



**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

SCHEDULE OF TECHNICAL REQUIREMENT (STR)
FOR
REPAIR OF PRINTED CIRCUIT BOARD
OF
3-PHASE ELECTRIC LOCOMOTIVES Type
WAP5,WAP7&WAG9

MARCH 2008

ISSUED BY:

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SCHEDULE OF TECHNICAL REQUIREMENTS FOR REPAIR OF PRINTED CERCUIT BOARD FOR 3-PHASE ELECTRIC LOCOMOTIVES

1. General :

- 1.1 Indian Railways imported 22 WAG9 locomotives and 11 WAP5 locomotives in 1997-98 from M/s. ABB, Switzerland. Later on, CLW started the manufacturing of these locomotives by procuring Power Converter, Auxiliary Converter & Control Electronics from ABB, Switzerland. These equipments were indigenised later on by M/s. BT, Vadodara, M/s. NELCO, M/s. BHEL and M/s. CGL through transfer of technology. There are 27 types of cards, 81 in Nos. in one locomotive. The Schedule of Technical Requirements (STR) is issued to serve as a essential guideline to repair of PCBs for 3-phase electric locomotives. The firm should satisfy themselves about having complied with the technical requirements and other infrastructure. The Technical Requirements are meant to serve as guideline only and are not exhaustive.

The firm should have currently valid ISO-9001:2000 certification including the its range of repair of PCBs.

- 1.2 All the machines and measuring instrument/gauges should be properly calibrated.
- 1.3 Firm should have technically qualified personnel in the field of design, repairing & testing of PCBs for 3-phase electric locomotives.
- 1.4 The firm should have its own testing laboratory.
- 1.5 Firm should have their Quality Assurance Plan containing the following as a minimum:-
- a) Organizational chart clearly bringing out the quality control set up.
 - b) Qualification of the key personnel maintaining the quality control set up.
 - c) Process flow chart indicating the process of repairing of PCBs for 3- phase electric locomotives.
 - d) The firm should have full-proof system of monitoring the customer complaints including warranty obligations with facility of traceability by the repair PCBs identification number.

2. REQUIREMENTS:

The information shall be furnished as per details required in the following Annexures :

- 2.1 Repairing facilities of PCBs shall be required as per **Annexure-I**. It however does not specify the capacity and quantity of various repair PCBs of components which may vary according to the PCBs repairing capacity of the individual firm. The firm should also have the good facility for storing the components and repaired the PCBs so as to maintain them in a healthy condition.
- 2.2 Meticulous record of each batch of repair done during warranty investigation to trace out causes of failure etc.
- 2.3 QAP or procedure of repair of PCBs shall be as per **Annexure-II**.
- 2.4 The essential facility/machineries are considered for the repairing of PCBs of quality and reliable. This shall be as per **Annexure-III**.
- 2.5 The essential key words/definitions pertaining to three phase electric locomotives are placed at **Annexure-IV**.

ANNEXURE-I

PCBs Repairing Facilities:

The following minimum facilities Machinery and Plants are considered essential for PCBs Repairing at firm premises.

| Sl. No. | Details Of Machine |
|----------------|--|
| 1. | PCB in circuit components Diagnostics test system (ICCT jig) |
| 2. | Functional test jig for each type of card |
| 3. | Test program for each type of card |
| 4. | Ultrasonic cleaner |
| 5. | De- ionized water plant |
| 6. | Washing equipment |
| 7. | Spraying equipment |
| 8. | Conformal coating remover |
| 9. | Calibrated general purpose measuring instruments |
| 10. | ESD safe work benches |
| 11. | PC based Video Microscope System for inspection of soldering quality |
| 12. | Rework station with suitable nozzle for each type of card |
| 13. | Suitable soldering/desoldering equipments |
| 14. | Back-up Power Generator for uninterrupted working |
| 15. | Digital Oscilloscope with Probe (Storage type) |
| 16. | EPROM Programmer |
| 17. | IC Tester |

Note – All the measuring instruments shall confirm to relevant IS/IEC standards with up to date calibration.

ANNEXURE -II

QUALITY ASSURANCE PLAN

1. Organization:

The firm shall submit the organizational chart, along with the qualification and experience of key persons in management involved in Quality Assurance Programme. It will also be a prerequisite for a firm to submit QAP for repairing of PCBs for three phase electric locomotives.

2. Documentation:

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

3. Purchase of Components:

Components of repair PCBs shall be procured only from sources given in Qualified Manufacture Part List or Original Bill of Materials. New components if required, shall be procured from ISO: 9001 – 2000 certified vendors in case of obsolesce and the components should be got approved by RDSO.

4. Procedure for repairing of PCBs:

4.1 Issue of defective PCBs, racks or modules to Repair Agency

Electric Loco Shed shall issue the defective PCBs, or modules properly placed in Anti Static packing. Following documents shall be issued:

- (a) Type, Type Identification Number, Make and Serial Number
- (b) Locomotive in which failed.
- (c) Date of commissioning.
- (d) Brief details of failure and available investigations of the shed.
- (e) Accompanying Diagnostic Data Set (DDS) downloaded from the locomotive in which the PCB or module has failed(both hard copy and soft copy).

4.2 Receipt by repair agency:

On receipt of the defective units by the repair agency, the accompanying information about the unit shall be verified and receipt acknowledged. The acknowledgement will be kept on record by the Electric loco Shed, linking its reference in the master register.

4.3 Repair procedure

On receipt of the defective units, the main function of the repair agency is to identify the defective component, replace the same and test the unit for its proper functioning. For doing these basic primitives, a series of operations may have to be done based on the complexity of the failed units and the nature of failure and would vary from unit to unit. Though each repair agency can adopt different methods to finally identify the defective component and replace the same, in order to ensure consistency in the repair process, the following procedure shall be adopted:-

4.3.1 PCB / Module Functional Test

The PCB or module, needing further diagnostics and rework will be tested in the function test jigs designed for that type of PCB or module, as per the TOT documents. After functional tests, either of the two situations may arise viz. exact trouble shooting successful (ii) exact trouble shooting unsuccessful. If the troubleshooting is unsuccessful, the PCB/module is sent to the In-circuit test Jig (ICT) for component level troubleshooting. If the trouble shooting is possible at card level functional test, then it directly goes for re-work.

4.3.2 Remove coating & ICT

If it is found necessary to do ICT for component level troubleshooting, the conformal coating is first removed to get access to the test pads in the PCB. There after, it is mounted in the ICT jig for trouble shooting.

4.3.3 Replacement & Repair

The identified defective component is removed. In its place, a new component, of same type/make or as approved by RDSO shall be used. Documentary evidence of purchase of components from sources approved by RDSO shall be submitted. All other electrolytic capacitor shall be checked and replaced, if required.

4.3.4 Function test after repair

After the repair is carried out, the PCB or the module shall be tested in the respective function test jig to reaffirm that the unit is healthy with reworked component.

4.3.5 Cleaning & Re-coating

Once the reworked unit passes the function test, it is cleaned and the conformal coating is reapplied.

4.4 Inspection after repair

The railways representative and firms representative shall witness the functional test as described above. The test jigs used shall be normally the one used for the manufacturing of the electronic cards, which is as per the TOT documents as mentioned above. The firm however after developing test jig for the purpose, should get approval of RDSO. The results of the functional test shall be recorded jointly by the both the representatives.

4.5 Handling & transport

The PCB or module, as the case may be, shall be packed properly to avoid any transit damage, even if sent by road, air or courier. The PCBs and modules shall be packed in anti-static packing. All the investigations and findings during the repair process shall be well documented and accompanied with the repaired unit.

4.7 System level functional test in loco at shed:

The cards, after reaching to electric loco shed, shall be provided in a working loco and to be tested if any problem is encountered during loco testing. The card shall be sent back to repairing agency in case of any problem found during testing.

5. R&D Facilities :

The firm should have R&D facilities to investigate into the various types of failures and evolve necessary remedial measures to avoid failures of repair PCBs in future. The firm shall recommend upgradation of components, preventive replacement of certain components after certain age or even functional equivalent of cards after gaining sufficient experience in repairs of electronic cards of three phase locomotives.

ANNEXURE – III

INFRASTRUCTURE FOR QUALITY ASSURANCE :

The following facilities either firm's premises or sub vendor premises facility are considered desirable for the repairing of quality and reliable cards.

- i) Dust free environment for the assembly of PCBs.
- ii) E S D protection in line with IS: 10087-1981. Work procedure for following ESD practices needs to be submitted.
- iii) Exclusive R&D facility, apart from normal manufacturing set-up.
- iv) Necessary design and simulation software for electrical and mechanical design.
- v) Computerisation of record keeping and inventory control.

ANNEXURE – IV

Definitions :

- (i) IR** means Indian Railways
- (ii) RDSO** means Research Design and Standard Organisation
- (iii) CLW** means Chittaranjan Locomotive Works

- (iv) Sr.DEE/TRS** means Sr. Divisional Electrical Engineer.
- (v) PCB** means various printed circuit boards used in the three phase locomotive in traction converter, auxiliary converter and control electronics for carrying out different control functions. These are provided in racks (also called card cages) and are of 6U format, multi-layered employing SMD cum THT technology. Various types of PCBs used in three phase locomotives and covered under the scope of this contract are defined in clause 4.0 of this document.

- (vi) Electronic modules** means electronic equipment packed in the independent housing and meant for a specific function. These modules are used in the traction converter, auxiliary converter and control electronics.

- (vii) Traction converter** means electronic conversion equipment mounted on board the locomotive for converting single-phase 50Hz voltage into a three phase variable voltage and variable frequency three-phase voltage for driving the traction motors. This is also often referred as SR. There are two traction converters in one locomotive, each feeding the traction motors mounted in a bogie (SR1 & SR2).

- (viii) Auxiliary converter** means electronic conversion equipment mounted on board the locomotive for converting single-phase 50Hz voltage into three-phase voltage for feeding various auxiliary machines in the locomotive. This is also often designated as BUR. There are three auxiliary converters in each locomotive, viz. BUR1, BUR2 & BUR3, physically housed in two cubicles.
- (ix) Control Electronics** means the vehicle control units responsible for various control functions within a locomotive (called vehicle level) and also between locomotives (train level) in case of two or more locomotives. There are two cubicles, both functionally and physically dissimilar, housed in two separate cubicles. These are often referred as Z LT1 and Z LT2.

- (x) **Backplane** means the printed circuit board used in the rear of a PCB card cage (rack) for interconnection of various PCBs, including the discrete wiring.
- (xi) **Shed** means three phase electric locomotives user Shed
- (xii) **OEM** means original manufacturer of the PCB under consideration
- (xiii) **ABB** means Asea Brown Boveri (Switzerland), with whom, Indian Railways signed the transfer of technology contract.
- (xiv) **ABB make PCB** means any PCB for which OEM is ABB and having its logo or identification mark on the PCB, even though supplied by any of the TOT partner.
- (xv) **SMD** means surface mount device, which is a technology for populating the electronic component on the PCBs. The devices are soldered on the surface of the PCB for compactness.
- (xvi) **THT** means through hole technology process for populating electronic components on the PCB. The pins go through the holes provided on the PCBs and soldered on the other side.
- (xvii) **ALG** is the German short form for the traction converter control rack.
- (xviii) **Active component** means any component, which works on the principle of semiconductors, for example, diode, transistor etc.
- (xix) **Passive component** means any component, which does not work on the principle of semiconductors, for example, resistors, capacitors.
- (xx) **ESD** means electro static discharge. Electrostatic voltage gets developed on any body, for example on human body, which can gets discharged through the devices on the PCBs, while handling without adequate care. Some active devices are prone to damage due to ESD.
- (xxi) **QMPL** means Qualified manufacture part list.
- (xxii) **TOT** means transfer of technology.