Change in Technical Specification for Battery with Battery box, Doc. No.: PS4452881 - Part A, Rev. 01

Clause No	Existing clause description	New clause description
2.1.1.1 (e)	Active cell balancing	Cell balancing
2.1.2.1	Change in limiting dimensions	

Above changes are incorporated in Battery specification, and revision number is changed to 02.

TECHNICAL SPECIFICATION

Battery with Battery Box

Rev No.	Date	Altered	Checked	Approved	Revision details

Issued by: Traction Engg. Dept., BHEL-EDN	Approved by: S P Singh		
	Prepared by	**Checked by**	**Date**
	Girish Chand	P K Lakra	23.09.2023

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SECTION – 1

SCOPE, QUANTITIES & ELIGIBILITY

1.1 Scope

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of subject item of this specification.

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 and 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 / Scope of supply:

Sl. No.	Description	Qty (Per 16 car train)	Remarks
1	Battery Box containing Lithium Iron Phosphate (LFP) battery pack, Battery Management System (BMS) along all with accessories (contactors, fuses etc.), electrically and mechanically integrated, directly mountable on coach underframe.	4 sets	Details of Battery pack, BMS, and Battery box are provided in section 2.
2	Legrand 555688 or equivalent Panel Mounting Socket for external supply	4 Nos	Connector should be RDSO approved
3	Harting/Phoenix or equivalent make alloy connector for control connection	4 Nos	Connector should be RDSO approved
4	Mating connectors for all power/control connections	4 Set	
5	Mounting hardware	4 Set	Mounting hardware shall be Stainless steel (A2-70).
6	Any other electrical or mechanical accessory required towards mounting or overall functioning of the battery.	4 Set	

1.3 Eligibility Criteria

The Bidder should be a regular supplier of underslung mounted batteries of minimum 120Ah Capacity, and should have supplied the batteries for Railways projects of 3 phase IGBT Based Locomotive/ EMU/ MEMU/ Metros/ Trainsets/ Rolling stock/ other Multiple Unit Trains operating in India or abroad.

Alternately, Bidder should have supplied Lithium-Ion chemistry based batteries for Electric Vehicles with minimum capacity of 120Ah and in operation successfully for at least 1 year. The supplied batteries shall comply to AIS 156 standard.

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 RDSO Specification No. RDSO/PE/SPEC/EMU/0196 (Rev.0)-2019 along with addendums.

SECTION – 2

TECHNICAL SPECIFICATION

2.1 Technical requirement

This specification covers general guidelines for design, development, manufacturing, testing, supply, commissioning and field validation of Battery and its Battery Management System (BMS) for Trainsets.

Batteries are provided in each Basic Unit to feed the emergency 110V DC loads for at least 3 hours in the event OHE supply is not available.

Refer to clause 3.2.1 for train formation.

2.1.1 Battery Pack

	Parameter Name	Parameter Value
1.	Application:	Traction
2.	Type:	Lithium Iron Phosphate (LiFePO4 / LFP)
3.	Voltage:	103VDC to 116VDC (Nominal: 110VDC)
4.	Depth of discharge:	>= 80%
5.	Lifecycle:	> 3500
6.	Capacity:	71.5 kWH (23.8 kW x 3 Hours), 650Ah min.
7.	Charge / Discharge rate:	0.1C / 0.33 C
8.	Mounting location:	Coach Underframe (inside battery box)
9.	Cooling:	Natural
10.	Charging characteristics	To Be Determined by battery manufacturer

2.1.1.1 Battery Management System

A high efficiency Battery Management System (BMS) shall be integral part of battery pack. BMS shall be capable of cell level monitoring. Following minimum features & protections shall be implemented on cell level BMS:

a) Over-charge protection.
b) Over-discharge (deep discharge) protection.
c) Short circuit, Overcurrent protection.
d) Thermal runaway protection.
e) Cell balancing.
f) Current protection (protection against excessive charge/discharge currents)
a) Over voltage / Under voltage protection.

The above list of protections is tentative. List of protections shall be finalised during detailed design stage, and in consultation with Indian Railways.

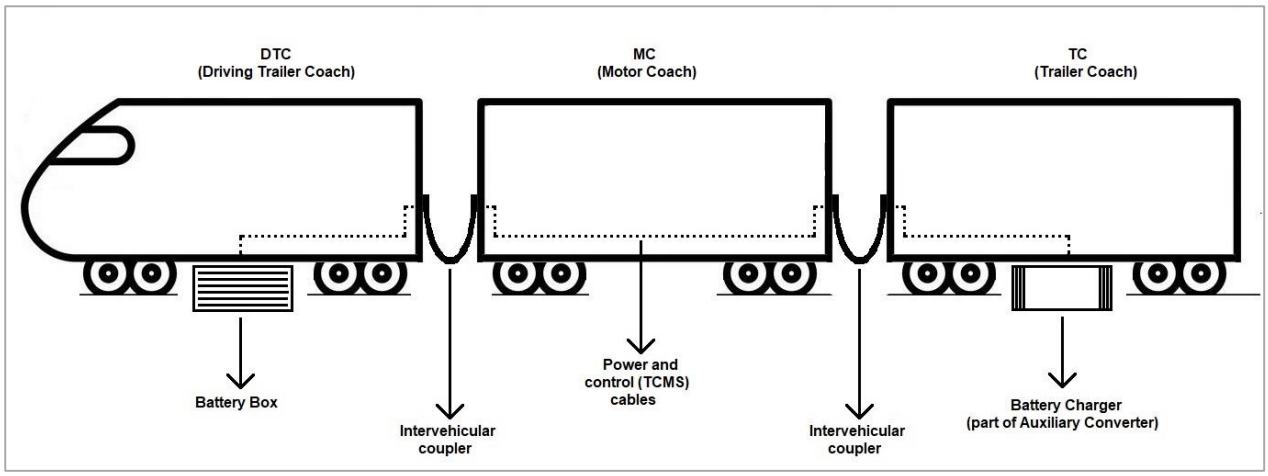
2.1.1.2 Interface with train TCMS

The train TCMS is implemented on Ethernet protocol (TRDP). BMS should be able to communicate with TCMS over Ethernet.

2.1.1.3 Interface with Battery Charger

BMS shall interface with battery charger through TCMS over Ethernet cables (Cat5e). Battery shall be mounted on DTC/NDTC coach, while the Battery charger, being part of Auxiliary Converter, shall be mounted on TC coach.

Location of Battery and Battery charger in a rake is shown below.



Distance between Battery box and battery charger is 60 meter approx.

2.1.2 Battery Box

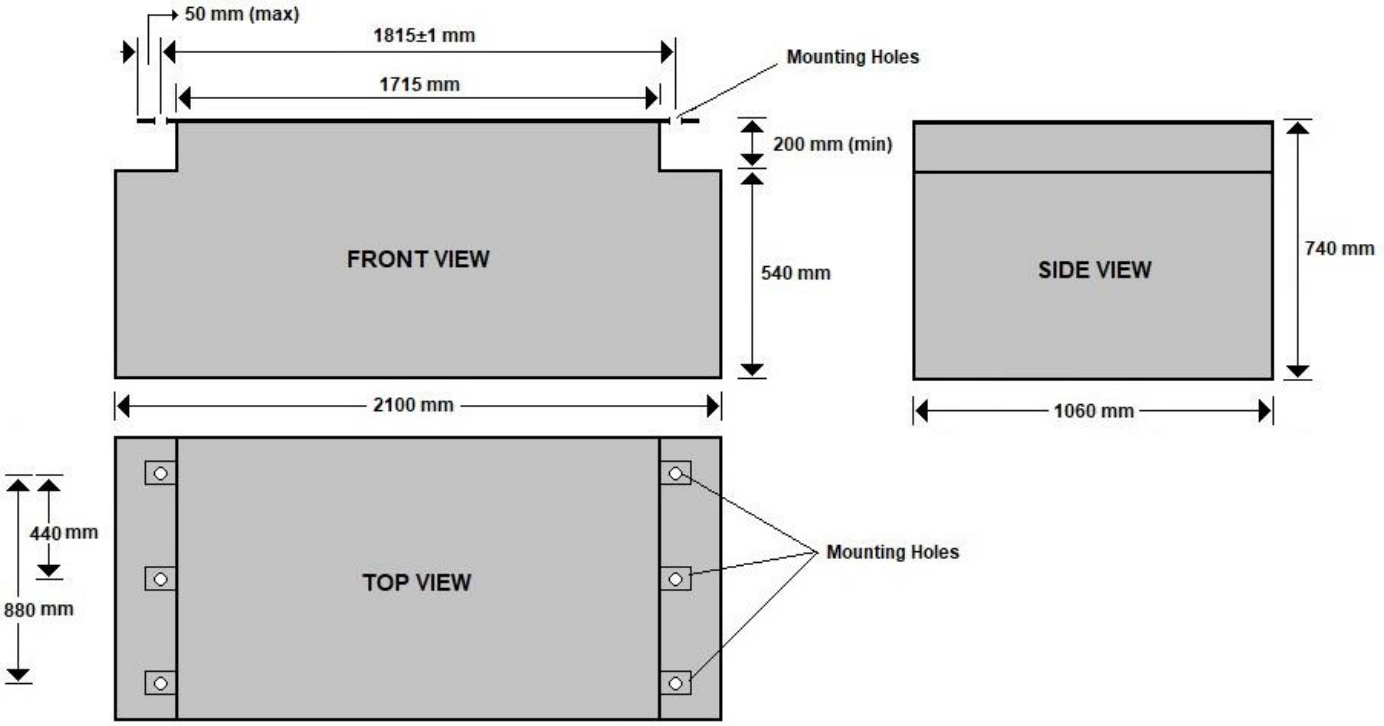
	Parameter Name	Parameter Value
1.	Body material	SS-304
2.	IP Rating	IP65 or higher
3.	Weight	To Be Determined by battery manufacturer

Battery box shall have external extraction/retraction provision for battery tray.

Mounting details shall be finalized during detailed design stage in consultation with ICF/ RDSO/ Indian Railways.

2.1.2.1 Mechanical dimensions

Limiting dimensions of the battery box shall be as per the below illustration:



2.1.3 Other technical requirement

i) Batteries shall be low maintenance, and explosion proof.
ii) It should be possible to charge a fully discharged battery from 110VDC shore supply available at maintenance sheds.
iii) Gross weight of battery box along with battery pack, BMS, and all accessories shall be approx. 1000 Kg.
iv) When auxiliary load is connected, the initial battery load shall not cause the battery output to oscillate.
v) The complete system shall be HL-3 compliant as per EN-45545-2.

2.2 Testing

i) 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.

ii) The performance, safety and other parameters of the battery / battery pack / Battery Management System shall be tested as per relevant standards mentioned in clause 2.5 of this specification. The standards stipulated are not exhaustive. The Supplier may adopt alternative internationally

recognized codes, standards and specifications, if it can demonstrate that such alternative is superior or more pertinent to meet the requirement of this specification.

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

iv) Standards followed shall be mentioned in the techno-commercial offer.

2.3 Erection and Commissioning

The supplier shall depute its technical manpower at car manufacturer's works during erection and commissioning process of prototype rake. Further, the supplier shall provide support during trails of proto rake till the rake is put into service.

2.4 Documents to be provided by supplier

i)	Technical manual of equipment	To be provided along with techno-commercial offer
ii)	Write-up/ description/ Datasheet of each component	To be provided along with techno-commercial offer
iii)	Circuit diagram, connection & wiring diagram, equipment drawing with mounting details, weights, center of gravity, etc. and any other relevant drawings	To be provided along with techno-commercial offer
iv)	Type test reports	
v)	Type test and Routine test protocol & procedure	To be provided after order placement.
vi)	Details of proven design	To be provided along with techno-commercial offer
vii)	Performance statement	To be provided in the attached format along with techno-commercial offer
viii)	Performance certificate	To be provided in the attached format along with techno-commercial offer
ix)	Approval letter from RDSO/ Competent authority.	To be provided along with techno-commercial offer
x)	Project specific AUTO CAD drawing-2D and 3D model	To be provided after order placement.
xi)	Project Specific Drawings in A3 size	
xii)	Technical Manual	
xiii)	Installation, Operational and Maintenance Manual	
xiv)	MTBF/MDBF Values along with the method of calculation	
xv)	Quality assurance plan (QAP)	

2.5 Applicable Standards

The offered system shall generally conform to the following standards:

1.	IEC 62133-2/ IS: 16046 (Part-2):	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications –Part 2: Lithium systems.

2.	IS 16893 (Part 2): 2018 IEC 62660-2: 2010	Secondary lithium - Ion cells for the propulsion of electric road vehicles: Part 2 reliability and abuse testing
3.	IEC 61960-3	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications –Part 3: Prismatic and cylindrical lithium secondary cells, and batteries made from them
4.	IEC 62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells, and batteries, for use in industrial applications.
5.	IEC 62620	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for use in industrial applications
6.	IEC 61508 IEC 62279:2015	Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems
7.	IEC 62928	Railway applications - Rolling stock - Onboard lithium-ion traction batteries
8.	IEC TR 62188	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Design and manufacturing recommendations for portable batteries made from sealed secondary cells
9.	EN-45545-2	Fire protection on rail vehicles Part2: Requirements for fire behaviour of materials and components.
10.	IEC 61373	Shock and Vibration Tests for rolling stock application
11.	IEC 60529	Ingress of protection
12.	UN 38.3	Transportation Testing for Lithium-Ion Batteries
13.	UL 1642	Standard for safety-Lithium Batteries
14.	UL 1973	Batteries for Use in Stationary and Motive Auxiliary Power appl.
15.	IEC 60571	Electronic equipment used on rolling stock
16.	RoHS Compliant2002/95/EC	Restriction of Certain Hazardous Substances- To reduce the amount of hazardous chemicals used in electronic manufacturing. Put another way, RoHS regulates the hazardous substances used in electrical and electronic equipment.

SECTION – 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

3 GENERAL

This section stipulates the General Technical Requirements under the contract and will form 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.

3.1 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 for design discussions and approval.

3.2 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) As 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) If 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 list of equipment and facilities required for maintenance and overhaul of equipment offered.

xii) Supplier shall submit 3D models of propulsion & other equipment, cooling system, driver/shunting desk, cab layout and roof/under frame/HT compartment layouts populated with equipment etc.

xiii) 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.

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

xv) SOFTWARE (IF 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. Logic of the Software of various sub-systems shall be approved by RDSO in consultation with user Railways at the design approval stage. 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 graphical representation on HMI etc. for the approval. Changes in parameters shall be demonstrated with their effect on the results.

c. The Supplier shall submit software logic with detailed explanation along with complete software packages used in TCMS and Converter control before commissioning of the prototype rake. Parametric changes shall be possible in the software in order to meet the future requirements viz. change in acceleration & deceleration, bogie & coach suspension, train configurations, OHE voltage, frequency etc. within permissible limits. 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 one copy of the licensed software to the user Railway before uploading the same on the train.

d. Software shall be fine-tuned through simulations & real life working conditions based on the extensive trials, associating 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 and shall be submitted after the expiry of the warranty period of the prototype rakes.

f. All the changes, thereafter, in software shall be approved by RDSO 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.

g. Internal independent review, verification & testing, using real & synthetic data, shall be performed at the software module and system level. RDSO/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.

h. 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.

i. 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.

xvi) 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 18 (Trainset) / EMU fitted with their equipment.

3.2.1 Train Formation

16 car Formation:

Basic Unit (BU) - 1	Basic Unit (BU) - 2	Basic Unit (BU) - 3	Basic Unit (BU) - 4
DTC-MC1-TC-MC2	MC1-TC-MC2-NDTC1	NDTC2-MC2-TC-MC1	MC2-TC-MC1-DTC

DTC: Driving Trailer Coach
MC: Motor Coach
NDTC: Non-Driving Trailer Coach
TC: Trailer Coach

3.3 INGRESS PROTECTION

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

3.4 AMBIENT CONDITIONS / OPERATING CONDITIONS

These Train set are operating at 25 kV AC OHE voltage fed through catenary and vacuum circuit breaker mounted on the roof of the motor coach. The incoming power supply is fed to the primary of the main

transformer and stepped down to a lower voltage, converted into AC voltage through IGBT based Converter and inverters and fed to four (04) parallel connected 3 phase traction motors.

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

i)	Relative Humidity	up to 100% saturation during monsoon season
ii)	Ambient temp.	Max. 50° C , Min. -10° C
iii)	Stationary rake temperature	The temperature of stationary Car in sun may go as high as 70° C. The equipment shall not be adversely affected in any way due to exposure to such high temperatures. Supplier shall furnish the precautions taken in equipment/component selection in order to conform to this requirement. The Supplier will indicate the expected temperature rise of equipment under the reference site conditions described above and shall submit the expected MTBF/MDBF at such temperature. The equipment shall function in accordance with this Specification following any period when stationary at the maximum ambient temperature and in full sunlight as specified in this clause, in other words any pre-cooling of equipment shall not be required.
iv)	Altitude (Max)	1600 meter
v)	Rainfall	Very heavy and continuous between 0 and 100 mm / hour (up to 2500 mm during rainy season).
vi)	Flood proofing of underslung equipment	All under slung equipment shall be designed suitably to ensure its normal working even in adverse conditions as mentioned in this Clause.
vii)	Atmosphere during hot weather	(1) Extremely dusty, humid and salty. The Train shall be working in coastal area also and thus may be continuously exposed to highly corrosive, salty atmosphere along with industrial pollutants. The equipment shall function in accordance with this Specification when subjected continuously to an atmosphere containing dust in concentrations up to 1.6 mg / m^3. (2) The equipment shall function in accordance with this Specification when subjected continuously to an atmosphere containing dust in concentrations up to 1.6 mg / m3. (3) The equipment shall function in accordance with this Specification when subjected continuously to a humid and salt laden atmosphere with maximum pH value of 8.5, sulphate content of 7 mg per litre, maximum concentration of chlorine 6 mg per litre and Maximum conductivity of 130 micro Siemens / cm. (4) The equipment shall function in accordance with this Specification when subjected to high wind speed in certain areas, with wind pressure reaching 150 kg/m2. (5) Equipment shall function in accordance with this

		Specification when exposed to solar radiation in the range from 0 kW/m2 to 1 kW/m2. (6) Special care shall be taken to ensure no damage to equipment due to deposition of atmospheric salts and industrial pollutants. Supplier shall enclose the details of specific measures adopted to ensure the satisfactory working of equipment against the deposition of salts & industrial pollution.
viii	Vibrations	Because of track irregularities, level of shocks and vibrations to which traction motors are exposed are far more than actually given in IEC for TM mounting arrangement. Supplier to carry out instrumented trials if considered desirable on existing stock for measurement of shocks and vibrations in consultation with RDSO at design stage. The suspension system and the mounting arrangement of underslung / bogie mounted equipment shall be so designed that the equipment performance is not adversely affected due to such high vibrations and shocks.

3.5 STANDARDS

The equipment covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.
The equipment to be furnished under this specification shall conform to latest issue (with all amendments) of specified standards.

The standards applicable and relevant to the complete Train and to the various systems and sub-systems shall be:
(i) IEC publications;
(ii) EN ;
(iii) UIC;
(iv) IEEE;
(v) BS;
(vi) RDSO specifications
(vii) Indian Standards

In the event of any contradiction in the aforesaid standards, the following standards shall have priority in the order listed:
(i) Standards specifically mentioned in the relevant clause of Specification
(ii) IEC/EN/UIC/IEEE/BS/ISO and
(iii) IS/other RDSO Specifications.

For avoidance of any doubt, in case of any conflict between the requirements of above standards, the stipulations of this Specification shall have precedence.

The latest version of the aforesaid codes, standards and specifications, which have been published at least 60 days before the last date of bid submission shall be considered applicable.

The standards stipulated in this Specification are the minimum. The Supplier may adopt alternative internationally recognized codes, standards and specifications, if it can demonstrate to the Purchaser/ RDSO that such alternative is superior or more pertinent to meet the requirement of this specification. The Supplier shall seek prior written approval of the Purchaser for any alternative specifications and standards proposed to be used. Where no standard is identifiable the Supplier shall make a proposal based on the best International practice, which shall be subject to review/ acceptance by RDSO.

3.6 Engineering Data

3.6.1 DRAWINGS

The contactor shall necessarily submit all the drawings/ documents unless anything is waived. The contactor shall submit 6 (six) sets of 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.

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.

Further work by the Manufacturer shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Manufacturer's risk. The Manufacturer may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Manufacturer’s drawing or work by the Purchaser shall not relieve the manufacturer of any of his responsibilities and liabilities under the Contract.
All engineering data submitted by the Manufacturer after final process including review and approval shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Owner in Writing.

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

1. Customer : BHEL /Indian Railways
2. Project: DESIGN, DEVELOPMENT, MANUFACTURE, SUPPLY, INTEGRATION, TESTING & COMMISSIONING OF IGBT BASED THREE PHASE PROPULSION EQUIPMENT, CONTROL AND OTHER SYSTEM FOR ELECTRIC TRAIN SETS
3. Contract No./LOA No. : P.O no. 08220144D1401 dated 09/05/2022
4. Main Contractor : Bharat Heavy Electricals Limited
5. BHEL Order No. & Date :

3.6.2 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

The dimensions, weight, capacity, etc. shall be in SI units. All drawings shall be submitted on CDs along with complete setup with software for reading and taking prints through desk top PC and suitable printer. In case the format is not compatible with AUTOCAD necessary customized hardware and software shall be submitted.

3.6.3 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

3.6.4 PHOTOGRAPHS

While the prototype equipment is under manufacture/ assembly, photographs of the various assemblies and sub-assemblies in various stages of production shall be taken. Photograph size shall not be less than 305 x 203 mm. Photographs shall be submitted in the form of books suitably bound with a cover of superior quality & durable material with the title block printed on the cover. Photographs/ short interval video clips on digital media shall also be furnished.

3.7 Marking of Equipment & Rating Plate

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.

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.

The details of rating plate of each of the equipment shall be as approved by RDSO.

3.8 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.

3.9 Quality Assurance Programme

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 after discussions before the award of Contract.
A quality assurance program of the manufacturer shall generally cover the following:

a) Manufacturer's organization structure for the management and implementation of the proposed quality assurance program:
b) Documentation control system;
c) Qualification data of bidder's key personnel;
d) 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.
e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
f) Control of non-conforming items and system for corrective actions;
g) Inspection and test procedure both for manufacture and field activities;
h) Control of calibration and testing of measuring instruments and field activities;
i) System for indication and appraisal of inspection status;
j) System for quality audits;
k) System for authorizing release of manufactured product to the Purchaser
l) System for maintenance of records;
m) System for handling storage and delivery; and
n) 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.
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.

3.10.1 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.

3.10 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 at the Supplier's cost where ever performed in presence of and to the satisfaction of RDSO, 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.

3. RDSO 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. The Supplier shall arrange instrumentation and record speed, voltage, current, temperature rise of various equipment, energy consumption, tractive effort and other relevant parameter as necessary for ensuring Complied of the Specifications.

7. 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.

8. 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.

9. In all cases where the Contract provides for tests whether at the premises or at the works of the Manufacturer or of any Sub-Contractor, the Manufacturer except where otherwise specified, shall provide free of charge items such as labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser Inspector or to his authorized representative to accomplish testing.

10. The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Manufacturer in respect of the agreed quality assurance program forming a part of the Contract.

11. The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site.

12. During the prototype tests/trials or services, 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.

13. 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/Indian Railway shall be implemented in the series production without any extra costs to the Purchaser.

14. Tests on Control electronics

    Control Electronics shall be tested as per IEC 60571/EN50155 IEC 60068, IEC 60721-2-5 and IEC 61373 including both compulsory and optional tests.

    Following tests shall be carried out on the PCBs as per IEC 60571/EN 50155 and IEC 61373 with the modified parameters.

    i) Dry Heat test: Dry Heat test shall be done at 80 ^{0}C. Along with the testing for the satisfactory performance, temperature stickers shall be put on the critical ICs, Controllers & capacitors etc. for monitoring the maximum temperature of these components during dry heat tests. It shall be confirmed that the temperature recorded during dry heat test as above does not exceed the specified operating/surface temperature of these components. For the purpose, data sheets of such components shall be referred and submitted during testing.

    ii) Cyclic Humidity test: The tests shall be done for 2 cycles of 24 hours each and components shall be examined for the performance tests and physical damage if any. The humidity cycle shall be as specified in IEC 60571.

    iii) Salt Mist Test: The test duration shall be 48 hours and after the tests the performance test shall be done. There shall be no physical damage, rusting or deterioration of the varnish/lacquer coating.

    iv) Dust & Sand Test & Mould growth test: The tests to determine the performance of the electronics in Sand and Dust ambient shall be carried out with the dust settlement rate of 6gm/m2/day. The dust particle size shall not be larger than 100 μm. Further details shall be worked out at design stage. The reference IEC shall be IEC 68; test Dust and Sand and IEC721-2-5 test Dust and Sand. The component shall be protected against mould/fungal growth. The test scheme shall be finalized during design stage.

3.11 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.

All the information concerning materials or components to be used in manufacturing, machinery, equipment, materials and components supplied, installed or used shall be submitted for approval. Without such approval the supplier shall run risk of subsequent rejection. The cost as well as time delay associated with such rejection shall be borne by the supplier.

3.12 Packing and Storage

All the equipment's 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. On request of the purchaser, the manufacturer shall also submit packing details/ associated drawing for any equipment/ material at a later date, in case the need arises.

The manufacturer shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage and other such charges claimed by the transporters, railways etc. shall be to the account of the manufacturer.

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.

Supplier shall ensure that equipment shall be properly packed, blocked, padded, coated and protected so that it is not damaged due to possible mishandling. 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.

3.13 Fire Prevention

i) The equipment's shall be designed to minimize the risk of any fire. 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's 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 Supplier shall comply with standard EN 45545 HL-3 for all equipment under scope of supply.

iv) All safety features in design, construction and materials used shall conform to the best safety standards and shall in particular prevent fires in Train in accordance with Good Industry Practice.

3.14 Maintenance Manual, Spare Parts Catalogue & Material Specification

The detailed maintenance and service manual (including the trouble shooting directory shall be prepared for the various equipment's and 3 sets of hard copies & soft copy of the same shall be supplied free of charge.
Detailed spare parts catalogue listing all components manufactured or purchased by the supplier along with their rating, source & schematic position etc. (04 copies) each shall also be supplied free of charge.

The documentation shall be provided on compact discs & pen drives (02 no's) along with relevant software and complete arrangements to read them or edit them in future to take prints in color.

Supplier shall submit the 3D models (for interface purposes) in SolidWorks and 2D drawings in AUTOCAD. To ensure tool independent exchange of models, step-files shall also be submitted. The complete documentation shall be provided on digital storage media along with relevant software and complete arrangement to read, edit and to take prints in color. In case the drawing format is not compatible with AUTOCAD, necessary customized hardware and software shall also be submitted.

3.15 Reliability, Availability, Maintainability and Safety (RAMS)

a) The supplier shall ensure Guaranteed Reliability, Guaranteed Availability and high degree of safety in order to provide a dependable service. The optimization of the system with respect to Reliability, Availability, maintainability and safety shall form an integral element of this Specification.

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 RAMS targets both for the complete system and for the major Sub-systems such as transformer, traction converter, auxiliary converter, electronics, traction motor, Transmission and Suspension System, high voltage equipment, blowers and other auxiliary machines, such that it will provide a high level of dependability. RAMS targets shall also be developed for bought out items. The supplier shall submit MTBF / MDBF at normal operating temperature considering ambient of 50^{o} C for following equipment:

Indicative List of Equipment's For Which MTBF/MDBF To Be Submitted:

S. No.	Equipment	MTBF/MDBF
1.	Traction Transformer	
2.	Traction Motor	
3.	Traction Converter	
4.	IGBT modules	
5.	Pantograph	
6.	Compressor, Air Dryer & Filters	
7.	Vacuum Circuit Breaker	
8.	Lightning Arrestors	
9.	Auxiliary Converter	
10.	Master cum Brake Controller	
11.	Train Control & Management System	
12.	Passenger Information & Communication system	
13.	Cables	
14.	Inter Vehicular couplers	
15.	Brake Electronic Control Unit	
16.	RMPU	
17.	CCTV	
18.	Car light	
19.	Sensors	
20.	Drive Control Unit	
21.	Gate Drive Unit	
22.	HMI	
23.	Display Panel	
24.	Head Light	

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

e) Components critical for safety shall fail 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.

f) The Supplier shall establish and operate a detailed reliability, availability, maintainability and safety (RAMS) Assessment system in support of the design, manufacture and subsequent testing, commissioning, operation and maintenance of the equipment.

g) Safety Assessment shall be carried out and shall include the following principles:
   i. Degraded modes and emergency operations as well as normal operations shall be considered;
   ii. Safety risk assessment shall utilize more than one methodology to assess risks; and
   iii. Safety risk assessment shall include the consideration of dependent failures, in particular the traction power, braking and control systems.

h) Every complete basic unit, as well as each constituent component, assembly, subsystem and system element shall be designed in such a manner as to perform its function reliably in service. To ensure reliability of the system, redundancy shall be built-in so that:

   i. The brake performance i.e. electro-pneumatic (EP) as well as regenerative brake force of 16-Car Train shall not deteriorate in case of failure of one Brake Electronics Control Unit. However, BP controlled back-up brakes shall always be available on the Train;
   ii. The Basic Unit control of each Traction converter shall be independent;
   iii. Further, the redundancy shall be built-in so that the performance of the rake shall not deteriorate in the event of failure of auxiliary supply system equivalent to that of one Basic Unit.
   iv. No single-point failure shall cause complete failure of the traction system, auxiliary supply system or inability to control the brakes on Train. Further every traction and auxiliary converter shall have independent control and cooling arrangement to avoid single point failure leading to complete failure of traction/auxiliary system at basic unit level.
   v. Where the system design of the equipment incorporates component redundancy as the method of reducing the consequences of a single point failure, such redundancy shall not allow hidden faults to remain undetected.

i) 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. Details to be worked out during detail design stage. Average running distance of a rake may be considered as 2000 kilometer per day.

The maintenance program prepared by Supplier shall have the following objectives ascertaining the above periodicity of maintenance schedules:

   i. Enhancement of availability
   ii. Minimization of maintenance costs
   iii. Minimization of coach downtime/MTTS (meantime to restore serviceability)

j) Based on the proposed maintenance schedules, the Supplier will submit average downtime on account of scheduled maintenance for the equipment to be supplied excluding the time required

for transfer of rake to and from the maintenance depot. Ineffective on this account should not exceed two percent. Supplier should also submit an estimate for the downtime for unscheduled maintenance in respect of equipment to be supplied. The Supplier shall assess and submit the figure for 'total percentage ineffective', in terms of percentage of rakes expected to be ineffective/unserviceable due to schedule and unscheduled repairs/maintenance of equipment supplied (excluding the time taken for transfer of the rakes to and from maintenance depot) against the total number of rakes fitted with the equipment under his scope of supply. This ineffective figure shall not exceed FOUR percent in any week (Monday-Sunday) calculated on 24 hourly basis. If during the test and service trial period of prototype rakes, it is experienced that downtime due to unscheduled repairs/scheduled maintenance of the equipment supplied is excessive, supplier shall be required to take suitable remedial measures to bring the ineffective figure within the limit submitted during the design approval stage.

k) Modular design principles shall be employed. Requirements for adjustments after module interchange shall be avoided except as required in the specification. All systems, components and structural areas serviced as part of inspection or periodic preventive maintenance shall be readily accessible for service and inspection.

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

Section -4

REVISION HISTORY

Rev No.	Date	Description/Update

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)