Fax : (0522)-2452581
Telephone: (0522)-2450374
Telegram : 'RAILMANAK', KO
Email:dsetpl@gmail.com

सत्यमेव जयते

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

No. EL/11.5.5/5 Date: 03.05.2017

1. M/s.ABB Limited, Survey No. 88/3-4, Nelamangala Taluk, Bangalore – 562 123
2. M/s. BHEL Limited, Electronics Division, PB.No.2606, Mysore Road, Bangalore-560 026
3. M/s. BTIPL, ERDA Road, Maneja, Vadodara-390 013
4. M/s. BHEL, CEE Division, Piplani, Bhopal – 462 022
5. M/s. CGL, Plot No. 9, MPAKVN Phase-2, New Industrial Area, Mandideep – 462 046.
6. M/s.Medha Servo Drives Pvt. Ltd., P-4/5 B, I.D.A., Nacharam, Hyderabad – 500076

Sub: Minutes of the Meeting held at RDSO, Lucknow on 19.04.2017 on Reliability of GTO & IGBT based three phase electric locomotives.

Ref: This office letter of even no. dtd. 06.04.17.

Please find enclosed herewith a copy of Minutes of the Meeting held at held at RDSO, Lucknow on 19.04.2017 on 'Reliability of GTO & IGBT based three phase electric locomotives' for information and necessary action.

3/5/17

(Suresh Kumar)
For Director General (Elect.)

Encl: As above.

Copy to:

1. **Secretary (Electrical), Railway Board, Rail Bhawan, New Delhi-110 001.** For kind information.
2. **Chief Electrical Engineer,** *(For information and necessary action)*
   - Central Railway, HQs Office, 2nd floor, Parcel Office Bldg., Mumbai-400 001
   - East Central Railway, Hajipur (Bihar)-844 101
   - Eastern Railway, Fairlie Place, Kolkata – 700 001
   - East Coast Railway, Railway Complex, Bhuvneshwar – 751 023
   - Northern Railway, Baroda House, New Delhi-110 001
   - North Central Railway, Allahabad – 211 001
   - South East Central Railway, Bilaspur-495 004
   - South Central Railway, HQs Office, Rail Nilayam, Secunderabad-500 071
   - South Eastern Railway, Garden Reach, Kolkata- 700 043
   - Southern Railway, Park Town, Chennai – 600 003
   - West Central Railway, HQs Office, Opp. Indira Market, Jabalpur-482 001
   - Western Railway, Churchgate, Mumbai – 4000 020
   - Chittaranjan Locomotive Works, Chittaranjan – 713 331(WB)

3/5/17

(Suresh Kumar)
For Director General (Elect.)

Encl: As above.

Minutes of the Meeting held at RDSO, Lucknow on 19.04.2017 on Reliability of GTO & IGBT based three phase electric locomotives

Members Present: (S./Sri)

RDSO

1. O.P. Kesari, EDSE (Co-ord)
2. Suresh Kumar, DSE/TPL
3. S.K. Deo, SSE/TPL

CLW

1. S.K. Singh, Dy. CEE/D2

Industry

1. Mahesh Handigol, Head Traction/ABB
2. C. Ramanujam, Head Business/BTIPL
3. R. Shekar, Sr. DGM/BHEL
4. S.S. Ostwal, DGM/CGL
5. A.N.V. Rao, Asst. Manager/Medha

Zonal Railways

1. S.K. Natarajan, Sr. DEE/ELS/RPM
2. Arjit Saxena, DEE/ELS/BIA
3. Hariram, Sr. DEE/ELS/KYN
4. Anurag K. Gupta, Sr. DEE/ELS/CNB
5. D.V.K.V. Prasad, ADEE/ELS/VSKP
6. Puneet Jeph, DEE/ELS/TKD
7. A. Sundaresan, Sr. DEE/ELS/BRC
8. Anant Sadashiva, Sr.DEE/ELS/TATA
9. Sachin Goel, ADEE/ELS/GZB
10. Manjay Kumar, DEE/ELS/HWH
11. Namdeo Rabde, Sr. DEE/ELS/AQ
12. K.P. Naveen, ADEE/ELS/GMO
13. V. Srinivasan, SSE/ELS/LGD

****

The meeting was held in accordance with the agenda circulated vide RDSO letter no. EL/11.5.5/5 dtd. 06.04.2017. At the outset EDSE (Co-ord) welcomed all the delegates for the meeting from Zonal Railways, CLW and industries.

EDSE (Co-ord) stressed upon the various failures on account of software malfunctioning, power module failure and electronic cards failure. He reiterated that in light of high software related failures, there is a need of software testing by the firms in their laboratories before their implementation in the locomotives.

M/s ABB did not send their senior officials in the meeting.

DSE/TPL/RDSO gave a presentation on reliability of GTO & IGBT based three phase locomotives highlighting trend of failures of various modules, cards, their analysis, action plan already finalized by RDSO, essential infrastructure required in Electric Loco Sheds, new action plan identified and all other agenda items.

Brief of the detailed deliberations and action plan as discussed and decided during meeting are as under:

1.0 GTO based converters and its electronics:

Performance of Traction Converter, Auxiliary Converter and VCU of GTO based locomotives has been deliberated in detail. It is noted that FRPCPYs of these equipments are very high. Based on the deliberations, following action plans have been decided for the GTO based converters and its electronics.

1.1 Valve Set

(i) It was opined that capacitors of valve sets having life 18 years or more may be the cause of GTO failures. Similarly old insulating rod of the valve sets also need replacement to avoid GTO failures.

(ii) During the last meeting, M/s CGL was advised to replace capacitor and insulating rods with new one in limited quantity of repaired valve sets so that their performance can be compared with the valve set in which the capacitors and insulating rods are not replaced. No report of the same has been submitted by Railways/CGL. Railways and CGL are requested to complete the investigation early and submit the report to RDSO.

(iii) ToT partners indicated that the snubber circuit capacitors are no more in the production of the supplier (M/s EPCOS). There will be requirement of the same in future once their codal life is over. Thus there is a need to develop these capacitors from alternate sources. ToT partners may also look into its development.

(iv) Cases of Valve set leakage in CGL make are very high as compared to other makes particularly in ELS/RPM. Sr. DEE (TRS)/RPM indicated that steps have been taken and leakage cases have been arrested.

(v) The need to follow Technical Report no. RDSO/2016/EL/IR/176, Rev.0 issued in October'16 was stressed by RDSO so that the valve set failures are contained.

1.2 PPA988B02 card (SR)

(i) RDSO has issued various reliability action plan to improve the reliability of PPA988B02 cards. It is observed that still some Railways to complete them. All the Railways have been advised to complete the same within next three months and their progress will be discussed in next quarterly meeting.

(ii) Malfunctioning of software is the main cause of failure. Therefore, it has been decided that software shall be downloaded by Windows based LDS.

1.3 Gate Unit (GVA 587) (SR)

(i) ELS/GMO has stated that BT make valve set failures are very high. M/s BT has stated that they have replaced the capacitor with Matsushita make and performance is being monitored. Railways have reported that failures have been contained in gate unit with Matsushita make capacitors. However, Railways need to have a close watch on these gate units and submit their performance during next quarterly meeting.

(ii) ELS/RPM has stated that failure rate of M/s CGL make is high as compared to other makes. ELS/RPM was nominated for complete investigation of M/s CGL make Gate Units vis-à-vis other makes to find out the problem. However report is awaited. Both ELS/RPM & M/s CGL are requested to submit their joint report by 15 May'17.

1.4 WRE module

(i) During the last meeting, M/s CGL was advised to carry out complete investigation of WRE modules failures duly checking the opto-isolators. However, the report is still awaited. M/s CGL is advised to complete the investigation and submit their findings by 31st May'17.

(ii) During the last meeting, Railways were advised to submit make wise failures in CTs so that suitable action could be taken. However, the report from the Railways is still awaited. Railways have been requested to submit the report by 15th May'17.

1.5 Back plane power supply card (KUC153A02) (BUR)

(i) M/s CGL has modified KUB921B02 card (VCU) in place of KUC153A02 card. Same modified cards were placed in one loco of ELS/AQ. The modified card is running in field satisfactorily for more than 5 months. It has been decided that M/s

CGL shall help Electric loco sheds to modify the KUB921B02 card. ELS/GZB & ELS/LGD shall facilitate M/s CGL and provide KUB921 card for the same.

(ii) M/s CGL was advised to submit the complete details of modification so that RDSO can issue as Modification Sheet for implementation by Railways.

(iii) Vide RDSO report no. RDSO/2016/EL/IR/0170 issued in August'16, Railways were advised to replace the capacitors in KUC153A02 card after every 5-6 years on condition basis and compulsory replacement after six years. All the Railways have once again been advised to follow this practice rigorously.

2.0 IGBT based converters and its electronics:

Performance of Traction Converter, Auxiliary Converter and VCU of IGBT based locomotives have also been deliberated in detail. Following action plans for different manufacturers have been decided for the IGBT based Traction Converter and Auxiliary Converter.

2.1 M/s ABB make Traction Converter

(i) Software issue

(a) It has been unanimously decided that regular cut-in of software version-37 (416T37AB) may be done.

(b) The final iteration of the software version 38 addressing all the pending issues like has been downloaded in 6 locos in Sept'2016.

ELS/GZB	-	2 locos
ELS/TKS	-	3 locos
ELS/AQ	-	1 loco

(c) This version addresses following issues:
- Harmonic Filter Over current.
- Time out release shut down due to non-availability of timely signal from converter to VCU (within 150 ms) for DC link voltage discharge.

(d) Performance is under watch for its regular use.

(ii) PEC (Controller card)

(a) The firm indicated that the reason for failure in PEC controller card is 'O/p voltage communication problem due to short circuit. Firm has carried out by removal of '0' voltage level.

(b) So far the modification has been done in 25 locomotives and Railways indicated that performance is satisfactory.

(c) Remaining about 160 locomotives to be modified by July'17 end.

(d) Railways to keep a close watch on this modification.

(iii) PEBB Modules:

(a) Earlier there were failures in PEBB module for which firm has mentioned the reason as:
- Particle impurity in the IGBT conduction area
- Thermal paste missing from the screw holes

(b) Defective lot of IGBTs (23 locos) identified and replaced in 2016.

(c) However, failure still persisting. The failure incidences have increased from 12 cases in 2015-16 to 18 cases in 2016-17.

(d) Reports of recent failures are still awaited.

2.2 M/s ABB make Auxiliary Converter

(i) Software issues:

Ventilation Adaptation: Updation rate was optimized by ABB to improve the ventilation feedback from BUR to the VCU/Traction Converter. However, problem is still in one loco of RPM (30479). Firm shall use data logger to capture the data to find the real cause. PDC – 15.05.2017.

(ii) IGBT failure:

(a) Earth fault detection system was causing flow of circulating current through IGBT.

(b) The earth fault detection from the output side has been removed in 1 loco no 30095 in ELS/BRC (Jan'17). Performance under watch.

(iii) Failure of PCB cards:

(a) There are total of 6 PCB failures in 2016-17. Out of them, Main Controller card (1 case) failed due to power supply short at terminal.

(b) Additionally there are failures in Gate Drive Unit (5 cases). Firm need to submit the investigation report early and take necessary action accordingly.

2.3 Other issues of M/s ABB:

(i) ELS/TKD indicated that in their some locomotives during failure the loco speed shows 202.41 kmph and the loco behaves as it is in simulation mode. The firm is to study the issue and find out the solution by 15.05.2017.

(ii) ELS/TATA indicated that door holding pins are failing in the locomotives which lead to complete load transfer on door latch. It is likely that door latch will fail due to extra weight on them. Firm need to study and take corrective action in all the locomotives. Action plan to be submitted by firm.

(iii) Railways indicated that firm has used Comet make relay in their converters which are failing. The Comet relays have been banned in conventional locomotives. Firm need to replace them with other reliable makes and action plan to be submitted.

(iv) There are about 100 locomotives with PEC-2 controller. These controllers have large booting time due to which separate VCU software is being maintained. Firm has indicated that they have optimized their software and reduce the booting time which complies with the latest specification of the converters. Firm has been advised to install the modified software in locomotives in ELS/AQ.

2.4 M/s BHEL make Traction Converter

(i) Software issue:

a. Problem still persists

- Harmonic contactor stuck ON/OFF, time delay increased from 1 sec. to 1.2 seconds. However, the problems are still persisting and firm was advised to increase the time to 1.4 seconds.
- Earth fault protection: TC to be isolated if problem occur 2-3 times.

b. Earth fault protection: Traction Converter is isolated if problem occur 2-3 times. Software uploaded in 1 loco each of ELS/BIA & ELS/LGD (Feb'17).

c. Performance is under watch.

(ii) Failure of Power Module/PMI

(a) Filter circuit introduced in PMI to address Usid_low error. Light intensity measurement in optic fibre cable connection being done 100%. Firm indicated

that these measures will solve the problem of power module failure. However, there is not respite from the failures of power modules.

(b) More serious investigation need to be carried out to find out the cause of failure of power modules. It appears that there is lack of seriousness in the part of BHEL to properly investigate and find out the real cause of failures. An action plan in this regard to be submitted positively by 15th May'17.

(c) Meanwhile, RDSO has already given approval for regular use of Mitsubishi make IGBTs.

(iii) Failure of VIU/Drive Control Unit (DCU) cards:

There are cases of track burnt/resistor in failed card. The failed components are PCB mounted contactors K1, K2, K3 & K4 and resistors & capacitors. The reason may be poor quality of the components or there may be design issues. BHEL has not carried out any investigation in this regard. BHEL is requested to carry out the complete investigation and submit the report by 10th May'17.

(iv) Coolant leakage/fluctuation:

(a) RDSO has issued Modification Sheet (MS No. RDSO/2017/EL/MS/0457) on this issue.

(b) All the Traction Converter henceforth shall be modified and implemented in new supplies by M/s BHEL per RDSO Modification Sheet No. RDSO/2017/EL/MS/0457.

(c) Existing Traction converters shall be modified as per modification sheet prepared by RDSO in Electric Loco Sheds as and when problem of coolant leakage/fluctuation is noticed.

(d) ELS/TKD indicated that they follow the coolant filling procedure submitted by BHEL and they do not have any coolant leakage case in BHEL make converters. Railways to follow the coolant filling procedure submitted by BHEL to prevent the leakage of coolant. Procedure is enclosed as annex-1.

(v) Problem has been noticed with Layher make pressure sensor. Honeywell make pressure switch have been used in 10 locos on trial basis in ELS/LGD & KYN. Railways reported satisfactory performance of Honeywell make pressure switch. BHEL may use the same on regular basis.

2.5 M/s BHEL make Auxiliary Converter

(i) Failure of Inverter modules has been increased. Mostly failures are due to components of PCBs like PCB mounted contactors – K1, K2, K3, K4 etc. Resistors and capacitors. BHEL shall look into these to improve reliability submit feedback to this office by 10th May'2017.

(ii) Failure of Rectifier module:

There are failures of different components of Gate Driver. No conclusive report submitted by BHEL. It appears that no investigation has been carried out. BHEL is requested to submit the investigation report by 10th May'17.

(iii) ACI card:

As per report received, No defect found – 9 cases, Software corruption – 5 cases, Track Burnt/resistor burnt – 3 cases

- Failed component are relays, K4-Aux contactor, K1-contactor due to over voltage/current.
- Resistor/track burnt.

- Failure of PCBs is mainly due to track burnt/resistor burnt. The reason may be poor quality of the components or there may be design issues.

(iv) AMC card:

This is a controller card to Gate drive unit. Failures are attributed to inadequate biasing of power supply regulator which leads to failure due to voltage fluctuation. Resistance value changed in the card to ensure powering even at low voltage. So far this modification has been implemented in new converters and the converters under operation in which this card has failed.

(v) Battery charger module

Problem mainly due to Measurement Sensors (LEM make) in imported modules. Out of 45 such sensors, 35 have been replaced by firm.

The firm needs to submit the action plan for the replacement of remaining 10 locos. In indigenous module, high rating LEM sensors are being used.

(vi) Software malfunctioning

- Problem of software locking of modules.
- No message against BA voltage less than 92 V.
- BA voltage charger message "BA not charging" should be generated by both BUR2 and BUR3.
- Software has been upgraded to version 187.2.

  Railways are requested to keep a close on its performance.

2.6 Other issues of M/s BHEL make converters

- M/s BHEL has used steel based studs used at input and output ends of the converters. These steel studs get heated up and ultimately get burnt. BHEL has already started using the brass based studs. However, they have not taken any steps to change in the existing locomotives. BHEL to replace all the steel studs in their make converter to prevent their failures.

- ELS/BIA indicated that there are issues of 'Transformer oil pressure not OK' message in some of the locomotives. BHEL to investigate them on priority and submit the investigation report.

- Modification for coolant leakage has been carried out by BHEL in Sheds and in new locomotives. However, Sheds informed that there are still some locomotives which require this modification. BHEL to provided material to Sheds and help them in early completion of this modification.

- BHEL indicated that the new radiators being procured by CLW from M/s Apollo are flushed with oil. This probably is being done by the firm to test the leakage before their dispatch to CLW. As the IGBT traction converters are water coolant based, the oil in the radiator contaminates the water. CLW should look into this and take necessary action to check the leakage test by the firm by oil.

- There are two serious cases of capacitor blast in auxiliary converters of loco nos. 30424 (ELS/RPM) & 31693 (ELS/LDH). No investigation report has been submitted by BHEL. The failed converter of loco no. 31693 has been lifted by BHEL but no replacement has so far been provided. BHEL needs to study the design of their auxiliary converter as the DC link capacitance being used by them

is much lower than that used by other make converters. This issue was raised earlier also but so far no intimation has been given to RDSO in this regard.

- Railways raised the serious concern about the poor warranty obligations being fulfilled by BHEL. In spite of high failure rate, no unit spare has been kept by BHEL in most of the sheds. This drastically impairs the availability of locomotive and their timely rectification.

2.7 M/s CGL make Traction Converter

(i) Software malfunctioning:

(a) Ventilation level mismatch in alt. 'C' converters. Software shall be modified as has been done for converters supplied as per CLW specification of Alt-D in 14 locomotives [ELS/TATA – 3, GMO – 7, LDH – 4].

(b) BUR current increase (> limit of 400 Amp)
This problem is observed during low OHE voltage with consequent increase in input current of auxiliary converter which leads to main power OFF. For solving this, firm has indicated that time delay will be introduced to 200 ms (presently instantaneous) to observe the triggering of protection action. This may eliminate this problem.

Firm intimated that they are working on the above issues and will come out with solution by 10th May'17.

(ii) Power module failure

- There are 6 cases of power module failure.
- In 4 cases, the temperature sensor (SCI/Spain make) found defective due to problem in welding process between sensor & cable. Firm shall replace sensors by Floricon make within 2 months time (31.05.17) in all the traction converters.
- 2 cases of IGBT burst have been observed. Burst IGBT has been sent to OEM (Hitachi) for investigation. CGL shall submit investigation report at the earliest.

(iii) PCB cards failure:
There are 2 cases of PCB cards failure. M/s CGL informed that failed PCB cards were sent to their principals M/s CAF/Spain. This was investigated in detail and software bugs were detected. There was no other component failure. Modified software uploaded in all PCB cards.

2.8 M/s CGL make Auxiliary Converter

(i) Failure of KUC153A02 card

(a) Failure of Power supply card (KUC153A02) is a serious cause of concern. M/s CGL has stated that they have modified the card by regulating -24V output supply.

(b) Alternatively VCU card (KUB921) modified and provided in 80 locos.

(c) The Railways indicated that the performance of KUB921 card is better and therefore it was decided that this modification will be implemented in balance 135 locomotives.

(ii) Failure of CCPU card:

- Sensitivity of CCPU card has been increased from 10 V being increased to 36 V by M/s CGL and provided in same locomotive mentioned above. Modified

cards have been provided in 23 locos for field trial (TKD – 7, AQ – 2, BRC – 4, GZB – 2, KYN – 2, LGD – 4, VSKP – 2). Railways are requested to keep a close watch on the performance.

(iii) Failure of INVCC card:

- Spurious inverter fault message generated in INVCC card. To resolve this problem the resistance to sense the over current has been increased by firm in gate driver and corresponding software modification in INVCC card.
- Firm is replacing the cards with modified software and replacement of resistance in driver card. Modified cards have been provided in 23 locos for field trial (TKD – 7, AQ – 2, BRC – 4, GZB – 2, KYN – 2, LGD – 4, VSKP – 2). Railways are requested to keep a close watch on the performance.

2.9 M/s BTIL make Traction Converter

(i) Failures of Power Modules

- It has been observed that IGBTs (Mitsubishi make) failed mostly on line side. M/s BT has stated that report from Mitsubishi is inconclusive due to heavy damage of the IGBT.
- M/s BT has sent the data-logger data to BT/Zurich for investigation. The investigation report will be submitted to RDSO for further action.
- Presently 2 IGBT in parallel combination (4.5 KV, 1100 Amp. Rating) is being used by M/s BTIL. To avoid mismatch in paralleling, single IGBT of higher rating (4.5 KV, 1500 Amp, Hitachi make) has been proposed by M/s BT. 41 locos are in service with 1500 Amp rating IGBT. Performance is under watch.

(ii) Software issue:

- Protective action not allowing DJ to reclose if OHE voltage >29 kV (Particularly after crossing NS). BTIL has changed the limit and proposed to increase 30 kV.
- To eliminate the issue of limitation of the TE in case module of other converter isolated, Interlocking signal modified by M/s BTIL. Modified software will be uploaded in locos (ELS/BRC & VSKP) before adopting it on regular basis.
- *Time out DC link circuit charge B1 & B2 message* leads to bogie isolation and main power off. M/s BTIL has installed data logger in two locomotives one each at GMO and BRC for capturing the environmental data during the fault. Detailed analysis of the same shall be submitted to RDSO.

3.0 Other action plans

3.1 Multi-loco operation issue: All the OEMs & suppliers of converters are advised to ensure that there should be provision of multi-loco operation with different make without any problem. M/s Medha and BHEL to ensure the formation of multi with each other. They will demonstrate the successful multiple operation at ELS/LGD.

3.2 Basic infrastructure facility:

Vide RDSO's report no. RDSO/2016/EL/IR/0170 issued in August 2016, all the sheds shall develop the basic infrastructure facilities. Optimistic timelines had been set in the report. However, still some sheds need to develop the facilities. Railways are

requested to take up necessary action for their early availability. The shed wise detail of infrastructure is annexed as annexure-2.

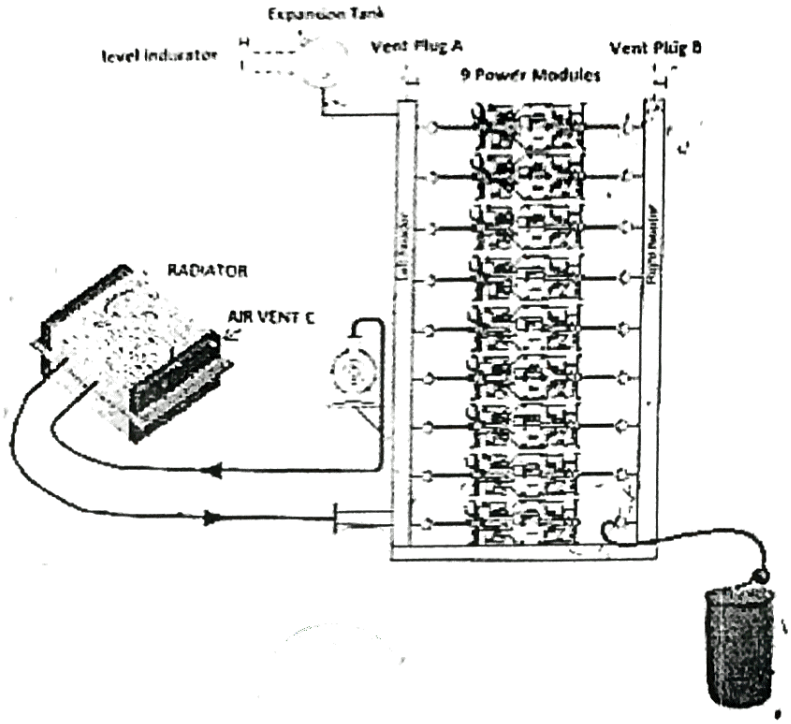
3.3 It has been observed that some loco sheds are not updating RAPs position in e-locos website regularly. Further, some sheds have given incorrect information. All Sr. DEEs (TRS) are advised to personally look into the position of the RAPs and update them at the earliest. The position should be in terms of loco sets.

3.4 The training calendar for different makes of converters have been prepared and circulated to Railways. Railways are requested to depute staff/supervisors for the training. The names of the trainees to be sent to the firms at least 7 days in advance so that firm can arrange necessary logistics.

Lureey
3/5/17
DSE/TPL

Annexure-1

PROCEDURE FOR FILLING COOLANT



Filling.

-Coolant must be pumped in by using an external pump. The amount of coolant that has been pumped in to be monitored

- A Ball Valve shall be fixed to Air Vent C on the Radiator

-Open both pump valves, Three way Valve in Panel inlet ,vent plugs A and B and Air Vent C on the Radiator.

1) Connect the external pump to the Right header (15A1 power module position).
2) Run the Pump till water flows out of the Air vent C of the Radiator .Close the Air Vent C
3) Coolant will continue to fill the circuit until it runs out of the Vent Plugs A and B
4) Close both venting plugs and the fill the system until the Expansion Tank level(indicated in Level Indicator) is approximately at the centre of "Min" and " Max".
5) 115 litre of coolant is required (heat exchanger + traction converter+ piping = 78+27+10 = 115 litre) for first time filling.
6) Check this quantity is approximately pumped in.
7) Immediately clean the leaking coolant away. Disconnect the filling Pump and reconnect the Power Module at 15 A1 position
8) Open the Air Vent C and Vent Plug B slightly such that only air is released.
9) Power the pump motor for a few seconds and check the rotation direction of the pump, right direction is indicated with an arrow. If direction is wrong take corrective action.
10) Switch on the Pump
11) Immediately switch off the pump motor, if coolant level goes below the Min level . This is to prevent dry running of Pump .Contact BHEL for assistance.
11) Run the Pump, readjust Air Vent C and Vent Plug B such that only air is released (use

PROCEDURE FOR FILLING COOLANT

Cleaning cloth to prevent coolant coming out).

12) Check the Level of Coolant. Top up if required

13) The cooling circuit can be assumed to be satisfactory vented if level is stable.

14) Step 11 can be continued if the level dip is not acceptable.

Annexure-2

SHED WISE DETAIL OF INFRASTRUCTURE

A. Basic Infrastructure

SN	Item	AQ	BIA	BRC	HWH	GMO	GZB	KYN	LGD	RPM	TATA	TKD	LDH	WAT
1	Loco Diagnostic System (LDS) – Defective/Total	4/6	1/7	3/4	1/3	3/8	5/8	1/4	1/6	2/6	3/4	5/8	0/0	1/3
	New windows based LDS	1	3	3	3	3	1	2	4	3	3	4	2	1
2	Set of Loop Boxes with Sub-D and Gimota Circular Connector	Yes	Yes	Yes	Yes	Yes	Yes*	No	Yes	Yes	No	Yes	No	No
3	Dedicated computers for storage of DDS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	System of interconnected electronic racks as TC/134	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

B. Test Setup Required in Maintenance Shed

Item	AQ	BIA	BRC	HWH	GMO	GZB	KYN	LGD	RPM	TATA	TKD	LDH	WAT
Testing of WRE Module as per SMI/261	Yes	No	Yes	No	Yes	Yes	N/A	Yes	No	No	Yes	N/A	No
Testing of WRE gate unit card as per SMI/256	Yes	No	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	N/A	No
Testing of SAP card as per SMI/260	Yes	No	No	No	Yes	Yes	N/A	Yes	Yes	Yes	Yes	No	N/A
Testing Pressure Sensors	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Testing of Temp sensor as per SMI/260	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	N/A
Testing of Speed Sensor	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Testing of SR gate drive	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	Yes	N/A	N/A

C. Other Facilities

Item	AQ	BIA	BRC	HWH	GMO	GZB	KYN	LGD	RPM	TATA	TKD	LDH	WAT
PCB handling and infrastructure for electronic lab	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Industrial type of vacuum cleaner	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Water Pressure jet for cleaning the radiator and air filters	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Facility for warm water for cleaning of the filters	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	No	Yes
GTO valve set repair facilities as per RDSO SMI for the sheds which undertake the GTO valve set repair.	Yes	N/A	N/A	N/A	Yes	Yes	N/A	Yes	N/A	N/A	Yes	N/A	N/A