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भारत सरकार – रेल मंत्रालय
अनुसंधान अभिकल्प और मानक संगठन
लखनऊ – 226011
Government of India - Ministry of Railways
Research, Designs & Standards Organization,
LUCKNOW - 226011

No. EL/1.2.9.1

Dated: 21.06.2016

All chief Electrical Engineers,

**SPECIAL MAINTENANCE INSTRUCTION NO. RDSO/2016/EL/SMI/0291 (REV. '0'),
Dated 21.06.2016**

1.0 Title:

Technical Scope of work for Annual Maintenance Contract (AMC) of 180 KVA Static Inverter (SIV) fitted in conventional tap changer electric locomotives.

2.0 Brief History:

- 2.1 180 KVA Static Converter were developed by Railways and different vendors In the year 2000. First unit was introduced in the year 2000. Since then more than 2540 units are working under Indian Railways. SIV replaced ARNO which is prone to failure and SIV is supplying controlled power sources to auxiliary machines. The performance of auxiliary machines were reported satisfactorily and the failure trends of auxiliary machines are nearer to NIL as they were fed from controlled power supply with low range of voltage variation ($415 \pm 5\%$).
- 2.2 During development phase it was felt that 180 KVA Static converter requires least maintenance as the converter is fitted with power electronics items. But during field experience it was observed that due to wide variation of ambient temperature (from 0 °C to 55 °C) SIV unit failed on line. The nature of failures was examined and it was felt that failures which occur can be categorized in two categories, namely internal & external reasons. The internal failures were happened due to internal component failures of SIV itself and external failures are due to any external reasons.
- 2.3 These locomotives are homed and maintained at 30 different Electric Loco Sheds of Indian railways. As per RDSO specification no ELRS /SPEC/SI/ 0018 Rev. "1" March 2006 the warranty clause says that the supplier shall be responsible for any damage to equipment provided in the locomotive due to defective design, materials, workmanship up to a period of 18 months after commissioning on the locomotive or 24 months from the date of supply, whichever is earlier. As more than 80 % population of about 2540 units have crossed the time limit of warranty period, there exist a requirement for formulation of strategies for maintenance of SIV by entering into Annual Maintenance Contract with OEM.
- 2.4 From maintenance point of 180 KVA Static Converter, RDSO has conducted various training programme, workshops, seminars for officials of different loco sheds through manufacturers. Many reliability action plans have also been formulated but failures still persists.

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2.5 Railway Board vide letter no. 2007/Elect (TRS)/440/8 Pt. dated. 27.08.2015 stated "strategy to be adopted for maintenance of SIV by keeping spares or by entering into Annual Maintenance Contract with OEM". In pursuance of Railway Board's letter, the special maintenance instruction is being prepared as general guideline to Zonal Railways for implementation of Annual maintenance contract for 180 KVA SIV.

2.6 As per record, the total populations of 180 KVA SIV firm wise up to 31.03.2016 are tabulated below:

SN	Name of supplier	Total population
1	M/s. Autometer Alliance Limited / Noida.	878
2	M/s. Siemens/ Mumbai	900
3	M/s. Hind Rectifier/ Bhandup / Mumbai	275
4	M/s. Medha Servo Drive/ Hyderabad	324
5	M/s. ABB/ Bangalore	117
6	M/s. Bombardier Transportation	51
	Total	2545

3.0 DEFINITIONS

Throughout this document, the terms:

- a) **'SIV'** means Static Inverter.
- b) **'IR'** means Government of India, Ministry of Railways, Railway Board, New Delhi or its nominees.
- c) **'Tenderer'** means the firm/company submitting the offer for annual maintenance of SIV fitted on Conventional tap changer Electric locomotives.
- d) **'Contract'** means the contract for annual maintenance of SIV fitted on Conventional tap changer Electric locomotives between IR and the firm, against the tender.
- e) **'Contractor'** means the firm / company or its wholly owned subsidiary in India on whom the order for annual maintenance of SIV fitted on Conventional tap changer Electric locomotives is to be placed.
- f) **'Sub-contractor'** means any person, firm or company from whom the contractor may obtain any services for maintenance of SIV
- g) **'User Railway'** means the Zonal Railway or Divisional Railway which has placed the contract on firm in terms of this agreement.
- h) **'Designated Shed'** shall be the shed so designated by the user Railway, within the zone of that user Railway, where the locomotives shall be brought for maintenance including the maintenance of SIV.

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- i) **'Nominated Officer'** means the person nominated by user Railway for the purpose of execution of contract.
- j) **'RDSO'** shall mean Research, Design and Standards Organization / Lucknow for the purpose of consultation regarding up gradation.
- k) **'GCC'** shall mean General Conditions of Contract (Works) contract, of the concerned zonal railway.
- l) **'Minor Schedule'** The inspection schedule IA, IB and IC
- m) **'Major Schedule'** The schedule TOH and IOH
- o) **'OEM'** means Original Equipment Manufacturer

4.0 Object:

To provide technical scope of work for Annual Maintenance Contract (AMC) of 180 KVA Static Converter.

5.0 Scope of work of AMC:

- 5.1 This is a comprehensive Annual Maintenance Contract for 180 KVA Static Converter where Original Equipment Manufacturer (OEM)/contractor shall at its own cost and expense attend, replace and install materials which get consumed, wear out due to ageing /use in the normal course of operation as well as attend failures/breakdowns /out of course repairs of 180 KVA SIV including components, assembly/ sub-assembly, electronic cards etc. for efficient and reliable operation of equipment under AMC. During the maintenance period OEM/contractor shall arrange transport of man and material at its own cost as and when required for maintenance of the equipment.
- 5.2 The contract shall be comprehensive in nature wherein preventive as well as Breakdown Maintenance of SIV shall be carried out by the contractor including the arrangement of spares, tools, consumables, technical expertise and man power. The released defective cards, consumables, tools, items etc. will be contractor's property. Contractor shall remove the same from the shed's premises with due authority/procedures.
- 5.3 Railways will enter into AMC for SIV with manufacturers of SIV for their own make of SIV units or with sources approved for repair of SIV of a particular make.
- 5.4 SIV units under warranty shall not be included in scope of AMC. SIV units beyond manufacturer's warranty shall only be included in scope of AMC. However, Railways may enter in to AMC contract for SIV units covered under warranty, but in such cases, AMC for units still covered under warranty shall commence from the next day of completion of warranty period.
- 5.5 AMC will be carried out for SIV units in working condition.
- 5.6 The maintenance and support by the contractor shall consist of periodical preventive checks as per the maintenance schedule of SIV for trouble free operation of the equipment as well as attending the failures/breakdown/out of course repair etc.

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- 5.7 Contractor shall ensure that AMC maintenance schedule should match with the loco inspection schedules. i.e. IA, IB, IC, AOH/TOH, IOH & POH, etc. The scope of maintenance by the contractor shall be largely as per preventive maintenance schedule of the equipment, but shall include out of course attentions including breakdown, if any required, to ensure trouble free operation of the locomotive.
- 5.8 AMC shall not cover the 180 KVA Static Converter failures due to circumstances such as fire in locomotives, accident, earth quake, floods etc. However, in such circumstances payment for spares to be replaced by the tenderer will be made extra as per the price list of OEM submitted along with their offer.
- 5.9 All maintenance activities shall be carried out as per the schedule approved by Railways. In case of any abnormalities found during minor/major schedules, associated component/subassemblies shall be replaced/repared by the contractor. The activities to be covered under scope of work of AMC of 180 KVA Static Converter are given below:
- 5.10 The scope of work is divided in two schedules:
- General work applicable in all makes of SIV – Included in Schedule A.
 - Scope of work specific to make wise – Included in Schedule B

5.10.1 Schedule A

The details of proposed maintenance activity to be checked during schedule A are listed below:

SN	Maintenance Activity	IA	IB	IC	TOH	IOH	POH
1.	Data to be down loaded, stored from Static Inverters during schedules & Temporary repair. Transient failures are also to be attended.	✓	✓	✓	✓	✓	✓
2.	Check the tightness of all mounting / fixation bolts.	✓	✓	✓	✓	✓	✓
3.	Check the earth connections of SIV.	✓	✓	✓	✓	✓	✓
4.	Check the battery charger load current, battery charger voltage.	✓	✓	✓	✓	✓	✓
5	Overall cleaning of converter and Battery Charger	✓	✓	✓	✓	✓	✓
6	Cleaning of heat sink duck by Vacuum cleaner/ Dry air	-	-	-	✓	✓	✓
7	Checking the mounting and connection tightness of chokes and capacitors	-	-	-	✓	✓	✓
8	Proper functioning of QSVM relay	✓	✓	✓	✓	✓	✓
9	Checking the status of tightness of cables bus bars capacitors, MOVs, PTs, CTs and connectors of cards	-	-	✓	✓	✓	✓
10	Checking the sealing of cable entry and front cover and battery charger	-	-	-	✓	✓	✓
11	Checking of functioning of churning fan by pressing the push button switch provided at power panel side.	✓	✓	✓	✓	✓	✓

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SN	Maintenance Activity	IA	IB	IC	TOH	IOH	POH												
12.	ALL OFC coupler connections to be checked.	-	-	✓	✓	✓	✓												
13	Visual checking of DC link capacitors for its healthiness to be carried out.	-	-	✓	✓	✓	✓												
14	Check the earth fault protection	✓	✓	✓	✓	✓	✓												
15	Check loads ‘turn on and off’ for its sequence and timing. Check functioning of relays in control circuit.	✓	✓	✓	✓	✓	✓												
16	Checking of functioning of cooling fan & churning fan.	✓	✓	✓	✓	✓	✓												
17	Check all the system parameters on the display of SI unit.	✓	✓	✓	✓	✓	✓												
18	Check the condition of out-put choke , DC filter choke	-	-	-	✓	✓	✓												
19	Clean the dust accumulated on all the internal parts including heat sink cooling fan impeller etc.	-	-	✓	✓	✓	✓												
20	Clean the dust accumulated on all the internal parts including heat sink cooling fan impeller etc. and check the cable connections of all components including capacitors, chokes, sensors, PTs, CTs.	-	-	-	✓	✓	✓												
21	Protection & fault simulation test for various faults.	-	-	-	✓	✓	✓												
22	Checking of protection settings and reload the software if required.	-	-	-	-	✓	✓												
23	Replacement/Repair of cooling & churning fan: The rotational movement of Churning fan & the bearing of cooling fan are to be verified during TOH, IOH schedule. But the replacement of the bearing of cooling fan is to be replaced as per schedule submitted by firm or as & when required.	-	-	✓	✓	✓	✓												
24	Battery Charger: monitoring of battery charger condition by taking following reading:	✓	✓	✓	✓	✓	✓												
	<table><tr><td>Item</td><td>CHBA load current (Amp)</td><td>CHBA Voltage</td><td>Battery Voltage</td></tr><tr><td>Normal Values</td><td>8 Amp (Max)</td><td>107 – 114 V</td><td>100 – 110 V</td></tr><tr><td>Actual value</td><td></td><td></td><td></td></tr></table>	Item	CHBA load current (Amp)	CHBA Voltage	Battery Voltage	Normal Values	8 Amp (Max)	107 – 114 V	100 – 110 V	Actual value									
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Actual value																			

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SN	Maintenance Activity	IA	IB	IC	TOH	IOH	POH
25	QSVM Relay: 1. Proper functioning of QSVM relay to be checked (Only functional test for shutdown of SIV for 02 Sec after BLVMT switched ON and then re-start). 2. Visual checking the condition and connection of C1-C2 damping panel near auxiliary winding of transformer and values to be measured.	-	-	✓	✓	✓	✓
26	Earth fault & its by-pass mode checking.	-	-	-	✓	✓	✓
27	Total SIV blowing in major schedule.	-	-	-	✓	✓	✓
28	Visual checking, tightness of fixing bolts and couplers, intactness of earthing shunt and availability of gasket on door and cable entry point/hole is being checked in every schedule.	✓	✓	✓	✓	✓	✓
29	Tightness of cooling fan mounting bolts is being ensured in every schedule	✓	✓	✓	✓	✓	✓
30	Checking of capacitor bulging in all SIV's	✓	✓	✓	✓	✓	✓
31	Measurement of capacitance of AC output filter and checking its healthiness.	-	-	-	-	✓	✓
32	Measurement of output current, capacitor of battery Charger for its healthiness.	-	-	-	-	✓	✓
33	Replacement of Gasket: The replacement of gasket on door and cable entry point/hole is being checked in every schedule and replacement on conditional basis.	✓	✓	✓	✓	✓	✓
34	Measurement/ checking of resistances of input / output CTs and ZCTs for its healthiness.	-	-	-	✓	✓	✓
35	Condition of QCON timer card. Replacement of QCON timer card on conditional basis wherever applicable	-	-	-	✓	✓	✓

5.10.2 Schedule B

Scope of work specific to make wise:

- (a) The additional works are to be carried out for AAL make SIV
- Checking of IGDU card pulse transformer healthiness by measuring pulse out put in every major schedule.
 - Linearity checking for voltage sensors in every major schedule.
 - Checking of external earth fault and its bypass modes in every major schedule.
 - Simulation test of MCU card on test bench in every major schedule
 - ZCT resistance value, power supply card checking on Test bench in every schedule
 - Observing the total earth leakage current in every major schedule.

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- (b) The additional works are to be carried out for Siemens make SIV
- (i) Cleaning the heat sink and blower duct with vacuum cleaner
 - (ii) Earth fault and bypass operation checking.
 - (iii) Checking of external earth fault and its bypass modes in every major schedule.
- (c) The additional works are to be carried out for Medha make SIV
- Checking the operation of QCON, LSCHBA & LSIT.
- (d) The additional works are to be carried out for Hirect make SIV
- (i) Checking the snubber capacitor value (0.47mf) in every schedule (due to failure rate more).
 - (ii) The linearity test of input/output voltage sensors & DC link voltage sensors in major schedule.

5.10.3 In addition to above, modifications/reliability improvement measures / instructions related to 180 KVA Static Converter issued by Railway Board/RDSO/Manufacturers from time to time shall be considered as part of scope of AMC. The cost of modification (material portion) will be borne by either Contractor or Railways as per RDSO guide lines. However, labour portion including provision & testing is to be done at free of cost by the Contractor. Contractor will carry out the required modifications and inform Railways and RDSO.

5.10.4 Above schedule of works is for guideline. Railways may include any additional action/works deemed necessary to ensure proper maintenance.

5.11 Responsibilities of Railways:

- 5.11.1 The Railway authority shall permit the contractor to work on SIV fitted on conventional tap changer electric locomotives under preventive maintenance or break down.
- 5.11.2 Railways shall nominate the Officer/ Supervisor for supervision of the work done by the contractor under the contract.
- 5.11.3 The necessary space, electricity, and water connection shall be provided by Railway free of cost as required for at the nearest possible point of the site. In addition, a suitable covered space to store the tools and tackles shall be provided free of cost by the IR to the contractor. However, there shall be no separate exclusive security systems for the space/facility provided to the contractor by Railway.
- 5.11.4 Railway shall mention the details of the equipment covered under AMC including the locomotive numbers covered under Annual Maintenance Contract. In case the home shed of the locomotive is shifted to any other location, the scope of AMC shall shift to new home shed of the locomotive.

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- 5.11.5 Railways shall inform in advance (preferably 24 hours in advance or at least 12 hours in advance) the contractor regarding locomotives planned for scheduled repairs (i.e. IA/IB/IC/IC0/AOH/TOH/IOH/POH) so that contractor can also plan and carry out the activities as per scope of work of AMC.
- 5.11.6 Railways shall also inform the contractor regarding any line failures/breakdown of the locomotive and likely place (trip shed/ loco shed) and date where locomotive needs to be attended by the contractor.
- 5.11.7 The owning shed and the firm shall jointly arrive at the no. of locos that are under AMC at the start of contract and a record shall be kept for this purpose.

5.12 Responsibilities of Contractor

- 5.12.1 The contractor shall post adequate no. of qualified service engineers/backup engineers and arrange required materials exclusively for the execution of this contract at the designated shed/sheds with immediate effect.
- 5.12.2 Service Engineer shall carryout preventive maintenance on locos at all days and times including Sundays and Gazetted holidays depending upon availability of locomotive in the shed.
- 5.12.3 Normally Service engineer shall be available in the shed during normal working hours to attend breakdown calls/ preventive maintenance. A backup engineer shall be located at one of the contractor's office and shall be available at the designated shed if required to attend the complaints in case of absence of service engineer at the designated shed.
- 5.12.4 The service engineer nominated for the repair on the shed duty shall observe all safety and security rules prevailing at the place of work.
- 5.12.5 The contractor shall keep adequate number of spare cards/components etc. to ensure timely replacement of defective cards/components. Failed components are to be replaced with new/repared cards/components.
- 5.12.6 Firm shall make Joint Note along with shed staff for each and every line failure and shed detection cases duly indicating the root cause of failure and corrective measures to be taken in the format as prescribed by RDSO. Investigation report in each case along with remedial action taken/to be taken shall be submitted to Railways & RDSO.
- 5.12.7 In case of any 180 KVA Static Converter card found malfunctioning/behaving erratically showing fault intermittently not permanent it must be replaced by firm.
- 5.12.8 In some cases, the actual problem is not established and in these cases, loco is required to be escorted by the maintenance personnel. Hence, in such cases escorting of loco by the contractor's service engineer for finding the trouble to be ensured.
- 5.12.9 Firm service engineer should maintain 180 KVA Static Converter unit wise history of failure and other details and checks performed during the minor schedule in the

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form of check sheets which will be made as per RDSO guidelines and got approved from Railway Representative

- 5.12.10 Scheduled work and testing if required should be carried out during the schedule and testing hours as specified by Railways
- 5.12.11 After every attention to the 180 KVA Static Converter, contractor will give a report to the Railways giving details of activities carried out including details of components/subassemblies replaced.
- 5.12.12 The contractor shall quote the rates for comprehensive AMC (as specified in paragraph 5.1) considering both the break down & preventive maintenance (including spare materials, components, assemblies, labour, manpower, service, transportation etc.

5.13 PLACE OF WORK

- 5.13.1 Minor schedule activities (IA/IB/IC/ICO) will be carried out at the home shed of the locomotive.
- 5.13.2 Major schedule activities (AOH/TOH/IOH) will be carried out at the home shed of the locomotive.
- 5.13.3 Major schedule activities (POH) will be carried out at the POH shop where locomotive is undergoing POH as decided by the Railways.
- 5.13.4 Breakdown maintenance will normally be carried out at the nearest trip shed/loco shed where loco is sent after failure. If the locomotive cannot be attended at out stations, locomotive may be called to home shed.

5.14 Penalty Clause for AMC:

- 5.14.1 As soon as failure of equipment under AMC takes place, the same shall be informed to Contractor by Shed/Railway authority. Contractor shall attend the defects as early as possible but not exceeding 24 hours after the placement of locomotive in shed/trip shed covered under contract mutually agreed between parties (Railways and contractors).
- 5.14.2 For smooth execution of AMC by contractor, Zonal Railways may include suitable penalty clause as special condition of contract for AMC. However sample penalty clauses are given as under for guidance of Zonal Railways.

5.14.3 Downtime penalty for fleet of locomotives

- a) Downtime on account of online failures of equipment under AMC shall be from the time the locomotive fails on line and reported to the contractor till the loco is given ready for service.
- b) The contractor shall ensure that during the billing period (three months), combined downtimes of all the locomotives covered under AMC, on account of out of course repair and online failures of equipment under AMC does not

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exceed 1.5% of total loco hours for the locomotives covered in the AMC. Penalty for Downtime for the fleet of the locomotive shall be as under:

Down time	Penalty
1.5 % or less	NIL
1.5% to 5%	2% of the total monthly proportional bill
5% to 10%	5% of the total monthly proportional bill
More than 10 %	10% of the total monthly proportional bill

5.14.4 Downtime penalty for individual locomotive

- a) Downtime on account of online failures of equipment under AMC shall be from the time the locomotive fails on line and reported to the contractor till the loco is given ready for service.
- b) The contractor shall ensure that during the billing period (three months), individual downtime of all the locomotives covered under AMC, on account of out of course repair and online failures of equipment under AMC does not exceed 5% of loco hours for the locomotive covered in the AMC. Penalty for Downtime of the individual locomotive shall be as under:

Individual Down time	Loco	Penalty
5 % or less		NIL
> 5%		5% of the individual loco's monthly proportional bill

5.14.5 Overall liability in any case shall not exceed 10% of the contract value

6.0 Application to the Class of Locomotives:

180 KVA Static Converter fitted tap-changer 25 KV AC conventional electric locomotives.

7.0 Agency of Implementation:

All Electric Loco Sheds.

8.0 Periodicity of Implementation:

Minor schedule inspections (IA/IB/IC/IC0), TOH (Earlier AOH), IOH, POH overhauling schedules and any other unscheduled maintenance

Encl.: Nil

(Kishore Vaibhav)
for Director General (Elect.)

Copy to: As per standard Mailing List No. EL-M-4.2.3-19(latest revision).

Encl.: Nil

(Kishore Vaibhav)
for Director General (Elect.)