.																													
.																													

Corrective Maintenance Analysis

Doc. No		**Rev No.**	**00**
Date:			
Project	**Vande Bharat Project**		
Equipment:			
Supplier:			
Compiled by:			

			REMARKS
Manpower cost		**Rs/hrs**	
Yearly distance run	**3,50,000**	**km**	
LCC period	**35**	**Years**	
Fleet (nr. of trains)	**80**	**Trains**	

Name of project	Corrective Maintenance results	TOTAL COST	35	Maint. hours per 1000 km
System:	Name of system	Period:	years	

Material cost [Rs/1000km]	Manpower cost [Rs/1000km]	Total cost [Rs/1000km]	Train/year	
			Train/period	
MTTR [h]	Total failure rate [f/10^6 h]		Fleet/Period	

Maintenance time [h]	FLEET level maintenance hours sum
Global Manhours [h]	FLEET level manhours sum
For AVAILABILITY index calculation	

COSTs		
Material [Rs/years]	Manpower [Rs/years]	Total [Rs/years]

RAMS code	Description	P/N	Failure mode	Failure rate [f/10^6 h]	MTBF [h]	Duty Cycle [%]	Applicable Failure Rate [f/10^6 h]	Vehicle DTC	Vehicle MC	Vehicle TC	Vehicle NDTC	Train Total Q.ty	Maintenance level	Maintenance task
1	**Equipment / System**													
	(Sub-Assembly A)													
	Item 1		Description											
	(Sub-Assembly A)													
	Item 2													
	Sub-Item 1		Description											
	Sub-Item 2		Description											
	Sub-Item 3		Description											

Description	Standard Tool	Special Tool	People Level	People N°	Failure diagnosis [min]	Integrator accesibility [min]	Supplier accesibility [min]	Change/ Repair/ Functional check	Other activity [min]	Nr. of persons OFF train	Off train activitiy [min]	Global Operation Time [h]	Global Man Time [h/man]	Percentage of global MTTR	Material Price [Rs]	Remark / Note
Equipment / System																
(Sub-Assembly A)																
Item 1																
(Sub-Assembly A)																
Item 2																-
Sub-Item 1																-
Sub-Item 2																-
Sub-Item 3																-
																-

Description	Single item Partial Failure Rate [f/10^6 h]	Single item MTBF [h]	Single item MDBF [km]	Single item Material cost [Rs/1000km]	Single item Manpower cost [Rs/1000km]	Single item Total cost [Rs/1000km]	Interval/Years 35.0 Failure number	Interval/Years 35.0 % Failure per fleet	Interval/Years 35.0 Material [Rs]	Interval/Years 35.0 Manpower [Rs]	Interval/Years 35.0 Total [Rs]	COSTs Interval/Years 35.0 Material FLEET [Rs]	COSTs Interval/Years 35.0 Manpower FLEET [Rs]	COSTs Interval/Years 35.0 Total FLEET [Rs]
Equipment / System														
(Sub-Assembly A)														
Item 1														
(Sub-Assembly A)														
Item 2														
Sub-Item 1														
Sub-Item 2														
Sub-Item 3														

Preventive Maintenance Analysis

Doc. No		**Rev No.**	
Date:			
Project	**Vande Bharat Project**		
Equipment:			
Supplier:			
Compiled by:			

			REMARKS
Conversion speed		**km/hrs**	
Manpower cost		**Rs/hrs**	
Yearly distance run	**3,50,000**	**km**	
Running days per year		**days**	
LCC considered period	**35**	**years**	
Basic maintenance frequency		**km**	
Distance covered in the considered period	**1,22,50,000**	**km**	
Train-sets number in the fleet	**80**	**Trains**	

Name of project	Preventive Maintenance results	
System:	name of system	
Material cost [Rs/1000km]	Manpower cost [Rs/1000km]	Total cost [RS/1000km]

35
[YEARS] Maintenance

			Material	ManPower	Total
Maintenance time [h]	Train-set level maintenance hours sum	Train / Year			
Global Manhours [h]	Train-set level manhours sum	Train / Period			
		Fleet / Period			

				Vehicle				TRAIN																												
RAMS LRU code		Description	Part Number P/N	DTC	MC	TC	NDTC	Total Q.ty	Step N°	Maintenance Level	Maintenance task	Standard Tool	Special Tool	Material	Frequency unit	Multiple	Cancellation per year	Cancellation at life end	Frequency [km]	People Level	Nr	Failure diagnosis [min]	Integrator accesibility [min]	Supplier accesibility [min]	Change/ Repair/ Functional check [min]	Other activity [min]	n. people OFF train	Off train activity Time [min]	Global Operation Time [h]	Global Man Time [h/man]	Material cost [Rs]	Remark / Note	35 Years Nr of interventions	Per Type of Item Material cost [€ / 1000 km]	Per Type of Item Manpower cost [€ / 1000 km]	Per Type of Item Total cost [€ / 1000 km]
1		**Equipment / System**																																		
		(Sub-Assembly A)																																		
		Item 1																																		
		Item 2																																		
		(Sub-Assembly B)																																		
		Item 3																																		
		Sub-Item 1																																		
		Sub-Item 2																																		
		Sub-Item 3																																		
		Sub-Item 4																																		
		Sub-Item 5																																		
		Sub-Item 6																																		