



PREQUALIFICATION CRITERIA for Pantograph

Reference: TBSG/ACMEMU/02/Pantograph Rev 02

PS: 445/1476/BOS-
Pantograph

Revision No. 00

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1.0 Pre-Qualification Criteria: With respect to BHEL Technical specification TBSG/ACMEMU/02/Pantograph Rev 02

1.1 The bidder should be a manufacture/supplier of pantograph for Rolling stock application of Indian Railways for 3 phase IGBT based AC EMU/MEMU or 3 Phase IGBT based Locomotives or Metros rails.

1.2 The bidder should have manufactured 30 sets of this equipment which are in use successfully for a period of minimum 02 years on any Railway system in last 05 years, excluding the year of bid opening.

1.3 In case of Foreign Bidders, if they supply from their factory premises, they should comply to criteria as stated above. However, they can also use the manufacturing facilities of equipment manufacturers in India for sourcing these equipment, provided such manufacturers have established line of production (details of plants and machinery, testing facilities, design/technical team shall be furnished separately) for such equipment on the date of bid opening. Design of equipment has to be same as approved by Railways. Further, 10 nos. of similar equipment should have been Supplied by equipment manufacturer in India and also provide proof of satisfactory operation of such quantities of equipment/assemblies/sub-assemblies for a period of one year.

However, the responsibility for manufacture, testing, supply, commissioning & quality control will continue to rest solely with the bidder and he will be fully responsible for meeting with all contractual requirements. The bidder/sub-contractor shall enter into an agreement with such equipment manufacturer & copy of the agreement entered into shall form part of the bid documents. Alternatively, a "Letter of Intent" (to execute agreement in the event of a successful bid) signed by the bidder/subcontractor and equipment manufacturer shall be submitted with the bid. Agreement, duly signed, shall form part of the contract agreement.

Rev.00

Approved: Shekar.R

Prepared:
David

Issued: TE

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1.4 The product should have valid type test certificate complying to relevant IEC (latest) and other standards mentioned in the Technical Specification TBSG/ACMEMU/02/Pantograph Rev 02 for rolling stock application on the date of submission of the tender. The vendor shall fully comply with the type and routine test clause mentioned in the technical specification TBSG/ACMEMU/02/Pantograph Rev 02. The Purchaser has the right to ask for the repeat the type tests either partially or fully if required without any price implication to BHEL.

1.5 If the Bidder is not having the required vendor approval from RDSO/ICF/RCF/MCF for supply of the product, the bidder shall approach RDSO/customer with their technical offer for approval and get the approval within 45 days from the date of tender opening. If approval is not received within the above period, BHEL shall treat the offer is techno commercially not acceptable for this tender and offer shall be rejected. Customer approval certificate received from bidder after the due date will be considered for our future requirements. This Criteria is not applicable to the bidder who is already a RDSO/ICF/RCF/MCF approved supplier for the product. However, the technical /commercial offer will be evaluated based on the specification of this tender by the purchaser for suitability at his discretion.

2.0 DOCUMENTS TO BE SUBMITTED.

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

Rev.00

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 BHARAT HEAVY ELECTRICALS LIMITED TRANSPORTATION BUSINESS & SYSTEMS GROUP, INDUSTRY SECTOR, LODHI ROAD, NEW DELHI	DOCUMENT No. TBSG/ICF/ACMEMU/02/Pantograph Rev. No. 02 Prepared Checked Approved							
	TYPE OF DOC.		TECHNICAL SPECIFICATION		NAME	Ish Kumar	Prafful Lakra	A. K. Yadav
	TITLE Pantograph				SIGN			
					DATE	06/11/2019		
					GROUP	TBSG		
	CUSTOMER/CONSULTANT		BHEL/INDIAN RAILWAYS					
	PROJECT		DESIGN, DEVELOPMENT, MANUFACTURE, SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF 25kV IGBT BASED THREE PHASE ELECTRICS (ON BOARD MOUNTED) FOR AC MEMU					
	TECHNICAL SPECIFICATION PANTOGRAPH							
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	TECHNICAL SPECIFICATION FOR PANTOGRAPH	PROJECT- ICF/MEMU
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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 Pantograph.

The equipment is required for the following project.

Name of the customer : BHEL/INDIAN RAILWAYS

Name of the Project : DESIGN, DEVELOPMENT, MANUFACTURE, SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF 25kV IGBT BASED THREE PHASE ELECTRICS (ON BOARD MOUNTED) FOR AC MEMU.

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:

Sl. No.	Description	Qty. per Set (DMC Set)	Remarks
1.	Pantograph complete assembly	1 No.	
2.	Pneumatic Control unit with Auto Drop Detection (ADD) and Over Reach Detection (ORD).	1 No.	
3.	Valve Plate arrangement with Three (03) Pressure switches, Magnet valve, Harting connector, air filter and their interconnection.	1 No.	
4.	ADD, ORD and Main line insulating hose.	1 No.	Each pipe length shall be approx. 1500mm
5.	Accessories required for Mounting, Pneumatic and Electric Connections including TBs for termination of cables coming from Pantograph inside the Coach.	As reqd.	

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1.3 ELIGIBILITY CRITERIA

1. The Bidder should be a regular supplier to Indian Railway Projects and should have supplied the offered equipment for Indian Railways projects of 3 phase IGBT Based AC EMU/MEMU or 3 Phase IGBT based Locomotives or Metros operating in India.
2. The bidder should have manufactured 30 sets of offered equipment which are in use successfully for a period of minimum 02 years on any Railway system in last 05 years, excluding the year of bid opening. The bidders are required to submit only a self-certification in respect to the make and their performance.
3. In case of Foreign Bidders, if they supply from their factory premises, they should comply to criteria as stated above. However, they can also use the manufacturing facilities of equipment manufacturers in India for sourcing these equipment, provided such manufacturers have established line of production (details of plants and machinery, testing facilities, design/technical team shall be furnished separately) for such equipment on the date of bid opening. Design of equipment has to be same as approved by Railways. Further, 10 nos. of similar equipment should have been supplied by equipment manufacturer in India and also provide proof of satisfactory operation of such quantities of equipment/assemblies/sub-assemblies for a period of one year.
However, the responsibility for manufacture, testing, supply, commissioning & quality control will continue to rest solely with the bidder and he will be fully responsible for meeting with all contractual requirements. The bidder/sub-contractor shall enter into an agreement with such equipment manufacturer & copy of the agreement entered into shall form part of the bid documents. Alternatively, a "Letter of Intent" (to execute agreement in the event of a successful bid) signed by the bidder /subcontractor and equipment manufacturer shall be submitted with the bid.

1.4 CLAUSE BY CLAUSE COMPLIANCE

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

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SECTION – 2

STANDARD TECHNICAL SPECIFICATION

3.1 TECHNICAL SPECIFICATION OF PANTOGRAPH

The pantograph is the link between the overhead contact system and the power circuit of the EMU/MEMU through which the required power is transmitted. This power is collected through a rudimentary form of contact consisting of a simple collector strip on the Pantograph sliding along a bare contact wire/ catenary of the overload system and conveyed to the roof line.

Pressure Switch: Pressure Switches of RDSO/ICF/IR/RCF approved make shall be supplied. 02 numbers of Changeover contacts for each pressure switch are required from pressure switch for feedback signal interface. 03 numbers of pressure switches have to be used. One pressure switch is required each for auto drop detection line (ADD), Over reach detection line (ORD) and Main line pipe.

Magnet Valve: Magnet valve of RDSO/ICF/IR/RCF approved make shall be supplied. The power rating shall be 8W or less with 110V DC power supply.

Technical data for Pantograph

Pantograph should comply the following:

1. A single pantograph suitable for satisfactory operation up to 120 Km/h under 25 KV AC power supply system as given in clause stated below and environmental conditions specified in clause 3.3 shall be provided.

“The equipment shall be suitable for operation on the electrical suburban sections of the user Railways. The general particulars are:

The operating voltage: 25KV AC power supply:

- i) Normal variation: 19 KV to 27.5 KV
- ii) Occasional maximum (cut off): 30 KV
- iii) Occasional minimum: 16.5 KV
- iv) Cut off voltage: 16 KV
- v) Frequency variation: 47 Hz to 53 Hz

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The power supply system shall be 25 KV, 50Hz single phase AC, 25 KV being the nominal voltage of the system. The guaranteed performance shall be based on voltage of 22.5 KV.”

2. The design of pantograph shall incorporate the following desired features:
 - a. Pantograph shall be suitable for satisfactory working in dusty, humid and saline atmosphere with heavy rains during monsoon seasons. The IR has experienced the failure of nylon bushes, bolts, washers and plungers due to ingress of heavy dust. In view of this, their use shall not be acceptable. Auto drop function of the pantograph shall drop the pantograph automatically when excessive height is detected. An indication shall be provided to the driver when this function is operated.
 - b. The design shall provide for efficient damping arrangement for pan assembly and articulation assembly.
 - c. The minimization of the pan mass shall be preferred.
 - d. The adoption of proven “Air Raising Springs” for pans and hydraulic damping for articulation assembly shall be used.
 - e. The limiting of aero dynamic effect from 3 kgf to 5 kgf for maximum speed by the use of aero foils shall be preferred.
 - f. Efficient current collection at all speed with least sparking while traversing the OHE shall be ensured. As a design criterion, the maximum limit of contact loss should be of the order of 0.2 percent in the regulated OHE. **The current collection tests under the actual field conditions shall be the responsibility of the supplier. Simulated test results and performance of pantograph for the similar rolling stock and OHE system shall be preferred during the design stage.**
 - g. The maximum electrical resistance between current collector and power take-off should be limited to 2 milli ohms.
 - h. The pantograph shall have the feature to protect itself in case there is any panto entanglement with OHE. The pantograph shall also have auto drop function in case of worn current collection strip or damaged pan head. The pantograph offered shall be complete with all parts and accessories

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including Auto Drop Device as per clause 4.9 of IEC 60494-1 and over reach detection device necessary for its efficient operation”.

- i. Supplier shall conduct on-line current collection test with GPS supported location recording system. The output report in soft copy shall be supplied for continuous / selective viewing of location having abnormal behavior and in hard copy with exception report of spark image, location wise report in excel/ word format for complete section selected for trial. One set of complete test equipment loaded with recording, analysis & reporting package in image and Microsoft word/excel format shall also be supplied to each EMU maintenance car sheds.
3. The insulation system of pantograph shall be suitably designed to ensure satisfactory operation under 25 KV AC systems without any need for attention other than the specified scheduled maintenance.
4. The pantograph shall be capable of sustained operation and satisfactory current collection from 100 mm above the collapsed pantograph level up to the full range of contact wire height, and at all operating speeds as specified.
5. Pantograph controls shall be configured in the cab car such that any one pantograph or all pantographs can be raised or lowered. When all pantographs are raised, there shall be a time delay function such that the instantaneous line current demand peak and inrush current characteristic are reduced to less than the operating limit of the traction power and OHE system.

Following technical parameters have to be complied:

Maximum Extension		>=2400 mm
Working Range (Min. Extension)		98 mm
Working Range (Max. Extension)		2395 mm
Mounting dimension		On Four supports
Lockdown height		585 ±10 mm
Earth clearance		≥250mm
Standard		IEC 60494-1
Rated Voltage		25kV
Nominal Current (Approx.) at rated voltage		100A
Contact strips	Current collector strip material	Metallised carbon strip
	Collector head length	Approx. 1800 mm
	Collector head width	Approx. 390 mm
	Collector head height	Approx. 310 mm
	Length of contact strips	Approx. 1030 mm
Raising time to Full extension		Max. 10 sec

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Lowering time up to fold from max Working height	Max. 10 sec
Air pressure for continuous operation dry and oil free	Min. 6 bar
Static upward force of pantograph	70N $\pm$ 5N
Weight (Of Pantograph only)	$\leq$ 150 Kg

In addition to the above mentioned technical requirements, the offered equipment must comply IEC 60494-1 and other relevant IEC/other applicable standards.

3.2 DESIGN REQUIREMENTS TO BE PROVIDED BY SUPPLIER:

• Write-up/ description of each equipment	To be provided by Supplier
• Following details of Pantograph to be covered: ➤ Type no. ➤ Make. ➤ Maximum current capability with complete technical details. ➤ References where used. ➤ Overall dimensions. ➤ Weight. ➤ Overall design parameters vis-a-vis specification requirements.	To be provided by Supplier.
• Circuit diagram/connections diagram/equipment drawing with mounting details/ other relevant diagrams	To be provided by Supplier
• Datasheets of the equipment including Make and type, working and maximum range, variation of pressure over working range, rated current capacity, maximum and recommended operating speed, Dimension of mounting insulators, Lock down height, Clearance from roof, weight of the equipment.	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

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	proposed/offered equipment. In case type test is required to be done, supplier to submit the detailed test procedures for approval.
Complete Bill of Material for 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

3.3 EQUIPMENT TESTING

- (1) **Valid Type test report** is to be submitted for the equipment along with offer, if the equipment is already type tested. In case, ultimate customer insists to repeat the type tests due to any reason, the type test shall be conducted again by the supplier, for which test procedure shall also be submitted by the supplier for approval before conducting the type test. In case ultimate customer desires to witness the type tests, the supplier shall have no objection. The supplier is required to quote for the type test charges if any, separately in commercial offer. These charges will be loaded in the equipment price at the time of final evaluation.
- (2) Supplier to submit Routine test certificates and inspection certificate of equipment as per QAP along with equipment.
- (3) Test specification/protocol shall confirm to IEC 60494-1.
- (4) Type and routine test will also confirm to clause 3.11 of section 3 of technical specification.

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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. fully in conformity with the technical specification. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously.

3.2 GENERAL DESIGN REQUIREMENTS

- i) The traction equipment shall be suitable for operation with 25 KV AC, 50 Hz supplied by overhead contact wires. In case of MEMUs, the control equipment shall be suitable to permit multiple operation up to 24 coach formation of 06 basic units here each basic unit shall comprise of 01 (one) Driver Motor Coach and 03 associated trailer coaches.
- ii) The equipment design shall incorporate all essential features necessary to yield high traffic use, low maintenance requirements, easy maintainability, high reliability in operation and high efficiency with low Specific Energy Consumption (SEC).
- iii) The stock fitted with the supplied equipment shall meet the operating/service conditions and performance requirements as specified in section 3.3 Ambient conditions/operating conditions of this specification respectively and shall be suitable for varying loading conditions.

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- iv) The entire equipment shall be designed to ensure satisfactory and safe operation under the running conditions specified in section 3.3 Ambient conditions/operating conditions and especially under sudden variations of load and electric pressure as may arise under working conditions due to faulty operation and short circuits. The design shall also facilitate erection, inspection, maintenance and replacement of the various units comprising the equipment.
- v) All working parts of the control and auxiliary circuit specifically electronics and PCBs, shall be suitably covered in cubicles with essential interlocks/keys to keep them free from moisture and dust. As a minimum, equipment shall be sealed to the standard below:
 - a. Under frame mounted equipment (except traction motor) IP65.
 - b. Equipments mounted inside the car body IP54.

The protection level (IP level) shall be furnished by the supplier during design approval.

- vi) All the electrical equipment's shall comply with the latest edition of 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 this specification. Specified temperature rise of equipment shall be calculated after taking into account at least 25 % choking of air filters and radiator fins etc.
- vii) All equipment's shall be adequately earthed, insulated, screened or enclosed. They shall be provided with essential interlocks and keys as may be adequate to ensure the protection of the equipment and the safety of those concerned with its operation and maintenance.
- viii) If applicable, supplier shall study the currently available lubricants/cooling oils in India and employ these as far as possible. Full lubrication scheme and schedule for the equipment shall be submitted. Wherever the imported lubricants or cooling oil are used, Supplier shall study and furnish details of equivalent Indian lubricants/oil.
- ix) The equipment shall be designed keeping in view that the EMUs/MEMUs operates with doors and windows wide open.

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- x) The design shall also facilitate easy erection by means of suitable tools & equipment, inspection, maintenance and replacement of the various units comprising the equipment.
- xi) 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.
- 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 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.

xiv) **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: Dependability for Guided Transport Systems - Part 2: Safety, EN 50128: Railway Applications: Software for Railway Control and Protection Systems, and EN 50129: Safety related Electronic Railway Control and Protection Systems. Any deviation from this requirement will need approval of RDSO in design stage.
- 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 sets, hierarchy of fault display, fault categorization, trouble shooting of each fault, etc. for approval of RDSO. Changes in parameters shall be demonstrated with their effect on results.
- c. The supplier shall submit software logic diagrams with detail explanation along with complete software packages to be loaded in train management system before the commissioning of the prototype rake. Parametric changes shall be possible in the software in order to meet future requirements, such as change in acceleration and deceleration, bogie and coach suspension, train configurations, OHE voltage and frequency, etc. While listing out the

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values of various parameters, the contractor must provide a range within which any change can be made without jeopardizing the functionality of the system.

- d. Software shall be fine-tuned through simulations & real life working conditions based on the extensive trials, associating user railways before putting the rake into commercial services. As it requires, instrumentation and expertise of Software Design Professional, software expert (s) of supplier shall be based at the work place along with the commissioning engineers so that all the software related issues are 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 trials and experience of operating railways. This shall be approved by RDSO.
- 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, logics, explanations, parametric changes etc. to the satisfaction of Railways.
- g. Software documentation shall be provided to give the full understanding of the software function and operation. Documentation shall be complete, clear and concise, and include all modifications up to final acceptance. Documentation shall include software block diagram showing signal flow, logic, and hardware interfaces. 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 MEMU fitted with their equipment.

xvi) The specification has been prepared for the general guidance of the Supplier. Deviation from this specification may be proposed if it intends to improve the performance, utility and efficiency of the MEMU as a whole or part thereof. All such deviations shall be accompanied with complete technical details and justification for the proposed deviation.

3.3 AMBIENT CONDITIONS / OPERATING CONDITIONS

MEMUs are currently running in NR, NER, ER, ECR, SECR, SCR, SWR, SR and NCR etc. These EMUs/MEMUs are operating at 25 kV AC OHE voltage fed through pantograph

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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.

For AC MEMU, the configuration of the coaches shall be of either 8/12/16/20/24. Indicative train formation for 8 and 12 cars is as shown below:

8 car Formation:

DMC-TC-TC-TC-TC-TC-TC-DMC

12 Car Formation:

DMC-TC-TC-TC-TC-TC-TC-DMC- TC-TC-TC-DMC

DMC: Driving Motor Coach

TC: Trailer Coach

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

Relative Humidity	Up to 98% saturation during rainy season which may be as long as five (5) months.
Ambient temp.	i) Max. 50° C ii) Min. -5°C
Average annual ambient temperature	35°C.
Maximum temperature inside HT compartment of motor coach	Max. 55° C.
Stationary rake temperature	The temperature of stationary rake may go as high as 70-75 °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.
Altitude	At any altitude between 0 and 1200 m above mean sea level.
Rainfall	Very heavy and continuous (up to 2500mm during

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	rainy season) All underslung equipment shall be designed suitably to ensure its normal working even in adverse conditions as above. The equipment shall be so designed to run at 8 Km/h through water up to 203 mm above rail level, allowance to be made in addition for increase in the height of water level due to wave effect. In case of flood level increasing more than 203mm, the MEMU shall be made dead. There are certain sections of the track that get flooded with water to standing depth of 400mm. The traction gear and other under slung equipment must be completely water proof to this height above rail level. During the peak flood condition water may reach up to floor level. The equipment shall not get damaged due to such flooding and it should be possible to rejuvenate the equipment with minor attention without any adverse effect on their performance.
Atmosphere during hot weather	Extremely dusty, humid and salty. The MEMU shall be working primarily in coastal area and thus shall be continuously exposed to highly corrosive, salty atmosphere along with industrial pollutants. Special care shall be taken to ensure no damage to equipment due to deposition of atmospheric salts and industrial pollutants. Supplier shall enclose details of specific measures adopted to ensure the satisfactory working of equipment against the deposition of salts & industrial pollution.
Vibrations	The vibration levels at some intermittent points on the track may be higher than those specified by the relevant IEC publication (IEC 61373). The suspension system and the mounting arrangements shall be so designed that the equipment's performance is not adversely affected due to such high vibrations and shocks.

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3.4 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.

In addition to meeting the specific requirement called for in Sections 2 of the Technical Specification, the equipment shall also conform to the general requirement of the applicable standards, which shall form an integral part of the specification. The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other. When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards, which ensure equivalent or better performance than that specified in the standards referred, shall also be accepted. The bidder shall submit copies of such standards.

3.5 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc. for the equipment.

3.6 ENGINEERING DATA

3.6.1 DRAWINGS

The contractor shall necessarily submit all the drawings/ documents unless anything is waived. The contractor 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.

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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, INSTALLATION, TESTING & COMMISSIONING OF 25kV IGBT BASED THREE PHASE ELECTRICS (ON BOARD MOUNTED) FOR AC MEMUs.
3. PO No.: 029160577.T1720523 dated 15.01.2018.
4. Main Contractor : Bharat Heavy Electricals Limited
5. BHEL Order No. & Date :

3.6.1.1 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

The dimensions, weight, capacity, etc. shall be in SI units. All drawings shall be

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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.

3.6.1.2 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

3.6.2 PHOTOGRAPHS

While the equipment is under manufacture, photographs shall be taken of the various assemblies and sub-assemblies in various stages of production. Photographs on digital media and videos shall also be furnished.

3.6.3 BINDING

Each set of tracings together with a set of photographs shall be suitably bound within a cover of superior quality durable materials with the title block printed on the outside of the cover.

3.7 MARKING OF EQUIPMENT & RATING PLATE

All main assemblies of the equipment shall bear serial number for identification and initials 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 rating plates of anodized aluminium with embossed letters. 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.

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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 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 distribution copies of drawings in bound volume	2 Weeks from the date of award. 3 copies for Railways plus 3 copies for BHEL.
iii)	Furnishing of distribution copies of type test reports in bound volumes	Hard copy to be submitted 1 Week from the date of type test and total 3 copies for Railways plus 3 copies for BHEL to be given. Soft copy to be submitted immediately after the completion of the test by email.
iv)	Furnishing of distribution copies of Routine test reports	Hard copy to be submitted 1 Week from the date of routine test and 3 copies for Railways plus 3 copies for BHEL to be given. Soft copy to be submitted immediately after the completion of the test by email.
v)	CD/pen drive containing all documents including Installation, Operation & Maintenance manuals.	2 Weeks from the date of award. 3 sets of hard copy and soft copy in editable format i.e. MS word/ MS excel.

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3.10 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 following all the Quality Assurance Documents as stipulated in the quality plan at the time of purchaser's inspection of equipment/ material.

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3.11 TYPE AND ROUTINE TESTING & INSPECTION

- 1) The individual equipment, systems and sub systems shall be type and routine tested in accordance with the relevant RDSO/IEC/BS/DIN/JIS/IS or equivalent Specification inclusive of the mandatory and optional tests along with the special tests as specified.
- 2) All type tests shall be carried out at the Supplier's cost where ever performed in presence of and to the satisfaction of BHEL/RDSO/Indian Railways (IR)/ Third Party, who reserves the right to witness any or all of the tests.
- 3) 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.
- 4) 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.
- 5) The price of conducting all tests and additional type tests is deemed to be included in Bid price. 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.
- 6) 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.
- 7) 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,

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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.

- 8) 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.
- 9) 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.
- 10) 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.
- 11) 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 MEMU 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.
- 12) Before carrying out any modification, as found necessary on the basis of tests and trials, the drawings and execution plan shall be got approved from the RDSO.

3.12 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.

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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.

3.13 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.

While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The manufacturer shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the manufacturer. Purchaser takes no responsibility of the availability of the wagons.

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.

3.14 FIRE PREVENTION

- i) The equipment's shall be designed to minimize the risk of any fire.
- 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 specification NF F 16-101: (Railway Rolling Stock Fire behavior "Choice of Material"), NF F 16-102: (Railway Rolling Stock Fire behavior

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“Material choosing, application for electric system” category A2), BS 6853 – 1999 Category II or DIN 5510, EN 45545(for rolling stock design) CET.HL-2 or any other equivalent/superior international standard for fire safety plan in respect of their equipment. Whichever standard is selected for meeting the fire safety, the standard shall be declared and a copy shall be furnished to BHEL/RDSO.

3.15 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. (40 copies) each shall also be supplied free of charge.

The documentation shall be provided on compact discs & floppies (5 no's) along with relevant software and complete arrangements to read them or edit them in future to take prints in color.

3.16 MAINTAINABILITY

- 1) Supplier shall submit the basic maintenance schedules of the proposed equipment. Minimum interval between two maintenance schedules for the equipment supplied under the specification in the depot shall be 90 days except for the pantograph strips and 3 years for major works in workshop/major depot.

It may be noted that the periodicity of the present maintenance schedules is as under: -

I 'A'	45 days
I 'C'	180 days
POH	18 months

The maintenance programme prepared by supplier shall have the following objectives ascertaining the above periodicity of maintenance schedules:

- a) Enhancement of EMU/MEMU availability.
 - b) Minimization of maintenance costs.
 - c) Minimization of coach downtime /MTTS (meantime to restore serviceability).
- 2) 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

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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 without any cost."

- 3) 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.

3.17 RELIABILITY

In addition to meeting the performance requirements, the equipment, shall incorporate high standards of reliability to ensure that operating cost and operation performance are optimized.

The Bidder shall provide the achieved quantitative reliability data of major subsystem/equipment, expressed in Mean Time between Failures (MTBF) and/or Mean distance between Failure (MDBF), based on operations of proven coaches fitted with similar equipment for a minimum of 3 years and 450,000 kilometers per coach in revenue service, for purchaser's and IR's evaluation. The definition of MTBF & MDBF for this purpose may be considered as: MTBF = No. of equipment (Population) x Period (Time)/Total number of failures during that period. MDBF = No. of equipment (Population) x Kilometer run (Distance)/Total number of failures during that distance

The MTBF shall be submitted for the ambient temperatures of 45° C, 50° C, 55° C and at the temperature expected inside the HT compartment as per the Bidder's calculation.

A list of equipment for which the MTBF and/or MDBF values shall be submitted along with calculation (method) during the design approval stage is enclosed as annexure XIII. Bidder shall submit the list of equipment and confirmation at the bid stage.

Failure is defined as "An electrical multiple unit (on units) on a suburban service should be considered to have failed, when through some mechanical or electrical defect in the stock:-

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- a) Either unit is unable to complete its booked working throughout the day.
or
b)A delay of not less than 15 minutes is caused to any train included in the booked working of the day. Failures of all coaches, whether employed on traffic or departmental service, are to be included.