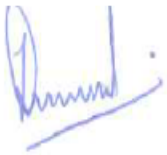
Corrigendum-01 dated 24-02-2024 to BHEL Technical Specification No.: PS4452966-part A (Rev. 0)- IV Coupler and Power Coupler for Train Sets.

Sl. No.	Clause No.	Changes made
1.	1.2 Bill of Material, B. Power coupler – Under frame inter coach power coupler for 16 car Rake: I.1	Cable voltage rating is changed from 4 GKW changed to 9 GKW.
2.	Addition of Cl. 2.1, xiv)	Requirement of HL-3 compliance.
3.	Annexure-II to PS4452966-Technical Specification of IV Coupler & Power Coupler for Train Sets.	1. Current ratings of C Coupler and D Coupler is revised. 2. Quantity of Jumper Cable (Normal and Fire Survival) in F1 & F2 Coupler is revised. 3. Voltage rating of Jumper Cable of P1, P2, P3, P4 Underframe power coupler is changed.

Note:
The changes are incorporated in revised Technical Specification and Annexure-II attached with this corrigendum.

		
Prepared by Shankar Narayanan	Checked by David J	Approved by Anjul

Annexure-II of Specifcation no PS4452886 **Rev-1**

COACH COUPLER JUMPER CABLE & SOCKET									
					Connector Details		PLUG & JUMPER CABLE DETAILS		
Coupler Arrangement	Coupler	Voltage (V) RMS/DC	Load(KVA for AC & KW for DC)	Current(A) RMS/DC	No of Pins inculding Erath/shield	Connector PIN rating	E-Beam Jumper Cable Size (in sqmm)	Cable Voltage (V) /other Ratings	Remarks
A- Coupler	ECN Line A - Operational network	NA	NA	NA	5	50V 10A	1RX2Px20AWG Ethernet Cat5e, Twisted Pair Cable,Shielded complying to IEC61375-3-4 and ,Fire survival Ph30 classs or above as per EN50200	100 Mbps	Complete jacketing shall be of Fire survival complying to EN50200,PH30 class
	ETB Line A - Operational network	NA	NA	NA	5	50V 10A	1RX2Px20AWG Ethernet Cat5e, Twisted Pair Cable,Shielded complying to IEC61375-3-4 and ,Fire survival Ph30 classs or above as per EN50200	100 Mbps	
	PAPIS &CCTV -Line A -Comfort network	NA	NA	NA	9	50V 10A	1RX4PX24AWG Ethernet Cable Cat7, Twisted Pair,Shielded,Fire survival Cable Ph30 classs or above as per EN50200	10Gbps	
	Infotinment 1- Line A-Comfort network	NA	NA	NA	9	50V 10A	1RX 4PX24AWG Ethernet Cable Cat7, Twisted Pair,Shielded, Fire survival Cable Ph30 classs or above as per EN50200	10Gbps	
	PAPIS Singnal-I- Audio line	NA	NA	NA	5	160V 10A	1RX4CX0.5Sqmm Screened cable,Fire survival Cable Ph30 classs or above as per EN50200		
	FDS System	NA	NA	NA	6		2RX2CX0.75Sqmm, 120Ω Screened Cable Complying to EIA/ TIA 485 standard,Fire survival Cable Ph30 classs or above as per EN50200		
	Brake sytem	NA	NA	NA	5		1RX4CX0.5Sqmm, 120Ω Screened Cable Complying to EIA/ TIA 485 standard,Fire survival Cable Ph30 classs or above as per EN50200		
	CT signal cable			175mA	4	10A	1RX4CX0.75Sqmm, Screened cable,Fire survival Cable Ph30 classs or above as per EN50200		
	Safety Cable				1	10A	1RX2.5Sqmm GYNE ,Fire survival Cable Ph30 classs or above as per EN50200		
G- Coupler	ECN Line B - Operational network	NA	NA	NA	5	50V 10A	1RX2Px20AWG Ethernet Cat5e, Twisted Pair Cable,Shielded complying to IEC61375-3-4 and ,Fire survival Ph30 classs or above as per EN50200	100 Mbps	Complete jacketing shall be of Fire survival complying to EN50200,PH30 class
	ETB Line B - Operational network	NA	NA	NA	5	50V 10A	1RX2Px20AWG Ethernet Cat5e, Twisted Pair Cable,Shielded complying to IEC61375-3-4 and ,Fire survival Ph30 classs or above as per EN50200	100 Mbps	
	PAPIS &CCTV -Line B -Comfort network	NA	NA	NA	9	50V 10A	1RX4PX24AWG Ethernet Cable Cat7, Twisted Pair,Shielded,Fire survival Cable Ph30 classs or above as per EN50200	10Gbps	
	Infotinment 1- Line B-Comfort network	NA	NA	NA	9	50V 10A	1RX 4PX24AWG Ethernet Cable Cat7, Twisted Pair,Shielded, Fire survival Cable Ph30 classs or above as per EN50200	10Gbps	
	PAPIS Singnal-I- Audio line	NA	NA	NA	5	160V 10A	1RX4CX0.5Sqmm Screened cable,Fire survival Cable Ph30 classs or above as per EN50200		
	FDS System	NA	NA	NA	6		2RX2CX0.75Sqmm, 120Ω Screened Cable Complying to EIA/ TIA 485 standard,Fire survival Cable Ph30 classs or above as per EN50200		
	Brake sytem	NA	NA	NA	5		1RX4CX0.5Sqmm, 120Ω Screened Cable Complying to EIA/ TIA 485 standard,Fire survival Cable Ph30 classs or above as per EN50200		
	CT signal cable			175mA	4	10A	1RX4CX0.75Sqmm, Screened cable,Fire survival Cable Ph30 classs or above as per EN50200		
	Safety Cable				1	10A	1RX2.5Sqmm GYNE ,Fire survival Cable Ph30 classs or above as per EN50200		
B1 - Coupler	415 V 3 Phase -BUS1	415	195	265	4	1000V,300A	3RX50 Sqmm Cable + 1Rx16 Sqmm GYNE	3GKW (600/1000V)	
B2 - Coupler	415 V 3 Phase -BUS2	415	195	265	4	1000V, 300A	3RX50 Sqmm Cable + 1Rx16 Sqmm GYNE	3GKW (600/1000V)	
C - Coupler	110 V DC, BD supply and Battery Charging line	110	14	130	5	1000V, 100A	4RX35 Sqmm Cable + 1Rx16 Sqmm GYNE	3GKW (600/1000V)	R1
D - Coupler	110 V DC, BN supply	110	27	250	5	1000V, 200A	4RX35 Sqmm Cable + 1Rx16 Sqmm GYNE	3GKW (600/1000V)	R1
F1 - Coupler	Train Lines-1	110	NA	NA	60	160V 10A	35RX1CX1.5 Sqmm Cables , Normal E beam cable 25RX1CX1.5 Sqmm, Fire survival Ph30 or above as per EN50200 1RX1CX1.5 Sqmm GYNE	3GKW (600/1000V)	R1
F2 - Coupler	Train Lines-2	110	NA	NA	60	160V 10A	35RX1CX1.5 Sqmm Cables , Normal E beam cable 25RX1CX1.5 Sqmm, Fire survival Ph30 or above as per EN50200 1RX1CX1.5 Sqmm GYNE	3GKW (600/1000V)	R1

UNDERFRAME POWER COUPLER JUMPER CABLE & SOCKET									
					Connector Details		Power Coupler Plug and Jumper details		
Coupler Arrangement	Coupler	Voltage (V)	Load(KVA)	Current(A) RMS/DC	No of Pins inculding Erath/shield	Connector PIN rating	Power Coupler E-beam Cable deails (in sqmm)	Cable Voltage Rating (V)	Remarks
P1- Coupler	1PH Supply ,50 hz -MC1-TC1	932	475	510	4	650	4RX 95 Sqmm jumper Cable, Power connectors shall be suitable for holding cable upto 120 Sqmm	9GKW (3600/6000V)	R1
P2- Coupler	1PH Supply ,50 hz -MC1-TC2	932	475	510	4	650	4RX 95 Sqmm jumper Cable, Power connectors shall be suitable for holding cable upto 120 Sqmm	9GKW (3600/6000V)	R1

	BHARAT HEAVY ELECTRICALS LIMITED **ELECTRONICS DIVISION TRACTION** **Mysore Road, Bangalore**	**DOC. NO: PS4452966 - Part A** **REV. NO: 01** **PAGE: 1 OF 37**

	CUSTOMER/ CONSULTANT	BHEL/INDIAN RAILWAYS
	PROJECT	DESIGN, DEVELOPMENT, MANUFACTURE, SUPPLY, INTEGRATION, TESTING & COMMISSIONING OF IGBT BASED THREE PHASE PROPULSION EQUIPMENT, CONTROL AND OTHER SYSTEM FOR ELECTRIC TRAIN SETS FOR OPERATION ON 25KV AC OHE SYSTEM

TECHNICAL SPECIFICATION

IV Coupler and Power Coupler Assembly for Train sets

Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS

Issued By: Traction Engg. Dept., BHEL-EDN	**APPROVED** **S P Singh**		
	PREPARED **David J**	**CHECKED** **Anjul**	**DATE** 23.02.2024

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 Inter Vehicular & Power coupler along with its accessories.

The equipment is required for 25kV IGBT based three phase Trainsets for Indian Railways.

The equipment is required for the following project:

Name of the customer: BHEL/INDIAN RAILWAYS

Name of the Project: DESIGN, DEVELOPMENT, MANUFACTURE, SUPPLY, INTEGRATION, TESTING & COMMISSIONING OF IGBT BASED THREE PHASE PROPULSION EQUIPMENT, CONTROL AND OTHER SYSTEM FOR ELECTRIC TRAIN SETS FOR OPERATION ON 25KV AC OHE SYSTEM

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 & RDSO 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:

A. Inter Coach Coupler for 16 car Rake:

Sl. No.	Description	Qty. per Set (16 Car train)	Remarks
I	**DOUBLE ENDED PLUG & JUMPER CABLE ASSEMBLY:-**	**Qty in Nos**	
1.	A Type	15	**(Refer Annexure-II & III for Details)**
2.	G Type	15	
3.	F1 Type	15	
4.	F2 Type	15	
5.	B1 Type	15	
6.	B2 Type	15	
7.	C Type	12	
8.	D Type	15	
II	**SOCKET CABLE ASSEMBLY:-**		
1.	A Type	30	**(Refer Annexure-II & III for Details)**
2.	G Type	30	
3.	F1 Type	30	

4.	F2 Type	30	
5.	B1 Type	30	
6.	B2 Type	30	
7.	C Type	28	
8.	D Type	30	
III	**COUPLER PLATES :-**		
1.	DTC, MC, TC, NDTC Coaches coupler plate socket cables A, G, B1, B2, F1, F2, C& D, their parking and equipotential connections (Original) **Note:** **(i) A, G, B1, B2 are upper plates** **(ii) C, D, F1, F2 are bottom socket type plates**	60No.	**Coach end outer wall Cutout - 290mm X 300mm For Coupler plates** **(Refer attached Annexure-IV for Cut out)**
2.	DTC, MC, TC, NDTC Coaches coupler plate socket cables A, G, B1, B2, F1, F2, C & D, their parking and equipotential connections (Mirror orientation) **Note:** **(i) A, G, B1, B2 are upper plates** **(ii) C, D, F1, F2 are bottom socket type plates**	60 No	
3.	**OTHER ACCESSORIES REQUIRED FOR MOUNTING AND ELECTRICAL CONNECTIONS**	1 Set	As required for 1 set of 16 Coach Train set rake

B. Power coupler – Under frame inter coach power coupler for 16 car Rake:

Sl. No.	Description	Qty. per Set (16 Car train)	Remarks
I.	**Under Frame Power Coupler Jumper and socket connector assembly: - 8 set of underslung power coupler (Jumper +Socket)**		
1.	Under Frame power coupler plug with Jumper cables between TC and MC , each coupler suitable for set of Eight power connections with 95Sqmm or 120 Sqmm, 9GKW cable and with feedback switches for disengagement /disconnection	**8 set**	**(Refer attached Annexure-III & IV)**
2.	Under Frame power coupler connector Box , each box for connection of Eight nos 95sqmm or 120 sq mm power connections mounted on the TC and MC coaches with feedback switches for disengagement /disconnection	**16 set**	**(Refer attached Annexure-III & IV)**
3.	**OTHER ACCESSORIES REQUIRED**	**1 set**	As required

	FOR MOUNTING AND ELECTRICAL CONNECTIONS		for 1 set of 16 Coach Train set rake

C. Tools for Crimping –:

Sl. No.	Description	Qty one set For every four Rakes	Remarks
1.	Crimping tools for Jumper & socket Control cable	**1**	
2.	Crimping tools for Jumper& socket Power cables	**1**	
3.	Crimping tools for Jumper & Socket Data Communication cable (Cat 5 E and Cat 7 category cables)	**1**	
4.	Crimping tools for Under frame Power coupler connectors	**1**	
5.	Special tools if any	**1**	

Note:

i. Supplier shall quote single price for complete scope as per Bill of Material. Any change in lengths in cable assemblies after finalization of first prototype 16 car train shall have no price repercussion in further series supplies.

ii. Details of wires with signals for each cable assembly is attached as per annexure -II.

iii. Drawing of coach IV coupler arrangement and Under frame power coupler for the 16 car train set is attached as annexure-IV

iv. Fire survival cable shall be considered for the applicable cables as per Annexure-II complying to EN50200.

1.3 ELIGIBILITY CRITERIA

The Bidder should be a regular manufacturer/ supplier of IV coupler & jumper cable assembly for Rolling stock application of Indian Railway for 3 phase IGBT Based Train sets /RRTS/Semi high speed trains/AC EMU/MEMU operating in India or any other railway systems in the world.

1.4 CLAUSE BY CLAUSE COMPLIANCE

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

SECTION – 2
TECHNICAL SPECIFICATION

TRAIN CONFIGURATION:

(1) Rake configuration consist of multiple of 04 basic units. One 16 car train formation is as follows: Refer Annexure-1
DTC-MC1-TC-MC2-MC1-TC-MC2-NDTC1-NDTC2-MC2-TC-MC1-MC2-TC-MC1-DTC
Where DTC: Driving Trailer Coach, MC: Motor Coach and TC: Trailer Coach

(2) Train (Rake) formation in Train set is dynamic and is possible with minimum of 4 basic units and maximum of 6 basic units. Thereby Train set rakes have 16/20/24 coaches.

(3) Refer Annexure II for the Train formations.

2.1 TECHNICAL SPECIFICATION OF IV COUPLER & JUMPER CABLE ASSEMBLY

i) The electrical coupler shall be capable of making all necessary electrical connections between adjacent cars to permit controls of all cars in a rake from the leading cab. On minimum radius curves, the covers shall not exceed the allowable clearance envelope of the car. Sufficient spare contacts (at least 30 %) shall be provided for catering to future needs of the IR. As such multiplexing of signal shall be adapted to the maximum extent possible in line with the current international practices.

ii)The outer cover of the electrical coupler shall be additionally strengthened to protect the coupler against ballast or external hitting.

iii) In order to secure the cables from external hitting, the cables connected with the coupler shall not hang lower than the lowermost face of the coupler and shall be suitably secured to arrest any dangling.

iv) Electric couplers shall use a configuration so that any end of the standard unit can couple to any end of any other standard-unit. Contacts shall preferably be spring loaded, of silver surfaced alloy, shall have sufficient capacity, shape and positive action to prevent fouling in coupling, shall maintain positive contact under all specified operating conditions and shall be capable to work even with the impacts to which the car coupler may be subjected in service.

v) The inter-vehicular coupler arrangement for both power and control system shall be proven and shall conform to international standards. However, special arrangement shall be made to ensure that it is not damaged due to external reasons like vandalism, ballast hitting and the flooding conditions. The layout shall be such that it is out of the reach of any passenger or common man.

vi) The design shall cater for relative movements between the coaches. It shall be that there is no disruption and sparking due to vehicle behavior under worst conditions of operation.

vii) All end connection and fittings will be supplied by supplier. The jumper cables assemblies i.e. jumper cables along with the inter-vehicular couplers & adaptor assemblies in assembled condition shall be supplied by the suppler. These assemblies shall be tested for endurance test for 20 million cycles on test rigs simulating the conditions of end of coach at level, curves & crossings.

viii) These assemblies shall be supplied by the supplier and be fitted on the newly manufactured Train sets coaches by ICF/manufacturing unit. The electrical couplers to be used shall be designed for trouble free operation under all operating conditions.

ix) Couplers shall allow coupled coaches to negotiate curves of radius 152.4 meters and shall be capable of passage in either direction over standard 1 in 8 ½ turn outs and shall function satisfactorily with difference in head stock heights of adjacent coaches up to 75 mm. Supplier shall ensure that the jumper cable assemblies do not touch/rub the couplers under any circumstances.

x) The coupler system shall permit train operation up to 24 cars in Train sets and shall enable one cab in a rake to control all other cars in a rake through the electric train lines.

xi) Coupling shall be capable of being accomplished by one person and shall be practicable with longitudinal axes misalignment between cars of eight degrees and 100 millimeters different in height.

xii) All train lines and inter vehicular couplers shall be so designed that they are not susceptible to any damage due to vandalism and external hitting during the run. Further, adequate safety measures shall be taken to safeguard against ballast hitting, vandalism, rains and flood water. The layout shall be such that they are accessible to maintenance staff only. Adequate measures shall be taken to reduce the number of train lines to bare minimum. Details of the arrangement shall be furnished during the design approval stage.

xiii) The proposed design of IV Coupler & Jumper Cable Assembly (No. of couplers, jumpers, pin/core configuration, etc.) is to be approved by RDSO/ICF and changes as required by RDSO/RCF/ICF shall be incorporated by the supplier.

xiv) Design and manufacturing of complete IV Coupler and Power Coupler assembly shall be in accordance with EN45545. The applicable Hazard level will be HL 3.

2.2 RATING OF IV COUPLER & JUMPER CABLE ASSEMBLY

i) The number of pins in each Coupler and the corresponding size of jumper cable shall be as per Annexure I & II. The supplier shall confirm in the technical offer that all the required number of coupler pins can be accommodated in each coupler and shall submit the datasheets for the connector and jumper cables. The specifications/IS/IEC followed for designing of IV Coupler and Jumper Cable Assembly shall be mentioned.

ii) The IV Coupler & Jumper Cable Assembly with base plate for a 16 Coach train sets shall be as per BHEL Drg. No. DTC1, DTC2, NDTC1, NDTC2, MC & TC, (Refer Annexure VI). The total weight details of the assembly shall also be mentioned.

iii) The supplier shall study the load requirements at Annexure I and must confirm that the connector pins and sizes of jumper cables used are suitable for these loads. The cables shall be de-rated to take care of the adverse ambient conditions. All de-rating factors shall be applied, together with the maximum permissible conductor temperature for the particular insulation type. In no case the conductor continuous temperature shall exceed 90^{o}C. The maximum short circuit temperature shall not exceed 250^{o}C. The cable insulation shall be capable of withstanding these temperatures. Detailed calculations must be submitted for the current carrying capacity of each core of the jumper cable.

iv) All the inner cores of jumper cables shall be electron beam irradiated, thin walled cables conforming to International standards using low smoke, low toxicity & halogen free materials suitable for Train sets applications. The outermost sheath of jumper cable shall preferably be electron beam irradiated.

v) High grade electrolytic copper stranded conductors tinned as per approved international standards and practice shall be used.

vi) a) Relevant IEC as applicable to the type of cable used:
IEC 60332-1 (1993); 60332-3 (1992); 60754-2 (1991) Amendment 1 (1997); 61034-2 UIC 895, UIC 541-2, UITP Part 2; VDE 0298-T3, RDSO, CLW.

b) For Data communication cables: shall comply to IEC61375-3-4 twisted par cable and other standards such as IEEE802.3, IEC61156-6, EN 50288-2-2, TIA568-c.2 for cat5E (Category 5 E),100Ω, 1 to 100Mhz cable suitable for IEC 61375-1 communication standards

c) Comfort Network 1000Mbps/ 10 GPS cables complying to IEEE802.3, IEC61156-6, EN 50288-2-2, TIA568-c.2 for cat7(Category 7 E), 100Ω, 1 to 600Mhz cable suitable for media transportation standards

d) For RS485/ CAN Cables with characteristic impedance 120 Ω shall comply to TIA485 standard latest edition/version

e) For fires survival cables as of Annexure -1, EN 50200, PH30 grade shall be applicable

vii) The material of insulation and sheath of each core and layer in the jumper cable must be mentioned in the datasheet of the jumper cable.

viii) The thickness of insulation and sheath of each core and layer in the jumper cable must be mentioned in the datasheet of the jumper cable.

ix) Datasheet of jumper cable shall mention the diameter of cores of cable and overall diameter of the jumper cable. The standard to which Jumper Cables conform shall also be mentioned in the datasheet.

x) The internal test results of jumper cables along with the standards to which they conform shall also be submitted by the supplier.

xi) The contact material for control and data couplers for wire size up to 2.5 sq mm shall be Copper alloy with gold plating. The contact material for rest of the couplers (for wire size more than 2.5 sq mm) shall be copper alloy with silver plating.

xii) For A and G coupler, no of pins requirement–for PAPIS, CCTV & Infotainment Signals in each coupler shall be decided during detailed engineering. The wire cross section for PAPIS, CCTV & Infotainment may vary from 0.5 sq mm to 2.5 sq mm. Exact size of PA/PIS cables shall be informed after finalization of PA-PIS system.

xiii) Details of fire-retardant protective sleeve and suitable strain relief arrangement shall be submitted by the supplier.

xiv) Proper marking and color-coding arrangement shall be followed. Details shall be finalized in consultation with RDSO/~~RCF~~/ICF. Printing information / cable marker details provided by BHEL after finalization of scheme.

xv) Base plate as per Annexure-III shall be used for mounting of couplers, which would be mounted on the coach with suitable gasket. Earthing point shall be provided on the base plate. The material of base plate shall be Stainless Steel.

xvi) Only crimped connections shall be used for all type of connectors. The socket of the IV Coupler should be suitable for termination of cables on the socket coming from the end wall panels. All the lugs, cable marker s/accessories required for cable termination on the socket shall be in scope of the supplier.

xvii) The supplier shall also submit the list of tools required for the crimping and connections.

xviii) The QAP including quantum of checks, type test plan, design details with test protocol shall be submitted.

xix) The vibration test shall be part of type test plan.

xx) The IV Coupler and Jumper Cable assembly shall have IP-68 or higher protection.

xxi) The supplier shall submit the supportive document of IV Couplers offered for proven-ness under environmental conditions prevalent in India.

xxii) The IV Coupler & Jumper Cable Assembly shall be sturdy and suitable for ambient and operating conditions at Clause 3.3.

xxiii) Connectors shall comply to latest standards for EMC /EMI compliance.

xxiv) Coupler Plates shall be of SS-304 grade, IP-68 or higher protection, complying to welding standard –DIN-EN15085 -2 level CL2 and DIN-EN ISO 2553. Powered coated with RAL7024 glossy finish with coating thickness 50 µm according to ICF spec-ICF/MD/SPEC-091

2.3 TESTING OF IV COUPLER & JUMPER CABLE ASSEMBLY

The supplier shall submit the test protocol for routine and type tests. The tests for IV Coupler & Jumper Cable Assembly shall necessarily include the following tests as per international standards for rolling stock: -

i) Life Cycle Tests (Dynamic bending & Torsion Test and Vibration Test): -
   a. Vibration Cycles Test: - Minimum 20,000,000 cycles
   b. Movement cycles Test: - Minimum 4,000,000 cycles

Detailed test protocol shall be finalized in consultation with RDSO/ICF/RCF.

2.4 TECHNICAL SPECIFCATION FOR UNDER FRAME POWER COUPLER

(i) Under Frame power couplers are meant to transfer power from TC coach transformer to MC coach Traction convertor

(ii) Couplers shall be designed for Rated power / short time and short-circuit rating

(iii) Couplers connectors are susceptible to Harmonics be designed for the Same with respect to IEEE519

(iv) Couplers are to comply to EMC / EMI requirements as per EN50121

(v) Under Frame Power Couplers shall have feedback control system in case of disengagement/ disconnection and bidders shall furnish all mounting and interlocking arrangement for the same

(vi) Design & conceptual drawing shall be submitted by the bidder for Suitable mounting arrangement and interlocking mechanism for this underframe power coupler arrangement.

2.6 EQUIPMENT TESTING:

(a) 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.

(b) Supplier to submit Routine test certificates and inspection certificate of equipment as per QAP along with equipment.

(c) Type and routine test will also confirm to clause 3.11 of section 3 of technical specification.

2.7 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 ≥28^0C - 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.

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)

REVISION HISTORY

Rev No.	Date	Description/Update
1	23.02.2024	Annexure-II updated. Point no. 2.1.xiv) added for HL-3 compliance.