

**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS**



**SCHEDULE OF TECHNICAL REQUIREMENTS (STR)  
FOR  
MANUFACTURING, TESTING & SUPPLYING  
OF  
IGBT BASED 3-PHASE DRIVE PROPULSION EQUIPMENT  
FOR  
THREE PHASE ELECTRIC LOCOMOTIVES  
As per**


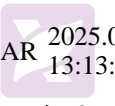
**Specification No. RDSO/2008/EL/SPEC/0071, Rev '5**

**(Issued On: June, 2016)**

ISSUED FROM

CENTRE FOR DESIGN & DEVELOPMENT  
CHITTARANJAN LOCOMOTIVE WORKS  
CHITTARANJAN, WEST BENGAL

Approved By	Signature
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DETAILS OF REVISIONS				
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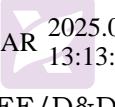

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**1. Preface:**

Schedule of Technical Requirements (STR) is a stipulated document which describes the requirements to be met by the vendors who are interested in manufacturing, testing and supplying of IGBT based Three Phase Drive Propulsion Equipment for Three Phase Electric Locomotives as per specification no. RDSO/2008/EL/SPEC/0071, Rev '5 (Issued On: June, 2016) or latest. The perspective vendors have to comply all the points mentioned in this STR to get into the project of developing IGBT based Three Phase Drive Propulsion Equipment.

**2. Abbreviations used throughout this document:**

STR	:	Schedule of Technical Requirements
TCN	:	Train Communication Network
VCU	:	Vehicle Control Unit
MVB	:	Multi-function Vehicle Bus
GPS	:	Global Positioning System
CCB	:	Computer Control Brake System of M/s KNORR BREMSE
E-70	:	Brake Control System proprietary to M/s FAIVELY
BP	:	Brake Pipe
FP	:	Feed Pipe
BC	:	Brake Cylinder
AFI	:	Air Flow Indicator
MR	:	Main Reservoir pressure
MU	:	Wired Multi Unit of Two or More Locomotives
QAP	:	Quality Assurance Program/ Plan
M&P	:	Machinery & Plant
PCB	:	Printed Circuit Board
CNC	:	Computerized Numerical Control
ESD	:	Electro-Static Discharge
SMD	:	Surface Mount Device
PTH	:	Pin Through Hole
ESS	:	Environmental Stress Screening
CNC	:	Computerised Numerical Control
PTH	:	Pin Through Hole
BGA	:	Ball Grid Array
RTOS	:	Real Time Operating System
CPLD	:	Complex Programmable Logic Device
FPGA	:	Field Programmable Gate Array
TI DSP	:	Texas Instruments digital signal Processor

**3. General:**

- 3.1. Indian Railways has taken 3-phase propulsion technology under Transfer of Technology (TOT) Contract from M/s. ABB Switzerland for manufacturing of WAG-9, WAG-9H, WAP-7 and WAP-5 class of 3-phase Electric Locomotives. Indian Railways are procuring IGBT based 3-Phase Drive propulsion equipment comprising of Traction Converter, Auxiliary Converter, Vehicle Control unit, Driver Display Unit and Active Speed Sensor as per RDSO's Specification No. RDSO/2008/EL/SPEC/0071, Rev '5 (Issued On: June, 2016) or latest. The Schedule of Technical Requirements is issued to serve as an essential guideline to the manufacturers. The firm should satisfy themselves about having complied with the technical requirements of the Specification and other infrastructure. The Technical Requirements are meant to serve as guideline only and are not exhaustive.


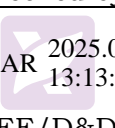

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- 3.2. The firm should have currently valid ISO: 9001:2008 certifications for his works address, covering the items for which the Firm seeks registration with CLW. It shall be ensured that the certifying body which issues the ISO: 9001:2008 certificates are accredited by an accreditation body that is a part of the International Accreditation Forum (IAF) under the Multilateral Recognition Arrangement (MLA). The list of all such accreditation bodies is available at the IAF website at: <http://www.iaf.nu>.
- 3.3. All the machines and measuring/testing equipments should be properly calibrated and the validity of calibration should be current and verified by physically checking the calibration certificate issued by Calibration Agency from whom it was calibrated. Calibration shall be done by NABL accredited labs whose accreditation is valid on the date of calibration. The latest calibration certificate may be required to be shown during assessment of the Firm.
- 3.4. Firm should have sufficient no. of technically qualified personnel in the field of design, manufacturing & testing of 3-Phase Drive propulsion equipment comprising of Traction Converter, Auxiliary Converter, Vehicle Control unit, Driver Display Unit and Active Speed Sensor.
- 3.5. The contractor should have its own testing laboratory, otherwise services of a NABL accredited laboratory can be availed. The detailing of NABL accredited laboratory is required to be furnished for the tests to be conducted therein.
- 3.6. The Firm should have complete control over the design modification/alteration of basic configuration/ circuit and features of 3-Phase Drive propulsion equipment comprising of Traction Converter, Auxiliary Converter, Vehicle Control unit, Driver Display Unit and Active Speed Sensor.
- 3.7. The Firm premises should be clean, dust and moisture free environment and adequate safety precautions should be taken during production of 3-Phase Drive propulsion equipment comprising of Traction Converter, Auxiliary Converter, Vehicle Control unit, Driver Display Unit and Active Speed Sensor.
- 3.8. The firm shall have fire extinguisher, warning board and shock treatment chart and medical first aid kit in their premises.
- 3.9. The Contractor is expected to study existing machine room layout, cable routing etc. in detail and may have a look on the locomotive if required. Such a visit shall be arranged on prior intimation by CLW.

#### 4. Minimum Facilities/ Requirements:

The information shall be furnished as per details required according to the following Annexure:

- 4.1. M&P required shall be as per **Annexure-I**. It however does not specify the capacity and quantity of various items of equipment/components. M&P may vary according to the manufacturing capacity of the individual contractor. The contractor should also have the good facility for storing the raw materials and finished product so as to maintain them in a healthy condition.
- 4.2. Measuring/ Checking Instruments/ Gauges: List of facilities required for measuring/ checking the instruments/ gauges in the contractor's premises shall be as per **Annexure-II**. The accuracy and capacity of the measuring equipment shall be adequate to meet the requirements. Records of calibration of all measuring instruments shall be maintained and made available, on demand.
- 4.3. Meticulous record of each batch of repair done during warranty investigation to trace out causes of failure etc shall be properly documented and required to be submit during renewal of the contract.
- 4.4. Meticulous record of QAP shall be as per **Annexure-III**.

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**5. Responsibilities of the contractor:**


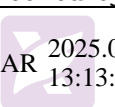
- 5.1. A time bound programme shall be made for the development of prototype. Further, the Contractor shall agree to a programme of indigenization if any, mutually with IR.
- 5.2. The contractor shall be responsible for complete indigenous development of the above stated IGBT based Three Phase Drive Propulsion Equipment for 3-phase electric locomotives based on the technical documents passed on to him by IR. The design shall be developed based on the requirements given in the relevant specifications for the 3-phase Loco Equipment and sound, proven and reliable engineering practices should be adopted. The Contractor will maintain close contact with IR for this purpose.
- 5.3. The contractor shall be responsible for converting drawings into a version suitable for use in his factory. Nevertheless, before implementation of such converted drawings for manufacture, the contractor shall obtain approval (means the approval of general design features) from RDSO/CLW. Approval of RDSO/CLW means the approval of general design features. Notwithstanding approval from RDSO/CLW, the contractor will be wholly and completely responsible for the satisfactory performance of the equipment developed.
- 5.4. The contractor shall arrange for free of cost training of IR personnel in installation and commissioning, operation, maintenance and troubleshooting of the system supplied. Contractor shall also provided detailed technical write-up to all the trainees.
- 5.5. The contractor shall supply sufficient copies of user manuals in hardcopy as well as soft copy. This shall include system description and operating, maintenance, calibration and troubleshooting instructions. List of spares with part number with technical specification shall also be included.
- 5.6. Representative of IR shall be free to visit the works of contractor or his vendors during the stage of development and later during manufacturing to assess/check the manufacturing process, quality assurance etc. The contractor shall ensure that Railway representative are given access to all information during their visits.

**6. Assistance to be provided by IR:**

- 6.1. IR will give latest relevant specification, Design/ Drawings etc to the contractors as per the agreed terms and conditions.
- 6.2. IR, to the extent possible, will assist the contractor during testing of components, sub-assemblies and the equipment by way of deputing suitable Railway personnel to witness such tests.
- 6.3. IR will assist the contractor in timely completion of prototype testing and field trials of the equipment developed.

**7. Tests and Trials:**

- 7.1. The equipment shall be tested in accordance with the relevant IEC, IS, IRS, BS etc., as stated in the specification to the satisfaction of IR. The contractor shall arrange to conduct all such tests at his own responsibility and cost.
- 7.2. IR, at their discretion, will witness some or all the tests as stated in above clause. The contractor shall provide all reasonable facilities to the inspecting officer for testing/ inspection at any stage.
- 7.3. The developed equipment will also be evaluated during operation under actual load conditions. These will be termed 'Field Trials'. Apart from checking on repeatability of the operational performance under actual working conditions of a locomotive, these trials will also be used to access the maintainability, accessibility, reliability and such other aspects, which have been mentioned in the

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relevant specification.

- 7.4. During the period of prototype tests/ trials, if any problems are thrown up or feedback information is obtained, which warrants a re-check on the design/ manufacture/ quality of the equipment and components, action shall be taken as may be necessary by the contractor to carry out the required investigations and to incorporate the improvements considered most appropriate to reach compliance with the relevant specification without any extra costs to IR. Such improvements shall be carried out on all units of the equipment developed and will be evaluated for their validity for a further period of time as decide by IR in each case. Modifications mutually agreed to comply with the specification will be incorporated by the contractor at his own cost in all the prototype units as well as in all new units manufactured thereafter.

### 8. Quality Assurance Plan :

The contractor should have their Quality Assurance Plan containing the following as a minimum:

- 8.1. Organizational chart clearly introducing the quality control set-up.  
8.2. Qualification log sheet of the key personnel, maintaining the quality control set up.  
8.3. Process flow chart / Description of manufacturing Process: -  
a. Process Flow Chart indicating process of manufacturing for an individual product, with quality control points.  
i) Process flow chart shall indicate all the operation involving manufacturing & testing of product from raw materials to finished product, including inspection and dispatch.  
ii) There should be separate flow chart for each individual item.  
b. Brief description of different manufacturing process mentioned in flow chart:-  
i) Details of the manufacturing & testing process specially mentioned in the specification.

Sl. No.	Clause no. of Specification	Requirement of manufacturing/testing process as per specification	Details of the process being carried out/ follows

- ii) Brief details of the other manufacturing process, not mentioned in the specification.


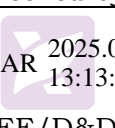
Sl. No.	Name of the manufacturing process	Brief description

- 8.4. Brief description of ancillaries & additional units (if any):  
i) Whether all the facilities are available at a single location (or) multiple location.  
ii) In case of multiple location give details in following formats:

Sl. No.	Name of the unit	Address	Whether unit is covered under factory license	Whether unit is ISO certified	Details of manufacturing process accomplished in the unit

- 8.5. The contractor should have a well-defined process evolution regarding selection of its sub-vendors/ suppliers as a part of their quality management system which shall be well documented incorporating the following points as a minimum:

- Name of the item for which sub-vendor is approved by the contractor.
- Sub-vendor should be ISO: 9001 - 2008 or latest certified.

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- Sub-vendor should submit the quality manual to the contractor.
- Sub-vendor should have all the requisite infrastructure of manufacturing and testing facilities, preferably under one roof. The contractor shall approve the QAP of the sub-vendor after proper verification justifying to the well-defined process evolution.
- Periodical inspection schedule for sub-vendor needs to be followed strictly by the contractor for maintaining the quality of the product.

#### 8.6. Inspection & Testing Plan for bought out material:

##### a. Incoming raw materials/parts/sub-assemblies

Sl. No.	Incoming Material / part/ assembly	Sample Size	Frequency of inspection	Parameters for inspection	Mode of inspection/ equipment used	Acceptance limits/ criteria/ specified Value	Inspected value/ result	Remarks	Traceable register no.

##### b. In process inspection (of the product)

Sl. No.	Name of the process	Sample Size	Frequency of inspection	Parameters for inspection	Mode of inspection/ equipment used	Acceptance limits/ criteria/ specified Value	Inspected value/ result	Remarks	Traceable register no.

##### c. Final internal inspection of the product by the contractor

Sl. No.	Name of the test/ process	Sample Size	Frequency of inspection	Parameters for inspection	Mode of inspection/ equipment used	Acceptance limits/ criteria/ specified Value	Inspected value/ result	Remarks	Traceable register no.

d. In the test format, gauges should be mentioned for each operation, if used.

e. Flowchart presenting detailed system control.

#### 8.7. Calibration scheme and status of calibration for test equipments:

Case-I : In-house calibration facility is available with the contractor.

##### A. Details of the master calibrator

Sl. No.	Model	Make	Range	Frequency of calibration	Name of the calibration agency	Date of calibration	Calibration certificate no.	Validity

##### B. Personnel trained for in-house calibration

Sl. No.	Name	Qualification	Experience

##### C. Calibration plan for measuring instrument

Sl. No.	Equipment name	Range	Accuracy	Frequency of calibration	In-house/ Outsourced	Date of calibration

Case-II : In-house calibration facility is not available with the contractor.

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Sl. No.	Equipment name	Range	Accuracy	Frequency of calibration	In-house/ Outsourced	Name of calibration agency	Date of calibration


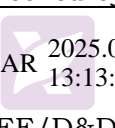

#### 8.8. Customer complaint:

The contractor should have foolproof system of monitoring the customer complaints including warranty obligations with facility of traceability by the product identification no.

Warranty failures/ In-service failures reported from customers should be maintained in the format like below:

Sl. No.	Date of receipt of complaint	Letter no.	Complaint received from	Classification of failure	Brief details of complaint	Whether any person deputed for collecting	Date of joint inspection	Failure analysis & cause of failure	Date of compliance in case of warranty	C & P action taken
				Warranty failure/ In-service failure/ Call for joint inspection / Consignee end rejection / General complaints						

The contractor shall maintain a complaint register in the above format and the summary required to be given during renewal of the contract.

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**ANNEXURE-I****Manufacturing Facilities:-**

The following minimum facilities are considered essential for manufacturing unit at the contractor's premises or at the approved sub-vendor's premises. The availability of facility either at the contractor's premises or at sub-vendor's premises shall depend on activity being done on that place.

Sl. No.	Details Of Machines
<b>1</b>	<b><i>IGBT based Three Phase drive propulsion equipments enclosure assembly facility</i></b>
1.1	Drilling Machine (Vertical, Surface & Hand) with jig upto 2" drilling DIA
1.2	Hand Grinder, Tool Grinder, Angular Grinder, Bench grinder, Buffering machine.
1.3	Welding Machine with current upto 300 Amp
1.4	CNC Milling machine (400 mm) for PCB face plate fabrication
1.5	Material handling trolley for 250 Kg
1.6	Digital Weighing Machine upto 0-5 ton and above
1.7	Anodizing/Plating/Powder coating
1.8	Torque wrench upto 300 Nm
1.9	Crane (5T or above), material handling trolley and Fork lifts.
1.10	Automatic Cut and Strip Machine
1.11	CNC Turret Punch
1.12	Insulation Stripping tool
1.13	Various Type of crimping tools (hydraulic/battery operated preferable)
1.14	Pull out testing machine for checking crimping of harness cables
1.15	Horizontal planer
1.16	Shearing machine
1.17	Bench vice for holding the material
<b>2</b>	<b><i>PCB Assembly facility</i></b>
2.1	Oven for PCB baking with range upto 100 degree C
2.2	ESD Protection as per IS:10087-1981 (Workstation including concern persons should have proper ESD band Protection & ESD protected boxes for keeping PCB etc.)
2.3	Automatic/light beam guide component insertion machine or pick & place machine for SMD based PCBs
2.4	PCB wave solder machine for PTH, SMD and BGA technologies or Robotic soldering
2.5	Machinery for assembling Press fit connectors
2.6	Crimping tool for FRC and control power supply wires
2.7	PCB Conformal coating facility
2.8	Environmental chamber for Production Stage ESS for PCBs and IGBT based three phase drive propulsion equipment with range upto 85°C
2.9	Ultrasonic Cleaner
2.10	Temperature controlled de solder pump with range upto 450°C
2.11	Temperature controlled hot air gun with range 0-400°C and Illuminated


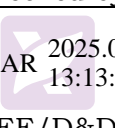

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	Magnifier
2.12	Dust free environment facility
2.13	Component lead forming machines/ fixture for assembly of PCBs
2.14	In-circuit testing machine for checking the correctness of component inserted in PCBs and/or Automated optical inspection machine.
2.15	Solder dispensing system for repair of cards
2.16	IC insertion-removal machine

**Below mentioned facilities are considered to be essential and should be available at contractor's premises.**

<b>3</b>	<b><i>PCB and VCU functional test facility (essential at contractor premises)</i></b>
3.1	Test bench for PCB and IGBT based three phase drive propulsion equipment for functional testing equivalent to locomotive operation.
3.2	DC Power Supply (Variable from 60 V to 160 V)
3.3	Testing Jigs for testing of assembled PCBs along with measuring instruments for different parameters
3.4	Burn-in test chamber (Minimum: minus 25° centigrade & plus 85° centigrade) for PCB
3.5	NiCd battery, capacity 199Ah, 110V
<b>4</b>	<b><i>Cooling System (essential at contractor premises)</i></b>
4.1	Compressor with reservoir & pressure switch for pressure upto 12 bar
4.2	Coolant cooling system of 20 KW or above.
4.3	Fixture for Contactor, Pump & Module Roller Assembly Mounting.
4.4	Fixture for Module & Capacitor Insertion in Converter.
4.5	IGBT Pasting and Screen-Printing Fixture.
4.6	AC power supply and/or Diesel Generator set (250KVA and above)


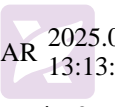
<b>5</b>	<b><i>Debugging equipments and software (essential at contractor premises)</i></b>
5.1	IGBT based three phase drive propulsion equipment application software in application of the processor PCBs.
5.2	Flash programmer for DSP/FPGA/CPLD
5.3	Programmer for controller programming
5.4	Licensed software for circuit, PCB, layout and mechanical design tool
5.5	Embedded software development IDE
5.6	MVB/WTB programming tools
5.7	Graphical Display programming tools for UI
5.8	GPS data acquisition tool for programming
5.9	IC programmer
5.10	Complete test bench for testing
5.11	Serial data port to parallel data converter
5.12	R/F signal generator
<b>6</b>	<b><i>Display system programming / data logging (essential at contractor premises)</i></b>
6.1	USB/PS2 Pen drive

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6.2	USB/PS2 Keyboard
6.3	Ethernet and Serial Cables
6.4	Desktop PC
<b>7</b>	<b>IEC-61375 TCN interface/Simulator (essential at contractor premises)</b>
7.1	MVB Diagnostic tool which can support TCN/MICAS based communication system (custom design)
7.2	Interface between MVB and Host PC (custom design)
7.3	IGBT based three phase drive propulsion equipment control simulator for testing (includes Master and Slave Combination test also) for replicating different functionalities of Locomotives as executed by Control Electronics.
7.4	Exclusive R&D facility, apart from Normal manufacturing setup.

**Note :**

- Firm should clearly mention about the details of outsourcing agency for respective activity, if any.

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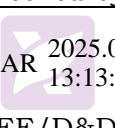

31.	3 Phase Auto Transformer / Isolation Transformer with multiple taps and rating of minimum 70KVA, 415V/1300V, 2170V or higher.
32.	Rectifier Bridge Panel, 35A $\Delta$ 3000V and above.
33.	Functional and full load testing arrangement as per IEC 61287 along with variable Load Bank for testing the Traction Power Converter corresponding to OHE voltage of 16.5 KV to 31 KV at no load, light load, 50% load, 80% load and Full load. – Inductive load per phase 1mH, 500A or above.
34.	High Voltage probe (0–5000V).
35.	Phase Sequence meter.
36.	Refractometer for coolant composition check.
37.	Motoring and Regenerative test setup with 3-phase Traction Motor of electric locomotive.
38.	Auto Transformer 600V-1300V, 50 Hz output/isolation Transformer with Multiple taps of synchronous generator with a provision to generate 525/670V-1200V. 50 hz
39.	Multi-meter Analog & Digital, Ammeter, Volt Meter, Milli voltmeter, Watt meter, Tongue tester AC/DC, Frequency Meter, True RMS meter (Adequate number of meters should be available), Ohm Meter, Milli Ohm meter, Micro Ohm meter, True RMS digital Multi meter, Digital stop Watch
40.	In circuit tester for testing of populated PCBs.
41.	Variable load bank (0KW to 200KW) continuous rating with 0.8 Power factor.
42.	EEPROM copier

**Below mentioned testing facilities should be available at contactor's premises or can be outsourced from NABL accredited laboratory:**

43.	<b>Test to be conducted as per IEC 60571:2012 and IEC 61373:2010</b> <ul style="list-style-type: none"> <li>➤ Cooling test facility</li> <li>➤ Dry and Damp heat test facility</li> <li>➤ Vibration and Shock test facility</li> <li>➤ Salt Mist test facility</li> <li>➤ Water tightness test setup</li> <li>➤ Transient Burst susceptibility, ESD and Radio Interference test facility</li> <li>➤ Flame proof test set</li> <li>➤ Brightness/contrast meter</li> </ul>
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**Note :**

- All the measuring instruments shall confirm to relevant IS/IEC standards with up to date calibration.
- Firm should clearly mention about the details of outsourcing agency for respective activity, if any.

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**ANNEXURE -III****1. Quality Assurance Plan**


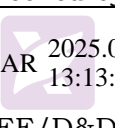
Firm should have their QAP containing the following as minimum:

- i) The contractor shall submit the organizational chart, along with qualification and experience of the key persons (in management) involved in Quality Assurance Programme. It will also be a perquisite for a contractor to submit QAP for getting approval for supply of IGBT based Three Phase Drive Propulsion Equipment for Three Phase electric Locomotive.
- ii) Process Flow Chart indicating process of manufacture for an individual product or for a family of products, if the process is same.
- iii) **Quality Assurance System** - Inspection and Testing Plan to cover::
  - a. Incoming material as per format in Annexure-V Clause-2.
  - b. Process control as per format in Annexure-V Clause-3.
  - c. Product control as per format in Annexure-V Clause-5.
  - d. Stage inspection /Test plan as per format in Annexure-V clause-4.
  - e. Calibration plan as per format in Annexure-V Clause-6.
  - f. All the format used for recording inspection plan.
  - g. System of traceability, traceability diagram linking traceability from raw material stage to final product stage.
  - h. Internal checks and finally lot offered for inspection.
  - i. All internal checks to be carried out during manufacturing shall be summarized and furnished. List of documents to be maintained for these internal checks, that need to be signed by inspecting official before issue of inspection certificate shall also be furnished
- iv) Stage inspection detailing inspection procedure, inspection parameters, method of testing / test procedure including sample sizes for destructive and non-destructive testing etc.
- v) Calibration Scheme and status of calibration of test equipment.
- vi) The Contractor should ensure that proper record of complaints received from users (Railways) is being maintained & corrective action is taken
- vii) Firm to submit QAP to CLW for necessary approval before supply of IGBT based Three Phase Drive Propulsion equipment for 3-phase Electric Locomotive. Whenever there is any change with respect to approved QAP, the same shall be promptly submitted to CLW for approval.
- viii) QAP shall include following details of sub-vendors
  - a. The name of item for which sub-vendor is approved.
  - b. The name of approving agency.
  - c. Inspection criteria of the sub-vendor.
  - d. The sub-vendor has ISO-9001:2008 certification.
  - e. QAP of sub-vendor approved by the Primary Vendor.
  - f. Sub-vendor has submitted the Quality Manual to the Primary Vendor.
  - g. Requisite manufacturing and testing facility, preferably under one roof. The sub-vendor to broadly meet with all the technical requirements laid down in this STR.
  - h. Periodical inspection schedule followed by Primary Vendor.
  - i. The primary vendor is following periodical inspection schedule for sub-vendor.
  - j. The sub- vendor is also liable for assessment by CLW/RDSO

**2. Documentation**

The contractor shall maintain all necessary documents and data that will help him to have consistency in producing quality product.

**3. Purchase of raw material**

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- i) Raw material/equipments shall be procured only from well-proven sources (having requisite ISO certificate), conforming to relevant standards and critical components shall be procured from ISO: 9001 - 2008 or latest certified vendors only.
- ii) Record of each sub-supplier clearly showing the quantity purchased and rejected as well as cases of late delivery, if any shall be kept
- iii) Process flow chart indicating process of manufacture of an individual product or a family of products for which the process is same
- iv) Incoming raw material shall be 100% inspected by Quality Control Department of the firm for any defect and deviation. The test results of incoming raw material with reference to the test certificate issued by the supplier and the results of internal tests carried out by the Firm for verification may be submitted as part of QAP

#### 4. Quality Control-Process


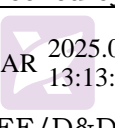

Screening of critical electronic components/devices shall be carried out as a part of in-process quality control.

#### 5. Inspection and Testing

- i) Bill of Material (BOM): A complete Bill of Material indicating all input material items, required for manufacturing of the product, alongwith specification and their sources of supplies as approved by the contractor in accordance with clause no. 7.4.1 of ISO:9001- 2008 or latest should be furnished. Test results of incoming raw materials with reference to test certificate issued by the supplier and the results of internal tests carried out by the contractor for verification may be submitted as part of QAP.
- ii) Receiving Material: The contractor shall ensure that incoming material is not used for processing until it has been inspected or otherwise verified by contractor's QC as conforming to specified requirements. Verification shall be in accordance with quality plan or laid down documented procedures.
- iii) In process inspection and testing: Inspect, test and identify product as required by the quality plan or documented procedures evolved on the basis of above-mentioned specification and other relevant specifications/standards.
- iv) The contractor shall carryout all final tests and inspections in accordance with the quality plan or documented procedures evolved on the basis of mentioned specification and specified standard to complete the evidence of conformance of the finished product.
- v) The consistency type testing shall also be carried out on the product as per the specification.

#### 6. Testing / Measuring Instruments

- i) The instruments and equipments, used for testing and inspection, shall be of the required accuracy and with properly calibrated.
- ii) All required facilities for routine testing shall be available at the contractor's premises. In the event of non-availability of shock & vibration test and environmental test or any other type test facility at the works of the contractor, the tests may be conducted at any NABL accredited laboratory and the relevant test results shall be submitted to IR for verification.
- iii) The accuracy & capacity of the testing & measuring equipments shall be adequate to meet the requirements of the specification. The testing & measuring equipments shall be duly calibrated at regular intervals from the NABL accredited lab & the valid calibration certificate shall be produced during the stage of development and later during regular manufacturing of the product on demand by the IR inspecting authority.
- iv) Facilities for lifting for weighment of the converter and electronics rakes.

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v) Cleaning facilities.

## 7. R&D Organization

The Contractor shall indicate the organizational structure of their R&D wing along with qualification of the personnel. Contractor should have sufficient number of Design Engineers with experience of more than 5 years in the field of power electronics and Software Engineers should have knowledge of Software being used in Converters provided on electric locomotives. Adequate numbers of Diploma Engineers with Experience of more than 5 years in the field of power electronics & software should also be available.

## 8. Laboratory Test House


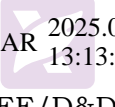
The contractor shall have a well-equipped Laboratory/Test House to carry out various tests on the raw material, stage inspection and inspection of the finished product.

## 9. Quality Audit

To ensure quality of the material supplied by the firms, regular checks/Quality audit shall be made on their quality assurance programme including machinery & plant, man-power, sources of raw material and the firm's own internal quality checks by Indian Railway inspection authority on demand, or on need basis based on adverse field performance report. The firms compliance of STR, Specification, Bill of material and QAP shall be verified during this quality audit Further the quality audit report shall consist of certain documents like valid factory license, latest electricity/water bill, Valid ISO and MSME certificate, latest ITR reports and certificate of incorporation under the companies act etc. Representatives of IR shall be free to visit the works of the contractor or his sub-vendors during the stage of development and later during manufacturing to conduct surprise check on manufacturing process and quality control along with any of the tests to ensure quality of the product and its conformance to the indicated specification. The contractor or his sub-vendor shall ensure that Railway representatives are given access to all information during their visits.

## 10. Handling/ Storage/ Delivery

The contractor shall have proper facilities for handling and storage of raw material and finished product. The contractor shall control packing presentation and marking process so as to ensure conformity to the railway requirement. Further Adequate dust free, clean and non-humid environment for separate storage of raw material, finished product and for product assembly area should be available. Also Adequate stacking/handling tables and racks in above storage area.


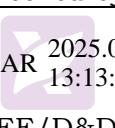

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**ANNEXURE – IV****INFRASTRUCTURE FOR QUALITY ASSURANCE:**

The following facilities at firm's and sub vendor's premises are considered desirable for the manufacture of quality and reliable product:

SN.	Details of Facilities/Machines
i.	Dust and Humidity free environment for the assembly of PCBs.
ii.	Component lead forming machines / fixture for assembly of PCBs.
iii.	Automatic / light beam guided component insertion machine for PCBs.
iv.	Temperature controlled wave-soldering machine with auto-fluxing facilities for Through Hole Technology (THT) components and SMD technology.
v.	Multi-channel temperature scanner of minimum 16 channels (0-300°C).
vi.	Functional testing of sub parts of PCBs with computer along with trained person for testing.
vii.	In circuit testing machine for checking the correctness of component inserted in PCBs.
viii.	Dry and Damp heat test chamber for PCB.
ix.	Testing jigs for testing assembled PCBs along with measuring instruments for different parameters.
x.	Exclusive R&D facility, apart from normal manufacturing set-up.
xi.	Necessary design and simulation software for electrical and mechanical parameters.
xii.	Burn – In Test Chamber (suitable for minus 25°C to plus 125°C) for PCBs

**Note:-** Firm should clearly mention about the details of outsourcing agency for respective activity, if any.

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**ANNEXURE – V****FORMATS TO BE SUBMITTED WITH QAP****1. Organization specific to the product**

Description	Name of person with contact no.	Qualification	Experience	
			Field	year
(a)	(b)	(c)	(d)	(e)
Design in – charge				
Production in – charge				
Quality Inspection in-charge				

**2. Incoming Material Control**


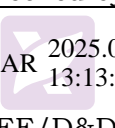

Subject/ Product/ Process	Sample size & Its frequency of Inspection	Parameter for inspection	Mode Inspection	Acceptance Limit/ criteria/ specified value as per Drg/Spec.	Document Reference	Record Format No.	Action in case of rejection
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)

**3. Process Control****a. Proposed M&P**

Sl. No.	Process/ Activity	Work Instruction Ref.	Machine Details					In- house / Out source
			Lead parameter	Make	Model	Comm. Dt.	Accuracy	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)

**b. Proposed jig & Fixture**

Sl. No.	Process/ Activity	Work Instruc tion Ref.	jig & Fixture drg. Reference	In-house/ outsourse	Inspection Agency	Record Format No.	Action in case of Rejection
(a)	(b)	(c)	(d)	(e)	(g)	(h)	(i)

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**4. Stage Inspection / Test Plan**

Subject/ Product/ Process	Instrument / jig & Fixture test bench used	Inspection Stage	Parameter for inspection	Sample size & its frequency of Inspection	Document Reference	Acceptance Limit/criteria/s pecified value as per drg/spec.	Inspection Agency	Record Format at No.	Action in case of rejection
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)

**5. Product Control**


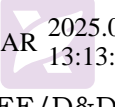
Subject/ Product/ Process	Instrument/jig & Fixture test bench used	Parameter for inspection	Sample size & its frequency of Inspection	Document Reference	Acceptance Limit/criteria /specified value as per drg./Spec.
(a)	(b)	(c)	(d)	(e)	(f)

**6. Calibration Plan**

Instrument Description	Serial No	Make Model	Year of Procurement	Capacity/Ra nge	Accura cy	Periodici ty of calibrati on	Calibrati on Agency	Record Form at No.
(a)	(b)	(c)	(d)	(e)	(f)	(h)	(i)	(j)

**7. Approved Sources for Raw Materials/Consumables**

Raw material/ Consumable	Specification/ Standard	Source with address	Whether Source is controlled by CLW/ RDSO/ Others
(a)	(b)	(c)	(d)

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