

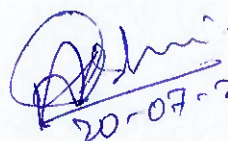
Document No: CEE/01/PQR/140760062

Additional Terms and Conditions for Bidders (including Pre-Qualification requirements)

Supply of "Full wave three phase silicon diode bridge power rectifier natural cooled for KMMC".

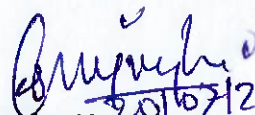
S. No.	Description of requirement	Document to be attached
1.	Bidder should submit a self-declaration stating that, "Offered item is same as per enquiry and there is no deviation".	Self-declaration on letterhead of firm.
2.	Bidder should have supplied minimum one set of Full wave three phase silicon diode bridge Natural Cooled Power rectifier for ACSPIC/DETC/KMMC to any Public sector/ Central Gov. sector/Private sector/ PSU/ Indian Railways working for rolling stock application before date of bid opening.	Invoice copy with supporting PO copy.

Prepared By



20-07-2026
Ashwini Kumar
Mgr (CEE)

Approved By



20-07-2026
(Sanjay K. Rai)
AGM(CEE)



Bharat Heavy Electricals Limited, Bhopal

CONTROL EQUIPMENT ENGINEERING DIVISION

Purchase Specification

For Supply of Full Wave 3 Phase Silicon Diode Bridge Natural Cooled Power Rectifier

For

KMMC

Document No	PS407613
Revision	00
Date	18.07.2026
Classification	Controlled Copy
Project	KMMC

	Name	Designation	Signature
Prepared By	Ashwini Kumar	Manager	
Checked By	Diwaker Kumar	Manager	
Approved By	Sanjay Kumar Rai	Addl.GM	

PS407613 R00

1 of 3



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1. Introduction:

This specification covers supply of full wave three phase silicon diode bridge Power rectifier designed for natural cooling to meet ICF specification ICF/MD/SPIC-349 R01 for Kavach Mobile Maintenance Car (KMMC).

2. Scope:

Supply of Full wave three phase silicon diode bridge Power Rectifier (designed for natural cooling) shall comply clause no. 3.11 of ICF specification ICF/MD/SPIC-349 R01 and Annexure-3. The following parameters shall meet:

- (i) The rectifier shall be suitable for on board natural cooled and well protected. Noise output from rectifier operating at full load shall not exceed 75 db when measured at a distance of 1 mtr all around.
- (ii) The rectifier unit shall preferably consist of three separate bridges connected in parallel on input and output side.
- (iii) The current rating of devices shall be such that even under one bridge (n-1) failure condition the rectifier, with two remaining effective three phase bridges shall be capable of meeting the full tractive power duty cycle.
- (iv) An unbalance of 20% shall be considered in the sharing of load between the bridges for design purpose. In actual testing the unbalance shall be limited to 10% only.
- (v) The diode shall have PIV not less than 3000V.
- (vi) The device shall meet all the requirement as per IS:7788.
- (vii) The power rectifier should have power loss not more than 1500 watt. It should be able to work in N-1 operation. The fuse blown indication should be available on driver desk.
- (viii) Outline dimensions shall be as per BHEL drawing no. 26670600425.
- (ix) Technical constructional requirement and testing shall be according of Annexure-3 of ICF Spec. ICF/MD/SPIC-349.



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3. Document submission:

Supplier to furnish following Drawings/Documents within 15 days from the date of PO.:

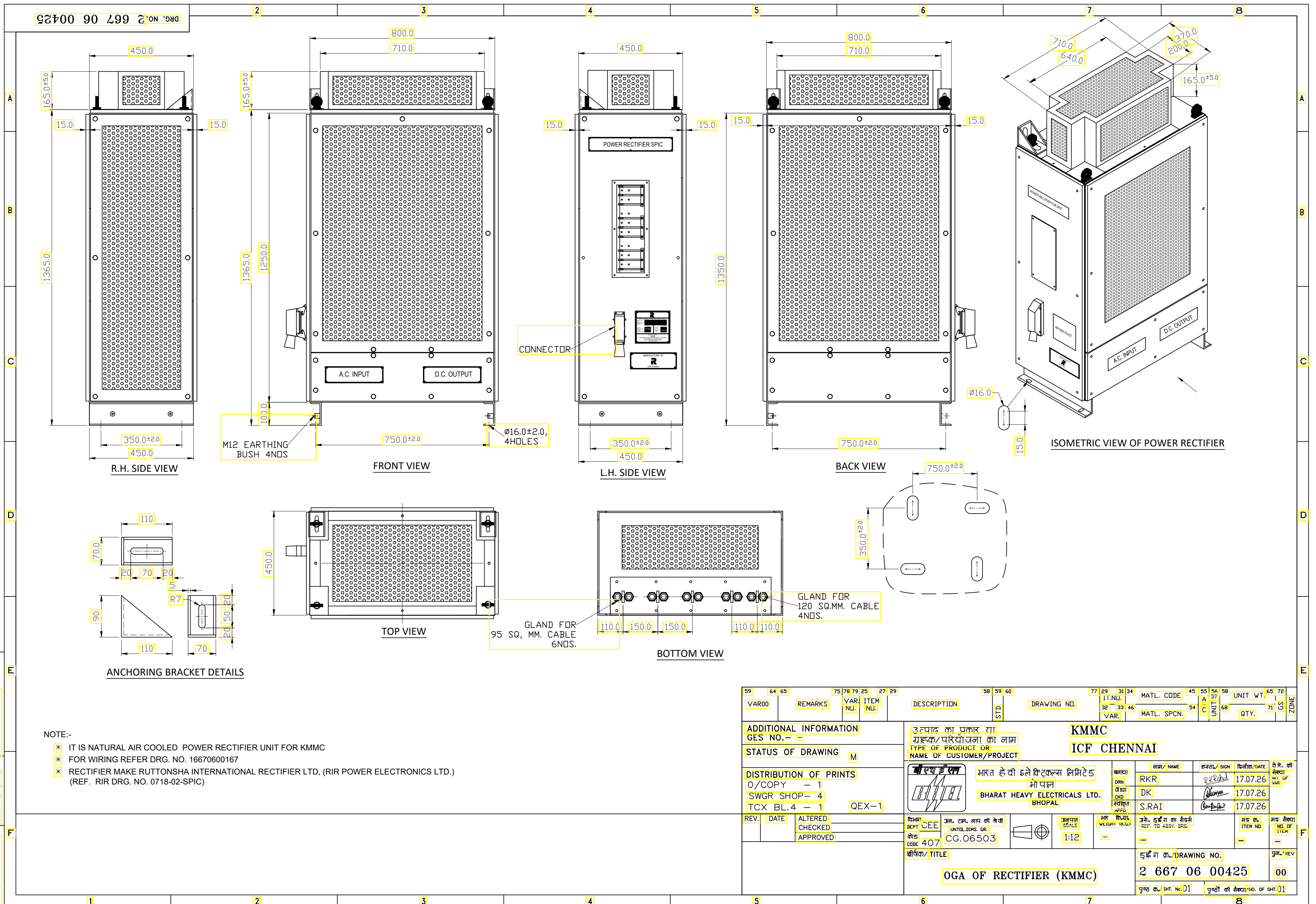
- (i) GA drawing of Power rectifier.
- (ii) Bill of Materials
- (iii) Wiring drawing
- (iv) Routine & Type test schedule
- (v) Quality assurance plan
- (vi) Routine & Type Test report

4. Commissioning:

Supplier has to extend necessary support during commissioning of 1st Rectifier on KMMC.

5. Warranty:

Equipment shall be under warranty of 30 months form the date of supply at BHEL, Bhopal. Warranty includes on-site replacement, troubleshooting, and rectification during warranty period.



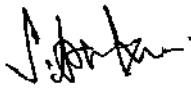
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ANNEXURE-3**POWER RECTIFIER SPECIFICATION****1.0 Technical requirements including the design features.**

- 1.1 The rectifier unit shall comprise of three phase full wave bridges using silicon diodes. It shall prefer-ably consist of three separate bridges connected in parallel on the input and output side.

1.2 Device Rating

- 1.2.1 The current rating of the devices shall be such that even under one bridge (n-1) failure condition the rectifier, with two remaining effective three phase bridges shall be capable of meeting the full Tractive power duty/duty cycles and abnormal conditions including short circuit.
- 1.2.2 An unbalance of 20% shall be considered in the sharing of the load between the bridges, for design purposes, though, in actual testing the unbalance shall be limited to 10% only.
- 1.2.3 The diodes shall have a PIV rating of not less than 3000 V or not less than 2.8 times the maximum crest working voltage whichever is higher.
- 1.2.4 Characteristics curves of the diodes indicating power loss, forward voltage drop, slope resistance, thermal resistance characteristics and characteristics curves of the fuse shall be submitted in A4 size.
- 1.2.5 The permissible junction and case temperature for the device shall be declared.
- 1.2.6 Diodes in the cubicle shall belong to one FVD group while they shall be in three consecutive FVD groups for all the units to be supplied. FVD shall have a band width of 50 milli-volts at the full rated diode current.

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- 1.2.7 The semiconductor device junction temperature shall be calculated for (n-1) condition operation at rated permissible current for three duty cycles after temperature stabilisation in heat run test at a current value equal to the one hour rating of the traction motors.

For this purpose, RMS value of the starting current over the notching up duration for 1 minute followed by RMS value of the steady state one hour rating current for eight minutes, followed by zero current for thirty seconds will form one cycle. At the end of three such successive cycles the junction temperature shall be computed. There shall be enough margin.

- 1.2.8 The devices shall meet all the requirements as per IS:7788.

- 1.2.9 The use of capsule type diodes are acceptable.

1.3 Snubber and Damping Networks

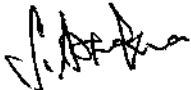
- 1.3.1 Each diode shall be provided with RC network to overcome the hole storage effect.

- 1.3.2 RC damping networks for input (AC side) and output (DC side) shall be provided to protect against switching surges expected. Supporting calculations shall be furnished.

- 1.3.3 The resistors and capacitors for the RC network shall be respectively of silicon coated, non-bursting type suitable for traction duty duly approved by RDSO.

- 1.3.4 Resistances - Silicon coated, non-inductive, wire wound resistors and stud mounting type with lug terminals shall be used. The wattage ratings shall be three times the calculated maximum wattage in the circuit under worst loading and high ambient conditions.

- 1.3.5 Capacitors - shall be of non- bursting type. The clearance and creepage distance between the live terminals and also the body shall

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comply with table 5 of IS-7788. The maximum working voltage across any capacitor shall not exceed 50% of the rated repetitive voltage. In the case of hole storage capacitors the voltage rating shall not to be less than PIV rating of the semiconductor device. The capacitors shall be designed for operation at 105 °C. The capacitors will be of ACSPIC Car shall be of GE make. Use of indigenous make shall have the prior approval of RDSO.

- 1.3.6 Adequate ventilation of RC damping networks of power rectifier to be ensured to avoid overheating of resistors/capacitors.

1.4 Fuses

- 1.4.1 The diodes shall be protected by semi-conductor fuses whose selection shall be supported by the calculation to ensure their matching with the diodes. $I^2 t$ values for the diode shall be more than the $I^2 t$ for the fuse. Diode and fuse characteristics shall be furnished along with the tender. The fuse selection shall withstand the short circuit current expected.

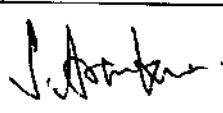
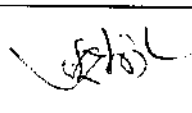
Note: The expected short circuit current/impedance with duration shall be specified.

- 1.4.2 The semiconductor fuses used for the diode protection shall be of approved makes. Fuses of la Ferraz, Bussman or English Electric make only are approved at present.

- 1.4.3 Since the rectifier unit consists of multi-bridges connected in parallel, signaling fuses, associated suitable relays and micro switches shall be provided to given an indication in case of single bridge failure and to trip the load on the alternator in case of double bridge failure.

1.5 Constructional Features

- 1.5.1 The tenderer shall submit details of the overall dimensions of the rectifier along with the offer.

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1.5.2 The cubicle as well as internal sub-assemblies shall be interchangeable from one unit to the other.

1.5.2.1 The cubicle shall be of cold rolled steel metal sheet with strong frame work suitable for on-board mounting to withstand shocks and vibrations encountered in service run with a maximum speed of 105 kmph. This shall be protected against damages due to ballast hitting. The minimum thickness of panels shall be 12.0mm and may be increased as panel width increases as mentioned below.

Maximum Panel Width

Upto 750 mm
> 750mm but < 1500 mm
>1500 mm but < 2000 mm

Thickness

2.0 mm
2.5 mm
3.2 mm

However the Dimension of power rectifier shall be finalized during detail design stage.

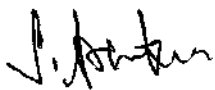
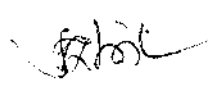
1.5.2.3 The cubicle shall be provided with two numbers of earthing bosses with M12x20 tapped hole on each side. The bosses shall have 5 mm thick copper/brass plate brazed.

1.5.3 Easily interchangeable inspection doors with locking arrangement shall be provided to facilitate easy access to vital parts like fuses, diodes etc. Location of vital parts are also well placed for easy accessing with respect to ICF coach layout as per Annexure-5

1.5.4 Withdrawable bridge racks consisting of diodes, fuses and associated components shall be provided on rails (if required) for withdrawing during maintenance.

1.5.5 The equipment layout should be such that to provide easy accessibility for maintenance.

1.5.6 Suitable ventilating louvers shall be provided for air outlet.

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1.5.7 The devices with heat sink shall be mounted of FRP (SMC)/ Epoxy panels of adequate thickness (not less than 10mm) with hand holds for easy removal and insertion in position.

1.5.7.1 Heat sinks shall be of extruded constructions. The sand casted or gravity die casted are not acceptable. ACSPIC care shall be taken to have proper surface finish and surface flatness. Current collection through heat sink shall be avoided. In case it is not possible, the heat sink device mounting surface and the current collection contact area shall be treated to prevent electro corrosion and bimetallic action.

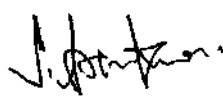
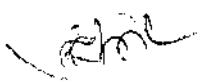
1.5.7.2 Recommended optimum pressures for mounting the devices on the heat sink shall be furnished. Suitable thermal compound having low thermal resistance shall be used to fill up the void between the mating surfaces of heat sink and device. The same shall seal the joint against moisture.

Note : Transient thermal impedance characteristics curves of the heat sink at different cooling air rate shall be submitted for approval.

1.5.8 The unit shall be painted with two coats of red oxide followed by two coats of white stove enamel on inside and aircraft grey on outside to IS-5:1961.

1.5.9 Fasteners used in the cubicle shall be of minimum M6 and screws of M10 and above shall be of high tensile strength.

1.5.9.1 Studs of the terminal board shall have adequate current rating with minimum size not less than M6 and shall be coated with cadmium plating. The method of connections shall be such that the current should not pass through the studs. Number of connections per stud shall be limited to two. The insulating boards shall be fire retarding FRP sheet moulding type. They shall pass the fire retardant test as per specification IS - 2046. Separate terminal board shall be provided for different voltages. Positive and negative terminals shall

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be separately located. All the terminal studs shall be legibly identified with their circuit numbers.

- 1.5.10 The bus sizes on the a.c. & d.c. sides shall be such that the final temperature when corrected to 47 °C ambient is not more than 100 °C copper bus bar must be tin plated after bending/drilling the required holes, with thickness of plating not less than 8 microns.

- 1.5.10.1 The bus bars used shall be of high conductivity electrolytic copper as per IS:613 with current density not exceeding 4 A/mm². The bus bar shall have colour code with red, yellow and blue on the a.c. side and brown and black respectively for positives and negatives on the d.c. side. Bus bars supports shall be made with insulators and be identified by engraving the respective circuit numbers with contrast colour paint applied on the engraved marking.

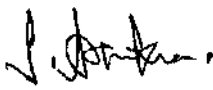
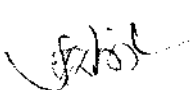
- 1.5.11 All the cable wire ends shall be terminated with suitable sockets using proper dies and tools.

- 1.5.12 Cables – All the cables/wires shall be multi-strand flexible insulated cables conforming to E/14-01/parts I, II and III. PTFE insulated cables of adequate voltage rating and size shall be used for inter-connection snubber circuits and signaling fuses.

- 1.5.13 All the wires shall be numbered with cables ferrules of approved design on both ends of the cables.

- 1.5.14 Wiring layout- The quality of workmanship and layout of wiring shall be of high standard to ensure long life. The following guidelines shall be kept in view.

- Complete separation of low, medium and high voltages.
- Separation temporarily and permanently energised cables with separate bunching.
- Avoiding of sharp bends.
- Provision of grommets for cables entries.

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- e) Supporting of cable bunches with insulated supports using nylon ties.

2.0 Tests :

- 2.1 Type tests on silicone diodes – At least ten diodes shall be subjected to type tests as per IS-7788 in the presence of RDSO Inspecting Official sufficiently in advance to avoid delay of prototype testing of the rectifier unit.

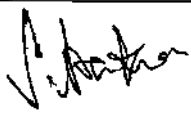
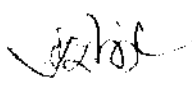
- 2.2 Routine tests on each diode shall be conducted as per IS-7788 and the results recorded by the manufacturer. 10% of the lot offered selected at random shall be subjected to routine tests in the presence of inspecting official of RDSO.

2.3 Type test on Rectifier assembly:

- 2.3.1 Temperature rise test – with normal ventilation, the rectifier shall be subjected to the duty cycle expected on the traction motors with the temperature maintained at 47°C and until steady temperature is obtained. The temperature stabilisation can be deemed when three successive readings taken at 15 minutes intervals do not vary by more than 0.5 °C. The maximum diode junction temperature arrived shall be less than the permissible junction temperature as declared by the diode manufacturer after the duty cycles as described in clause 1.2.7 of Annexure-3. The temperature rise test shall be conducted both for n and (n-1) bridge conditions.

- 2.3.2 Heat run test with (n-1) parallel paths will be conducted on first prototype and afterwards the test may be conducted corresponding to normal duty cycle with all bridges in operation.

- 2.3.3 Fuse blade temperature and bus temperature shall not exceed 100 deg. C for (n-1) parallel paths.

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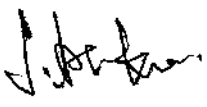
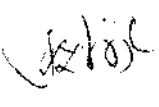
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2.3.4 Instruments used for type testing shall be of 0.5 class accuracy and shall have been calibrated within 6 months from the date of testing.

2.3.5 Power losses measured for the diodes shall not exceed 10% of the declared value.

3. Guarantee:

The diodes of the main Rectifier shall be guaranteed for satisfactory working for a period of five years from the date of commissioning.

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