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Government of India - Ministry of Railways
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No. EL/3.6.4/2

Dated: As signed

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5. North Central Railway, Subedarganj, Prayagraj-211 033
6. North Eastern Railway, Gorakhpur-273001
7. North East Frontier Railway, Maligaon, Guwahati-781 011
8. Northern Railway, Baroda House, New Delhi-110 001
9. North Western Railway, Jaipur-302 006
10. South Central Railway, Rail Nilayam, Secunderabad-500 071
11. South East Central Railway, Bilaspur-495 004
12. South Eastern Railway, Garden Reach, Kolkata-700 043
13. Southern Railway, Park Town, Chennai-600 003
14. South Western Railway, Hubli-580 024
15. West Central Railway, Jabalpur-482 001
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18. Banaras Locomotive Works, Varanasi - 221 004
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TECHNICAL CIRCULAR NO. RDSO/2017/EL/TC/0142(Rev. '1')

Sub: Reliability Action Plan (RAP) for Conventional & Three Phase Electric Locomotives.

Ref: (i) 38thMSG meeting held at Secunderabad/South Central Railway on 28th&29th July'2017- SN 1 of Other Important points discussed during MSG.
(ii) Railway Board's letter no. 2017/Elect (TRS)/155/1 dated 14.11.2017.

Introduction:

In order to improve the reliability of Conventional & Three Phase Electric Locomotives, a Reliability Action Plan based on nature of failures occurring frequently was prepared & issued in the form of Technical Circular no. RDSO/2017/EL/TC/0142(Rev. '0') dated 09.01.2018.

In light of issuance new SMIs/TCs & Modification sheets, the Technical Circular no. RDSO/2017/EL/TC/0142(Rev. '0') has been reviewed to incorporate the latest instructions & updating of existing instructions. Accordingly, Technical Circular no. RDSO/2017/EL/TC/0142(Rev. '1') has been prepared & same is being sent herewith. Zonal Railways are requested to implement

this Technical Circular to achieve the objective of perceptible improvement in the reliability of Electric Locomotives. Further, the local RAPs of Railways must also be continued & implemented to achieve the purpose.

1. Reliability Action Plan For Conventional Electric Locomotives

1.1 Electrical Equipments:

1.1.1 Traction Motor

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Reliability Action Plan

1. Use of Bore Gauge for measurement of internal diameters of End Shield/ Racer during bearing fitment in traction motors for Electric Locomotives as per SMI no. RDSO/2017/EL/SMI/0318 (Rev '0') Dated 16.10.2017.
2. Use of Dial Snap Gauges for measurement of shaft diameter of traction motor for Electric Locomotives as per SMI no. RDSO/2017/EL/SMI/0314 (Rev '0') Dated 29.9.2017.
3. Magnetic Particle Testing (MPT) of Traction motor (TM) nose stay in conventional locomotives, TM suspension holder support and motor support in WAG9/WAP7 locomotives and traction motor support arm in WAP5 locomotives as per SMI no. RDSO/2017/EL/SMI/0311 (Rev '0') Dated 25.8.2017.
4. Implementation of Preventive measures to be taken for crack detection of traction motor nose stay & lifting lugs to eliminate chances of falling of traction motor during service in 25 KV AC conventional electric locomotives as per SMI no. RDSO/2017/EL/SMI/0308 (Rev '0') dated 28.6.2017.
5. Use of Induction Heater for heating of End Shields/End frames of traction motors for bearing fitment as per SMI no. RDSO/2016/EL/SMI/ 0301 (Rev '0') Dated 8.11.2016.
6. Implementation of revised Q20 setting from 865/740V to 790/700V for conventional locomotives to reduce the TM flashover cases as per SMI no. RDSO/2015/EL/SMI/ 0284 (Rev '0') Dated 11.9.2015.
7. Instructions for bonded rubber sandwich mounting for nose suspension of traction motors issued as Special Maintenance Instruction No. ELRS/SMI/186 dated 15.05.1997 along with its amendment No. 2 dated 01.04.2014 to be followed.
8. Instructions to maintain gap between traction motor bottom nose and bonded rubber sandwich mounting unit issued as Technical Circular No. RDSO/2014/EL/TC/0126, Rev.'0' dated 25.03.2014 to be followed.
9. Specification No. RDSO/2014/EL/SPEC/0115 Rev.'0' dated 22.08.2014 for bonded rubber sandwich mounting for nose suspension of traction motor for electric locomotives to be followed.
10. Instructions for replacement of sandwich mounting assembly in POH issued vide Technical Circular No. RDSO/2013/EL/TC/0123 dated 16.05.2013 along with its amendment -2 dated 16.05.2016 & amendment-3 dated 03.04.2017 to be followed.

11. Instructions for replacement of sandwich mounting assembly in IOH issued vide Technical Circular No. ELRS/TC/0029 Rev.1 dated 15.7.2002 to be followed.
12. Instructions for replacement of sandwich mounting assembly of WAP4 locomotives in every TOH schedule issued vide Technical Circular No. ELRS/TC/0031 Rev.1 dated 15.7.2002 along with its amendment No. 1 dated 28.06.2017 to be followed.
13. Modification in the pinion end portion of armature shaft of Traction Motor type HS 1050Er/HS15250A as per Modification sheet no. WAG5/0244 Amendment 2 dated 14.2.2014.
14. Measurement of dimensions of various assembly components and ensuring adequate interferences as per modification sheet no. RDSO/2017/EL/MS/414 Rev 0 Amendment 1 dated 29.1.2013 during replacement of Hitachi TM bearings.
15. Replacement of Hitachi Traction motor Brush holder spacers for HS15250A Traction Motor made of brass with PTFE as per modification sheet no. ELRS/MS/0329 (Rev 0) Amendment 1 dated 13.1.2012
16. Modification in traction motor nose suspension system for provision of additional L clamps and split pins to prevent falling of vertical nose pin of traction motor type HS 15250A/TAO 659 as per Modification Sheet No. RDSO/2011/ELRS/ MS/0392, Rev.'0' dated 11.02.2011.
17. Testing of brazed joints of interconnectors of field coils and compoles coils in traction motors type HS 15250A and TAO 659 using high current injection test as per SMI no. RDSO/2011/EL/SMI/ 0271 (Rev '0') Dated 17.11.2011.
18. Use of Fixtures and Gauges for Brush holders and BHRR Assemblies of Traction Motors type TAO-659 and HS-15250A of Electric Locomotives as per SMI no. RDSO/2007/EL/SMI/ 0243 (Rev '0') Dated 22.3.2007.
19. Adoption of modified Arcing stud & fixing bracket on BHRR assembly of Traction Motor type HS-15250A as per Modification Sheet No. ELRS/ MS/0347, Rev.'0' dated 31.07.2006 with drawing no. SKEL-4707 ALT. 1 dated 23.11.2010.
20. Preventive measures to arrest the failures due to breakage of M16 X 40L Hexagonal head bolts of CE outer bearing stopper on HS 15250 A Traction motors as per SMI no. ELRS/SMI/0220-2000 (Rev '1') Dated 28.10.2004 to be followed.
21. Use of fixture for checking of concentricity & parallelism of suspension tubes of HITACHI TM as per SMI no. RDSO/ELRS/SMI/0226/2002 (Rev '0') Dated 28.1.2002.
22. Maintenance practices for MSU of traction motor type HS 15250A/TAO - 659 as per SMI no. ELRS/SMI/0221-2000 (Rev '0') Dated 4.8.2000 to be followed.
23. Procedure as per SMI no. ELRS/SMI/0218-2000 (Rev '0') Dated 19.4.2000 to be followed for improvement in the reliability of plain sleeve suspension bearing of TAO659 TM by arresting the leakage of suspension bearing oil from various locations.
24. Implementation of Remedial measures to arrest the failures of MSU of traction motor type HS15250A/TAO-659 due to the dropping of its adjustment washer/ failure of its taper roller suspension bearing as per SMI no. ELRS/SMI/0217-2000 (Rev '0') dated 24.2.2000 and amendment-1 dated 7.4.2000.
25. Checking main dimension of suspension tube while mounting on magnet frame of traction motor type HS15250A as per SMI no. ELRS.SLI/0207-1999 (Rev '0').
26. Procedure for tightening of axle cap fixation bolts of Traction Motor type TAO-659 as per SMI no. RDSO/ELRS/SMI/TM/0205-98 (REV. 0) dated 31.8.1998 to be followed.

27. Procedure for proper tightening of suspension tube fixation bolts fitted on the Traction Motor type TAO-659 and HS-15250A as per SMI no. RDSO/ELRS/183 Amendment -1 dated 19.3.1998 to be followed.
28. Neutral setting of brush holder revolving ring of Traction Motor by 'KICK METHOD' as per SMI no. ELRS/SMI/181 dated 30.5.1996.
29. Testing of armature shaft by ultrasonic testing during major overhaul as per SMI no. RDSO/ELRS/SMI/150 dated 23.11.1992.
30. Tan delta (Dissipation factor) measurements on Traction Motor armature as per SMI no. RDSO/ELRS/SMI/128 dated 19.6.1985.
31. Condition monitoring of bearings by SPM Meter as per SMI no. RDSO/EL-RS/SMI/58 of July 1979.
32. Bar to bar conductor resistance and equaliser resistance test on Traction Motors (Drop Test) of armature to be done during major overhaul as per SMI no. RDSO/ELRS/SMI/51 dated 30.4.1979.
33. Under cutting & chamfering of traction motor Commutators as per SMI no. RDSO/ELRS/SMI/31 dated 24.10.1978
34. Resurfacing of Commutators (by diamond tool) and measurement of ovality as per SMI no. RDSO/ELRS/SMI/29 of August 1978, and RDSO/ELRS/SMI/6 dated 30.12.1977. In the sheds/POH Shops, Commutators require a finishing cut, Diamond turning is best suited and finish of 0.3 to 0.8 micron can be obtained. SMI No. 29 of August 1978 prescribes diamond turning by sheds and POH shops. Carbide tools are most suited for coarse turning of the Commutator. Coarse turning of Commutator with roughing cut is normally required only during the initial turning of the Commutators in manufacturing units. SMI No. 29 to be followed by the shed.
35. Ensure the inspection cover for Hitachi TM is as per MS-364.
36. Ensure top and bottom lug for Hitachi TM is as per MS-363.
37. Provision of modified earthing brush assembly on TM type HS15250A as per Modification sheet no. ELRS/MS/0300-2000 (Rev 0) dated 30.10.2000.
38. Ensure the grease outlet i.e. drain hole in 'CE' outer bearing cap of TM type HS 15250 A and procedure for re-greasing of armature roller bearing (PE & CE) as per Modification sheet no. WAG5/0280 dated 29.1.1996.
39. Storage of TM/MSU bearings in horizontal condition, away from wall/floor in a stack of not more than 5 bearings and following First-In-First-Out (FIFO) system for storage.
40. Ensuring 24 X 7 working of air conditioners provided in air conditioned storage wards. Temperature and humidity indicators to be provided at the far end of AC Storage ward.
41. Fridge/Deep freezer of adequate capacity needs to be used for storage of varnishes which are to be stored at less than 10 degree C.
42. Implementation of Technical circular no. RDSO/2010/EL/TC/104 (Rev. 0) dated 16.7.2010 for storage & handling of lubricant/greases used in Electric locomotives. All barrels must be stored, preferably indoors; away from extreme heat/cold, dust, acidic fumes and moist atmospheric conditions. Lubricating oil barrels should be stored horizontally preferably on wooden rails dunnage to avoid contact with ground. The barrel bungs should be in the clock position at 3 & 9. Grease barrels must be stored vertically preferably covered with tarpaulin, if not stored indoors.
43. Use of induction heaters equipped with essential features like temperature display, temperature hold, auto cut off & de-magnetization. Induction heating should always be

- done in temperature mode as same/similar components of different manufactures may have different properties. Temperature setting should not be more than 120°C for bearing assembly components.
44. Use of grease guns equipped with Grease dispensing meter to provide prescribed quantity of grease.
 45. Bearings should be handled with protective industrial gloves. Lint free cloth should be used for cleaning purpose.
 46. To follow the prescribed replacement schedule for traction motor bearings. Conventional traction motor bearing is must change item during POH.
 47. Use of prescribed torque wrench for tightening of bolts etc.
 48. Area for blowing and cleaning activities should be separate from TM assembly area.
 49. Becktol Red is E Class (120 degree C) Anti-tracking finishing varnish. Prescribed anti-tracking finishing varnish for TAO-659 TM is F-93/RE-118 which is H Class (180 degree C). Prescribed finishing varnish for Hitachi TM is TVA-1410 which is Class 200 degree C. Only TVA-1410 varnish to be used as finishing varnish for Hitachi TMs and TAO-659/TM type 4601 rewound with insulation scheme as per TC-125/ TC-127. TVA 1410 is having shelf life of only 3 months when stored at less than 10 degree C. Proper storage facility to store TVA1410 at less than 10 degree C is required. Staggered supply of TVA1410 needs to be ensured so that it is used within shelf life.
 50. Ensure securing of balance weights during overhauling.
 51. Checking of resin glass band.
 52. Provision of PTFE band on armature cone during major overhaul.
 53. Deburring of Commutator during major overhaul to be done on machine only.
 54. Covering of Commutator to avoid damage during handling.
 55. Use of induction heater for heating pinion and racer of bearing during mounting/dismounting process.
 56. Measuring of K value of pinion during major overhaul.
 57. RDPT of pinion during major overhaul.
 58. Bearing seat and pinion seat of armature shaft in section to be kept covered with very thin film of grease inside polythene bags to avoid damage and dust deposition.
 59. Ready pinions to be covered with thin film of grease and to be kept inside polythene bags to avoid damage and dust deposition.
 60. Pinion bedding to be ensured.
 61. Interference between shaft and inner racer of bearing and dimension of the bearing in the end shield to be recorded.
 62. Must change items to be replaced during POH as per TC-0123.
 63. Use of assembly components in kit form vide RDSO's letter No. EL/3.2.172 dated 26.06.2007
 64. Follow Compendium of Instructions on Traction Motor, MSU and Axle Box Bearings given in document no. RDSO/2016/EL/PUB/0003 of DEC'2016.
 65. Cleaning of Commutator by movement of loco during IC schedule.
 66. To check cable socket and condition of ferrules during lifting & overhauling.
 67. Cleaning of stator by high pressure jet of air during overhauling.
 68. Terminal insulator cleaning with Orion-77 and checking tightness during overhauling.
 69. Cleaning of stator by Orion-77 during overhauling.
 70. Blowing of TM Commutator chamber by dry compressed air before IC inspection or as

required

71. Mechanical Repair /Rehabilitation with welding procedure of Magnet Frame for Hitachi HS 15250A Traction Motors as per Technical Circular no. RDSO/ 2013 /EL/TC/158 Rev 0 dated 23.03.2022
72. Modification Sheet for Development of Traction motor Dropping Detection System (TMDDS) in Conventional Locomotives equipped with Hitachi HS 15250A Traction motors as per Modification Sheet no. RDSO/2022/EL/MS/0487 Rev. '0' dated 21.05.2022.
73. RDSO had issued the preventive action plan for Hitachi TMs in Passengers Locomotives vide letter no. EL/3.2.172 dated 23.03.2022.
74. Improving reliability of Armature shafts of Traction motor by not building Armature shaft by welding for conventional as well as three phase locomotives as per SMI No. RDSO/2018/EL/SMI/0321 (Rev. '0') dated 28.03.2018.
75. Testing of Carbon Brush block properties from finished carbon brush of Hitachi HS 15250A Traction Motors as per Technical Circular no. RDSO/2013/EL/TC/147 Rev 0 dated 29.05.2018.

1.1.2 Transformer

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Reliability Action Plan

1. DGA analysis to be done in every IC/TOH/IOH inspection.
2. SMI-80 all 'L' clamps to be replaced by palm clamps on a0-a1 bushing and special clamp to be fitted on a3 bushings.
3. Shifting of sluice valve (MPH) 180 deg. To ensure the gap in between sluice valve operating wheel and a33 palm clamp also ensure the connection of wire No. EF-12 on a3 bushing. To be done during TOH/IOH.
4. SMI-193 Maintenance practices for improving reliability of cable head termination system.
5. SMI-179 Check point during commissioning of TFP fitted with M/s BSES bushing (A33).
6. Clamping of vent pipe to be checked during inspection, oil leakage from pipe line joint should also to check at supervisor level.
7. Cleaning of radiator with water jet on condition basis during TOH.
8. SMI-164 for maintenance of complete Loco Transformer along-with Transformer /Conservator tank.
9. As per SMI-159, the level of inhibitor is to be ensured by periodic checks duly ensuring necessary facilities.
10. Insulation resistance of transformer winding shall also be recorded during filtration of oil during TOH/IOH as and when carried out.
11. As per SMI-138, BDV of oil to be checked and centrifuge the transformer oil if required.
12. All the gaskets of the conservator and drain plugs shall be replaced during IOH. Cork sheet gasket should be used in place of rubber (SMI-178,124) of required thickness. Bushing cap O-ring (45mm inner dia) should also be replaced to avoid leakages.
13. Lengthy studs to be used on a0-a1, a7 & a8 bushings for better contact to the palm clamp during IOH or during over hauling of TFP.
14. Graphite grease is to be applied during TOH/ IOH at the threaded portions of palm clamps on TFP to avoid bad contact and overheating of clamps.
15. Only Fibreglass sleeves to be used for bushing leads (Modification No. 176).

16. Glass epoxy tubes to be used for core bolts. (Mod No. 176)
17. The size of the cleats opening should be such that the leads be held firmly. (Mod No. 176).
18. Whenever the TFP is taken for repairs or in 1st IOH core bolts to be tightened with 25 Kgm torque to avoid loosening in service/ breakage of bolts during tightening. (SM1123 & 164). Core bolts to be replaced on condition basis.
19. Whenever TFP is taken for repairs, wrapping of tap leads to be carried out (SM1-122) to overcome the problem of peeling off of the paper insulation and formation of a powdery sludge in the neck portion.
20. During transformer repair wrap 3 layers of creep papers, half lap on bare bus bars duly sealing with fevicol at either end. (Mod No. 182).
21. Core rests on the bottom supports to be examined with empty tank before final assembly
22. To avoid bulging of auto winding, parmali spacers are to be properly positioned before tightening the bolts of the core and those of supporting plates for the winding.
23. DGA plant, tan delta test equipment, acidity BDV and other test kits should be calibrated periodically.
24. Whenever tank modification/ repairs are taken up, repainting of tank inside should be carried out as per RDSO's instructions (SMI-125).
25. RTV compound is to be applied around the opening of the rubber enclosure of turret surface to avoid ingress of moisture and dust into the apparatus bushing (horizontal type CHT)
26. External earthing shunt of CHT is to be insulated with fiberglass tape and 3M fusible silicon tape near the RGR area to avoid external flash over.
27. In RGR (Lachhman make) additional base plate projection is to be cut to increase the clearance between CHT earth cable and RGR.
28. Provision of 'Oil trap chamber' in drainpipe of conservator tank of TFP (modn. No.324) to be provided on all locos. A suitable float with reflective paint will be an added advantage for trapped oil level reading.
29. Radiator cleaning shall be done and replacement of gaskets shall be carried out during 10H.
30. Temperature sensing strip provided on pipe line of MPH to detect the temperature rise on line.
31. Transformer and GR oil level to be checked and kept at adequate level as per seasons especially before summer & winter.

1.1.3 Tap-changer

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Reliability Action Plan

1. Regular replacement of PHGR filters silica gel & rubber gaskets of breather container assembly with cork grains.
2. Ensuring working of PHGRs in all locos.
3. Ensuring minimum BDV of 48KV when fresh oil is filled in GR and it should be done directly from the centrifuging plant avoiding any handling equipment.
4. Ensuring minimum BDV of 40KV when measured for oil in service.

5. DGA to be done in every schedule inspection.
6. Replacement of worn out lantern gears.
7. Replacement of worn out coupling shaft
8. Ensuring replacement of parts during TOH & IOH as per kit prescribed by RDSO.
9. No patch repair of GR contact plate and intermixing of GR parts.
10. Ensuring replacement of old copper washer with new ones every time PHGR is refitted.
11. Testing of PHGR on test bench during TOH/IOH schedule and replacement of rubber repair kit during every IOH schedule.
12. Replacement of top & bottom oil seals (Part No. 3897) during IOH schedule of RDSO approved makes (i.e. Fenner.) duly ensuring inner Dia of seal.
13. Sign of plate crack and leakage from any contact pins to be thoroughly checked during GR opening.
14. Rehabilitation of N-32 tap changers in compliance of Railway Board directives on a similar pattern.
15. All RDSO SMI Nos.82, 90,105,106, 113,117, 118,129.134.135 to be followed.
16. Proper contacts pressure in GR to be ensured by replacing the rollers during TOH/IOH which are below 17.3mm dia.
17. Modified PHGRs only to be procured.
18. Roll pin of GR main shaft to be checked visually during IC schedule.
19. During major schedule roll pin of GR main shaft ovality should be checked by measuring dia before and after changing of roll pin to avoid play.
20. CGR frame contact bolt (new design thicker neck) to be procured from approved vendor & to provide the same. Make sure that these bolts have firm name and Mfg. embossed on head.
21. Visual checking of RPGR connecting link to be done during every inspection.

1.1.4 SMGR

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Reliability Action Plan

1. Proper cleaning of Auxiliary contacts and maintenance of gaps to be ensured.
2. RDPT/magnaflux of crankshaft of SMGR during overhauling & replacement of defective crankshafts.
3. Replacement of manual operating mechanism on condition basis.
4. B02 type filter are to be ensured during overhauling,
5. 0.5mm Gap to be ensured in between push rod with seal and push rod of VE1/VE2 assembly.
Gap of 0.9mm to be ensured in between armature and setting screw of VE1/VE2 assembly.
Checking of freewheeling diode of VE1/VE2 assembly.
6. Healthiness and tightness of SMGR foundation bolts to be checked during IC inspection.
7. Clamping of reducing valve to be ensured to avoid passing of the vibrations to the pipeline connecting 3-way valve
8. Complete testing of SMGR to be done after overhauling on SMGR test bench.
9. SMGR stand should be used for transportation of SMGR.

10. All RDSO SMI Nos. 18,21,22,46,47,48,49,105 & 129 to be followed.
11. Air filters and strainer in the SMGR circuit should be cleaned in schedule inspection.
12. Pressure reducing valve to be overhauled in 2nd IC inspection.
13. Seal with the push rods of control valves to be replaced during TOH.
14. Loctite to be applied after tightening the fixing bolts of the journal pin TOH/IOH.
15. Spring between guide pin and toothed segment to be replaced during TOH.
16. Gap between control lever and intermediate gear wheel of SMGR should be checked during IC and adjusted between 0.4 to 0.7mm and whenever it is found to be more than 0.7mm, it should be recorded as a defect and adjusted.
17. SMGR auxiliary switches (4 nos), which are maximum used, should be replaced during TOH & auxiliary I/L of these switches to be cleaned during IC.
18. Universal coupling to be replaced during TOH.
19. Copper washers only to be used in SMGR copper pipeline joints
20. Checking of Q-53 & Q-54 (In AAL make SMGR) in IC.
21. Double roll pin with jaws procured from approved firms & to be provided.

1.1.5 RSI Block

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Reliability Action Plan

1. To ensure proper tightness/ crimping of cable sockets during major schedule.
2. To record R & C values of AC & DC damping panels in major overhaul & replacement of defective components & parts.
3. Testing of diodes to be carried out with recommended voltage in every_ overhaul (as per SMI No: 37, 70 & 71.)
4. To check micro switch for any breakage and malfunctioning in every schedule except IA as per SMI No.67, 68, 70 & 71.
5. To check trip indicator fuse for proper functioning in every schedule except IA/IB as per SMI No.67, 68, 70 & 71.
6. Checking the capacitance of the capacitors in ac damping, dc damping and snubber circuits of silicon rectifiers used on electric locos (SMI-110)
7. Dusting of diodes during TOH/IOH/by forced air and with brush during IC to avoid dust accumulation and flashes.
8. AC damping panels capacitance values to be checked during TOH/IOH and whenever QOP problem/TMs arc horns flashing reported
9. Guideline of maintenance of Capacitor in Single Phase AC Electric Locomotive. (SMI-230, Rev. 0))
10. Silicon rectifier damping capacitor failure. (MS-104)
11. Cleaning of heat sink with dry air during overhauling (TOH/IOH).
12. Protection covers of tail-tail fuse to be insured for proper fitment to avoid dust on micro switch.
13. Application of silicon grease between diodes & heat sink.
14. Check all RSI insulator in IC/TOH/IOH & replaced with new if found any defective/repared.
15. Thermostat resistance measurement in RSI during TOH/IOH.
16. The wiring between BTSI and HVSI should be in conduit pipe .This should be ensured.

17. One cycle drive of checking proper gap between tail-tail fuse cover/ its nut bolt and its micro switch or current carrying part.

1.1.6 Vacuum Circuit Breaker(Double Bottle)

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Reliability Action Plan

1. Checking contact pressure and crushing of auxiliary contact with suitable pressure gauge during major schedule.
2. Ensuring proper setting of indfoss make pressure switch, on test bench in every overhauling using calibrated pressure gauge. GEC 4/4.6, BHEL 4/4.6 AAL/BT 3.3/3.6 kg/cm² pressure setting for open/Close respectively.
3. Check surge suppressors for current in range of 14 to 19mA by applying 110V AC & replacing defective ones during overhauling to prevent CCDJ/CCPT cases on line.
4. Replacing of components in magnet valve assembly in every overhauling.
5. SMI-136, SMI-137, SMI-161, SMI-162, SMI-208, Mod-209 and Mod.302 to be followed.

1.1.7 Vacuum Circuit Breaker(Single Bottle)

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Reliability Action Plan

1. Aux. contact assembly should be changed after every 5 years along with related springs (as per OEM)
2. Filter cartridge of pressure control valve set be changed during every IOH
3. Dampers, shock absorbers plate and that joint gasket should be changed after every 3 years (as per OEM).
4. Application of silicon sealant on the mouth of rubber protective sleeve and other exposed joints of VCB on roof to avoid ingress of dust and moisture during run.
5. Checking of VCB damping and HV leakage test of vacuum bottle to be ensured during overhauling.
6. Replacement of auxiliary switch during POH
7. Paralleling of DJ closing interlock in VCB auxiliary switch during TOH/IOH.

1.1.8 Head Light

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Reliability Action Plan

1. DC-DC converter unit should be tested on load.
2. Paralleling of BLPRF, BLPRD, and BLPRR limit switch interlocks in headlight circuit during major schedules should be ensured.
3. Removal of RTPR from all locos.
4. Checking and focusing of H/L during every schedule.
5. Cables around the holder should be provided with fibreglass sleeves.
6. Modification of twin beam headlight with DC-DC converter as per MS-0325 to be ensured.
7. Provision of cable (10 sq. mm) from DC-DC convertor to head light to improve voltage (TOH/IOH) as per MS-453.
8. Replacement of reflector during TOH/IOH.
9. Millivolt drop/contact resistance measurement of two way toggle switch in both input

and output side during OH of DC-DC converter.

10. Checking of DC-DC converter toggle switch in IC schedule.
11. Terminal dust cover in DC-DC converter should be provided.
12. DC-DC converter toggle switch to be provided with Loctite after tightness.

1.1.9 Flasher Light

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Reliability Action Plan

1. Provision of LED type flasher light in all locomotives.
2. Ensuring proper marking on terminal connection of control units during every schedule.
3. Ensuring that control unit is tested on load and then it is put in service.
4. Provision of automatic switching 'ON' flasher light during TOH/IOH.
5. Check flasher light working in every schedule for 10 Mins.
6. Terminal dust cover on Flasher light control unit should be provided.
7. F/L light unit (Hood) glass fuse holder contact tension to be checked during every schedule.
8. Flasher light control box toggle switch and fuses to be provided with Loctite after tightness.

1.1.10 Speedometer

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Reliability Action Plan

1. To change PG rubber kit in TOH/IOH to avoid dust etc.
2. To ensure stiffener with JB to secure PG lead in every schedule.
3. To ensure proper securing of PG lead with help of clamp on bogie in every schedule.
4. To provide wire braided sleeve similar to WAP5 design on PG lead during IC/TOH/IOH
5. Replacement of three-core SC cable with shielded cable from SC to JB to avoid surges.
6. Provision of microprocessor based energy cum speed recording system as per RDSO specification (latest).
7. PG bearing should be changed from 6002 Z to double sealed bearing 6002 ZZ by sheds/shops. Manufacturers should provide only double sealed bearing.
8. Bearing should be replaced during IOH/condition basis.
9. Oil seal to be changed during every overhaul.
10. Proper clamping of PG cables to be ensured by sheds/shops
11. PG to be mounted on axle box such that cable entry is inclined 45° downwards from centre line and is towards centre line of loco.
12. Cover gasket must be replaced whenever it is opened.
13. All un-modified type driving forks wherever in service to be replaced by modified driving fork.
14. Rubber components to be purchased from OEMs.
15. ESMON timing to be calibrated during every shed visit as per SMI no. RDSO/2016/EL/SMI/0302(Rev.0).
16. PG to be checked during every IC schedule after its detachment.

17. ESMON data to be downloaded in every schedule and to ensure that all data are getting recorded along with any unusual.
18. All PGs to be provided with double sensors.
19. Physical Checking of the cables and cleaning of the unit with soft cloth. Inspect the cable for any damage. Cable should be properly clamped and it should not brush with bogie to be checked in minor schedule.
20. Checking for any grease ingress into the PG & removing of dust inside the PG unit. Check the free movement of the shaft with the hand to ascertain the proper functioning of bearings to be checked in minor schedule.
21. Inspection of driving fork for any damage. Length of driving pin shall be such that even with axial play, it engages the driving fork fully to be checked in minor schedule.
22. Cleaning of speed sensors to be checked in minor schedule.
23. Check the availability of protection guard on the axle cover to protect PG for cattle run over/foreign object hitting to be checked in minor schedule.
24. Checking the proper fitment and tightness of all Screws, bolts and connectors used for interconnection and mounting of different equipment to be checked in minor schedule.
25. Verify the correctness of setting of the various parameters made earlier to be checked in minor schedule.
26. Maintaining of CF card and data downloading & evaluation software to be checked in minor schedule.
27. Enter the new value of Wheel Diameter; if required & do the calibration to be checked in minor schedule.
28. Checking of components used in PCB and replacement of the components if required during major schedule
29. Functional test after maintenance work as per governing specifications to be done in major schedule
30. Change the IOH/POH kit as recommended by OEMs
31. Keep Record of maintenance work to be checked in minor schedule/major schedule.

1.1.11 Relays

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Reliability Action Plan

Air Flow Relays

1. SMI-173 regarding measures to improve reliability of relays to be followed
2. Air flow relay having 25mm dia orifice as per modification sheet No. WAG 5/10 be inducted in service while procuring new relays to replace flap type relays and 8mm/16mm dia. Switzer relays
3. Ensuring proper fixing clamp on mounting plate of micro switch for proper securing of lead wire from micro switch to terminal BD of air flow relay
4. Diaphragm to be replaced in every TOH/IOH and to be procured from OEM.
5. Checking of micro switch with multimeter to ensure healthiness of its N/O, N/C contacts during overhauling.
6. Alignment & setting of various adjusting nuts & screws of moving plate to be ensured during overhauling for proper functioning of micro switch.
7. Portable digital manometer for measurement of operating values of airflow relays to be procured as advised by RDSO vide letter No. EL/3.2.39/4 dated 12/01/01.
8. Base gasket & cover gaskets be replaced 100% during TOH/IOH.

9. Millivolt drop test in MTDJ circuit during 2nd IC schedule.

Time Lag & PC-8 Relays

1. Use of cleaning agent for cleaning contacts of various types of relays and micro switch of Q48 relay & C-118 chromatic relays to ensure its proper functioning.
2. Check proper functioning of various N/O & N/C contacts of PC-8 relays during every schedule.
3. Ensure proper functioning of timer unit of various types of relays on test bench during every schedule.
4. Ensure proper wiring of timers, relays & base connections.
5. Ensure proper clamping on contact holders and all springs for proper operation of contacts and contact holder.
6. During inspections, it should be ensured that freewheeling diodes of QTD-105 is in working order and without open circuit fault.
7. Replacement of PCB in Q-118, Q-44, Q-119 relay during IOH.
8. 100% replacement of contact tips and contact tensioning spring in every IOH schedule.
9. Coil resistance and contact pressure should be measured during every overhauling.

English Electric Relays

1. Check & ensure contact pressure/crushing and healthiness of push rod during every schedule.
2. Measure & record ohmic values of economy coil and economy resistance during TOH/IOH.
3. Replace QV60, QV61, QV62, QV63, QV64 & Q51 English Electric Relays with PC-8 type relays during TOH/IOH.
4. Ensure mechanical locking arrangement of QLM relay and its proper fitment of locking spring in every schedule.
5. Small size connecting screws of English Electric relay should be replaced with longer ones as has been provided in the relays of earlier version.

Pressure Switches

1. Overhaul and test thoroughly pressure switches during major schedule as per SMI No. 190.
2. Use proper tools for pneumatic connection and differential assembly.
3. Ensure differential locking to eliminate chances of getting loose during jerk / vibration on line.

DI/DU, QD, Q20 Relays

1. Record testing data and physical healthiness during TOH/IOH.
2. Check non-magnetic shunt for groove formation / wear in every overhaul.
3. QD relay has to be calibrated in IC0 and in TOH, IOH after overhaul.
4. Covers shall be provided on all the relays and availability of adequate quantity of these should be ensured sources of supply of these covers have been identified.
5. DI, DU relays after overhauling, shall be sealed before these are provided on the locos.
6. DC coils of the relays are the part of the relays and they should be procure only from OEMs to ensure reliability.
7. RTV silicon sealant is to be ensured to prevent dust entry at relay bottom base

1.1.12 Auxiliary Machines

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Reliability Action Plan

1. Use of electric motor checker for measurement of resistance and inductance of motors after overhauling.
2. To use induction heating for fitting bearing on the rotor shaft.
3. Use of mechanical puller for removing fan from MCP during overhauling.
4. To measure dia of end shield housing and rotor shaft by micro meter during overhauling as per SMI No. 16.
5. To measure shaft dia. at impeller seat and cooling fan seat and the inner dia of impeller / cooling fan during overhauling.
6. Bearing sound to be measured with the help of echo pulse meter during overhauling and bearing replaced on condition basis in MPH & MVSL. However, MVSI & MVSL bearings to be changed in TOH/IOH.
7. Use of thermocouple contact thermometer for checking the temperature of bearings while using induction heater.
8. Use of mechanical puller for removing impeller from MVMT, MVRH, MVSL & MVSI during overhauling.
9. Balancing of MVMT during overhauling.
10. To check impeller cracks by RDPT during IC/TOH/IOH.
11. To change impeller in case of blade crack/broken and do not resort to welding.
12. To check the tightness of the bolt of the duct chair of MVMT to avoid vibration, during every schedule.
13. To check alignment of MVMT duct and motor while fitting on the chair of locomotive.
14. To check winding lead lugs and crimping during every schedule.
15. Cleaning ARNO overhang portion in IC schedule.
16. Balancing of MVMT in position in loco on every changing/replacement.
17. Covering of MVMT duct on removal of MVMT is to be ensured.
18. Capacitors across MCP should be provided.
19. Unloader valve with timer circuit to be implemented
20. Time delay starting to avoid overloading on ARNO
21. RDSO modifications regarding provision of 3 capacitors across ARNO supply to be completed on priority and capacitance values to be checked.
22. 3-phase EMCs to be overhauled during TOH. Main contacts and auxiliary contacts should be checked during 2nd IC.
23. Contact bits of 3-phase contactors of compressor motor should be checked in IOH and contact pressure measured.
24. Growler test to be done on the rotor bars of ARNOs to detect any internal-cracks during TOH. It should be repeated by the supervisor on ARNOs, which are more than 5 years old. ARNOs which are more than 5 years old should be overhauled during 2nd IC.
25. Overhung of ARNOs should be cleaned during IC schedule because lot of grease is getting accumulated in the top portion of the ARNO. As dust is getting accumulated over the grease, heat dissipation is getting affected leading to failures.
26. To ensure that the compressor motor starts on No load, the non-return valves near the compressor delivery pipes must be provided between the compressor delivery and the

non-return valve as per the approved modification.

27. Proper functioning of the NRV can be certified by checking that continuous leakage of air from the leak hole is not there once the compressor has started. If the leakage is continuous, NRV needs to be attended.
28. Additional insulating sleeve should be provided over connection leads of stator winding to avoid insulation damage.

1.1.13 Reverser/CTF

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Reliability Action Plan

1. Ensure compliance of SMI-224 for operating coils (solenoids) in the equipment like Reverses/CTFs contactors (EP/EM) & electro valves.
2. Ensure compliance of SMI-234 to arrest flashing/melting of silver tips of fixed as well as moving segment breakage of other components of existing reversers/CTF and its up gradation to 1500 Amps high capacity CTFs/Reversers.
3. Implementation of MS-362 for modification in 1000 Amp reverser/CTF servomotor to avoid breakage of fork, roller bush and shaft.
4. Milli volts drop of J/CTF to be ensured during TOH/IOH.
5. Crushing gap of 1.5 to 2 mm to be ensured for fixed contact by using of Go - No Go gauge at the time of building up of contacts and in every overhaul.
6. Ensuring proper contact pressure in Reverser and CTF and application of conductive jelly on the contacts to avoid air gap.
7. Defective top and bottom valve of NC4 valve to be weeded out and VITONE type Top & Bottom valve to be used.
8. Fork material to be changed to forged steel.
9. Blowing of BA panel pipeline to be done during TOH/IOH.
10. J/CTF working to be checked for 100 operations on automatic test bench after overhauling.
11. J1 + J2 handle to be checked during major schedule and to be replaced with modified one in IOH.
12. Rubber gaskets/buckets must be changed during TOH/IOH (TC - 29 & 31 Rev. I).
13. Servomotor Epoxy bushes of Reverser, CTF must be replaced during overhauling and quality of material must be ensured.
14. Replacement of shunt leads on condition basis during overhauling
15. Broken/Cracked contact bits must be changed during all schedules and alignment & contact pressure to be ensured.
16. To avoid breakage of 'U' fork/shaft, damping arrangement for servomotor is to be implemented on all locomotives.
17. HV testing at 5.1KV, 50 Hz AC for one minute to be conducted to ensure proper insulation resistance level.
 - i) Between main contacts & frame.
 - ii) Between open main contacts.
18. On CTF & Reverser contact bit number to be painted to enable to pack proper bit while isolating TMs in case of earth fault in TM/Power circuit.
19. CTF/Reverser Ellen screws to be provided with 'M' seal after tightening, to avoid

- loosening in service.
20. Silver contact cleaning should be done during IC, TOH/IOH schedules as per the special instructions issued (SMI-30).
 21. Date of -provision of new contactbits may be punched/ painted at side face and failures/replacement to be recorded for wear rate & failure analysis.
 22. Aux. I/L cover to be provided with insulating paper pasted inside to avoid flashing/ earthing of cables/ I/L.
 23. Setting of contact pressure and proper bedding
 24. Checking of contact pressure of CTF/Reverser to be done during TOH/IOH.
 25. Sintered Bronze roller to be replaced with Bronze to avoid breakage during TOH/IOH.

1.1.14 EMC

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Reliability Action Plan

1. Solenoids or coil are used in large number of electric rolling stock on EP/EM contactors relays etc. (SMI-69)
2. Maintenance instruction for ensuring complete snap action of Siemens switch type K-138 (16 Amp) for loco application. (SMI-74)
3. Condition monitoring of fuses. (SMI-76)
4. Provision of RC suppression circuit across C-118 contactor coil. (MS-226)
5. Provide N/C interlock of QCVAR in C-118 coil branch (for WAG-7 modular loco). (MS-257) in MPCS locos only.
6. Adoption of improved version (High current carrying capacity) of EM contactors for C105/C106 (MVMT) C101, 102, 103 (MCP) and C107 (MVRH) applications. (MS-310, REV. 0)
7. Provision of N/C interlock of C-118 as a input on WAG-7 Locos as per ELRS/MS/0256.
8. To ensure locking groove for fingers of contactors during overhauling.
9. To test operation of EMCs on automatic test bench for 30 minutes and also to ensure proper bedding, during TOH/IOH.
10. C118 contacts with Tungsten copper nickel coated having thickness of 3 mm duly inserted on the existing copper contact to be procured to try with.
11. Reliability improve measure for operative coils (solenoids) in the equipment like air blast circuit breakers reverses/CTFs contactors (EP/EM) & electro valves of Electric locomotive. (SMI 224)
12. EM coils to be checked for internal shorting during TOH with the help of Q- meter.
13. Contact tips for mobile and fixed contacts with shunts must be changed items during IOH (TC No. 29 rev-1).
14. Contact tips for mobile and fixed contacts must be changed items during TOH (TC No. 31 rev-1).
15. In C-118 contactor mobile contact spring pressure to be ensured (5 - 6.5 Kg. / Sq.cm) as per CLW Spec. CLW/ES/C-15/C.
16. Ensuring proper fitment of mobile bits and shunts leads in all schedules. During OH defective shunts to be replaced
17. C-118 limit switches are to be replaced irrespective of the condition during O/H. Old limit switches to be immediately disposed off by cutting into two pieces
18. Araldite to be applied between the fixed contacts and nylon body of auxiliary switch

during IOH.

19. The spare N/o interlock to be used for paralleling in C-118 Aux. Switch.
20. EMC shunts should be examined critically and proper mouth profile on end fittings have to be ensured. Thread locking compound on fasteners of contactor on insulated bar during over haul is advised. Also proper flat/ spring washers have to be ensured.

1.1.15 EPC

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Reliability Action Plan

1. Checking up to clearance between the interlock operator (inter lock arm) and bottom fixing screw of the connector assembly of 22PC E-P contactor of BHEL/AEI make SKEL-2795. (SMI-9)
2. Cleaning of interlock contact of E.P. Contact changeover switch reverser master controller tap changer etc. (SMI-30)
3. Improved maintenance practices for CLW make EP contactors. (SMI-174)
4. Reliability improve measure for operative coils (solenoids) in the equipment like air blast circuit breakers reverses/CTFs contactors (EP/EM) & electro valves of Electric locomotive (SMI-224, Rev. 0)
5. Reliability improvement measures to arrest flashing/melting of silver tips of fixed as well as moving segment breakage of other components of existing reversers /CTF its up gradation and use of 1500 Amps high capacity CTFs/Reversers. (SMI-234, Rev. 0)
6. Modification to traction motor EP line contactor (Type 3421-212M). (MS-46)
7. Design improvements/modifications to be carried out on CLW make Electro-pneumatic line contactor. (MS-159)
8. Provision of additional silver tip contacts in parallel with existing main contacts on CLW make EP line contactors. (MS-219)
9. Design improvements for CLW EP line contactors. (MS-231)
10. Modification in unmodified 1000 Amp reverser/CTF servomotor to avoid breakage of fork, roller bush and shaft. (MS-362, Rev. 0)
11. To ensure that milli-volt drop across EPC contacts is within limit during overhauling.
12. To weed out defective top and bottom valve of NC4 valve and to use VITONE type Top & Bottom valve.
13. To change piston cup for EPC during TOH/IOH.
14. Rehabilitation/ conversion of all the 1000 A line contactors to 1500 A capacity, in a phased manner.
15. To ensure that arc chute horns are firmly held in place by riveting, during overhauling.
16. To test contactors on test bench for 100 operations after overhauling to ensure proper bedding.
17. To ensure that contacts close at minimum specified pressure and there is no air leakage perceptible to ear at working pressure, after overhauling.

1.1.16 Cab AC

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Reliability Action Plan

1. Ensure maintenance of CAB AC unit as per SMI No. RDSO/2016/EL/SMI/0293 Rev-0 dated 29.07.2016.
2. Modification for providing dummy plate in cab roof in place of Air Conditioning unit as

- per MS RDSO/2017/EL/MS/0461 (Rev 0).
3. Modification for providing cab AC unit in Electric Locomotives by Zonal Railways as per MS RDSO/2018/EL/MS/0469 (Rev 0).

1.1.17 Smoothing Reactor/SJ

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Reliability Action Plan

1. RDPT of the brazed joints of terminal cleat to be carried out whenever SL is taken out.
2. Insulated bushes from TMs are to be replaced with Mica sleeve.
3. Surge test on "OFF POH" locos incorporated in IC0 schedule & TOH/IOH to be carried out.
4. SMI-5/15 improvement measure for smoothing reactor type SL-42 & SL-30 to be followed.
5. SMI-147 modification to connection cable cleat from 18mm thick to 23mm.
6. Inductive shunt base should be thoroughly checked for any cracks during inspection
7. Surge Comparison testing of SL during IOH.
8. Measurement of mV drop at 1000A DC to calculate resistance.
9. Inductance measurement at 10V AC as per SMI 0304.
10. Polarity of SL to be checked during IC0 schedule (in OFF POH schedule locos) and whenever SL is changed.
11. Matching of SL sleeve & cleat size.
12. Gap between SL coils to be checked during every IOH.

1.1.18 Cables (Control, Power & Auxiliary)

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Reliability Action Plan

1. Ensuring proper cable bunching and phase segregation during every schedule.
2. Ensuring proper type crimping of power cables at TFP bushing, RSI block, TK panel and TM cables during TOH/IOH.
3. Checking cable socket for overheating, loose crimping etc. at TFP bushing, RSI block and TK panel during minor schedule.
4. Provision of rubber sheet/grommet at points where cable is in direct contact/rubbing with metallic parts, during every schedule.
5. Loco re-cabling to be carried out after 18 years along with respective POH & this is to be ensured duly coordinating with workshops.
6. Procurement of Elastomeric cables to be done as per RDSO specification No. E14/01 (Rev.2) 1993.
7. Neoprene rubber insulated sheet to be used for the protection of cables against mechanical damage.
8. In order to avoid failures of TM cables at ferrules, lay out of the cables to be ensured without sharp bends. Cables of short lengths are to be replaced. Ready stock of these cables to be maintained.
9. Whenever cable connections are made, size of ferrule to be checked before making connection with the help of Go- 'No-Go' gauge.
10. Whenever TM (TAO-659) is removed on account of burning/heavy flashing etc., particular TM cables should be inspected thoroughly.

11. Ensure that the cable insulation is well gripped by the socket (TC - 4)
12. To ensure soundness of crimped joints procedure given in SMI-114 to be followed, crimping tools should be checked periodically to ensure effective crimping.
13. While tightening the connections of the control wire, it should be ensured that the wire is held in one hand so that rotation of the lug is avoided.
14. Proper box spanner/Nut drivers should be used for tightening of control cable connections. Torque wrenches should be provided to avoid over/ under tightening.
15. Iron rods supporting the control cables should be first insulated with one layer of PVC adhesive tape followed by second layer of black adhesive cotton tape of Johnson make.
16. Cable to be tied up to an insulating rod fixed near the socket to-prevent flexing of the wire (SMI-32)
17. Ensure that there is no relative vibration between the socket and the insulated support rod. (SMI-32).
18. To minimize vibrations in the cables, various hinged boxes and panels need to be properly attended in respect of hinges and fixing bolts.
19. 1.5 mm thick rubber sheet should be pasted on the metallic surface below the control cables and above the supporting plates, channels, and angles.
20. Whenever control wires pass against angle frames 'U' type gaskets should be provided on the frames and fixed by using araldite.
21. Isolated control wires such as those to E.P valves, E.M contactor etc., should be properly secured with only adequate lengths to minimize shaking.
22. Provision of protection cover on MU couplers and their sealing to avoid water entry should be ensured.
23. Negative bonding of the cables to be checked during trip inspections and areas more prone to negative bonding should be specially attended to on priority, Cab light holders, corridor light holders and battery boxes are some of the vulnerable areas.
24. Crimping tool bits condition to be ensured to avoid bad crimping of cables.
25. Checking of any looseness and bad crimping of lug as one time drive during IC and there after TOH/IOH.
26. Checking the junction of TM cables (lug & crimping) in major schedule / unscheduled lifting.
27. Checking of overheating of terminals of cable/busbar/'C' clamps/bushings/TM terminal during major overhaul by Thermal Imaging Camera.
28. Ensure provision of fibre separator between terminal board (MVSI) and metallic base plate.

1.1.19 Bronze Support & Busbar

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Reliability Action Plan

1. Sharp bends to be avoided while making bus bars.
2. Bus bar to be provided with nylon insulators support where ever unsupported length is more than 100 cm.

1.1.20 **Battery****SN****Reliability Action Plan**

1. Condition of seamless pipe and it's clamping to be checked during every schedule and fixed if required.
2. Provision of rubber grommet and Anabond at cable entry points to be made to avoid damage to the cables from conduit edges, during every schedule.
3. Ensuring that there are no joints in the cable from BA box to SB inside the locomotive, during TOH/IOH.
4. Provision of PTFE sheet under batteries to be done during every schedule.
5. Ensuring provision of wooden packing between batteries during every schedule.
6. Batteries with life up to 4 years in locos to be maintained.
7. Proper crimping of cable sockets to be checked and heat shrinkable sleeve provided during every schedule.
8. Checking of MCB of Battery with reference to its enclosure that it is symmetrical and the connection are passed through insulated stuffing glands such that they do not get bonded with the body.
9. Panel type doors to be provided in place of covers in battery boxes in locos.
10. Batteries to be provided with ceramic vent plugs.
11. PVC adhesive tape to be provided near the terminals of the inter connectors to avoid acidic corrosion of the cable.
12. Inter connector leads and lifting ropes of the batteries to be replaced during TOH/IOH/POH. Released inter connector leads to be checked for any damages after removing the tape near the lug and serviceable ones utilized for unscheduled replacements after re-taping. Length of the inter connector should be such that these are not rubbing with the battery box cover.
13. During TOH, IOH, IC'0', the clamps of the battery box to be examined for any cracks.
14. During TOH/IOH/POH the capacity test must be done on the batteries And batteries having efficiency of less than 80% to be replaced with new ones.
15. 10sq.mm. Cable from HBA to HOBA middle point (in place of 3 sq.mm. cable) shall be provided. This should be checked during IC'0' schedule as a preventive check for new/ off POH/off re-cabling locos.
16. Provision of additional CCBA in the form of MCB / Fuse box near/ inside the battery box to take care of any earth fault in the battery positive cable before the CCBA. The location of the provision shall be so selected that the fuse does not get damaged during cattle run over or external hitting.
17. Packing material and battery box shall be painted with anti-corrosive and acid proof black paint during TOH/IOH/POH.
18. Necessary instruments and tools like voltmeters to read cell voltage, battery voltages, hydrometers thermometers, gauge for measuring the electrolyte level to be made available in good condition for the maintenance staff and should be calibrated periodically.
19. It shall be ensured that anti-theft rod of battery box is not touching with battery terminals.
20. Extra supporting clamps to be provided on battery box as per MS 351.
21. Only nylon nuts to be used for battery box tightness. All the nylon nuts to be replaced

whenever opened.

1.1.21 180kVA Static Converter

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Reliability Action Plan

1. Bearing of modified Havells's cooling fan to be replaced within a service period of 03 years in M/s AAL make SIV.
2. Repair/rehabilitation of failed GDU cards of inverter as well as battery charger is to be done in phased manner under AMC of M/s AAL make SIV.
3. M/s Siemens had submitted training CD on the process of bearing replacement of cooling fans. All sheds to implement the same.
4. Sheds to follow changing of bearing of cooling fan as per schedule in M/s Hind make SIV under AMC.
5. Provision of flange cum foot mounted blower motor in AAL make SIV as per RDSO MS no RDSO/2016/EL/MS/0449 Rev 0 dated 30.03.2016.
6. Blowing with dry air, Vacuum cleaner and Cleaning of heat sinks and other components by electro static brush in every IC schedule.
7. One cycle cleaning of SIVs as part of summer precautions as per RDSO letter no EL/1.2.9.1 dated 20.02.2014.
8. Measurement of capacitance value of DC link, sine wave filter and snubber circuits, wherever possible during IOH schedule as per SMI no RDSO/2016/EL/SMI/0291(Rev 0) dated 21.06.2016.
9. Downloading and analysis of recorded fault messages in every schedule for taking the corrective action as per SMI no RDSO/2016/EL/SMI/0291(Rev 0) dated 21.06.2016.
10. Checking of sealing gaskets in every IC schedule and replacement in every IOH on condition basis.
11. The rotation movement of churning and cooling fan & the bearing are to be verified during TOH, IOH schedule. But the replacement is to be done as per schedule submitted by firm. This has already been mentioned in minutes of meeting dated issued vide RDSO's letter no. EL/1.2.9.1 dated 17.07.2017.
12. AMC of all makes of SIV as per SMI no. RDSO/2016/EL/SMI/0291(Rev 0) dated 21.06.2016.
13. Checking of GDU card in AAL make SIV. As per the firm the main cause of failures of GDU card is due to deterioration of capacitance value of capacitors in GDU cards which leads to failures of pulse transformer and IGBT. The replacement of capacitors and pulse transformer after a service period of 06 years is to be done on the condition basis.
14. MCU Card – Provision of higher rating MCU card in M/s AAL make SIV.
15. Replacement of ABB make DCCT and Battery charger in AAL make SIV.
16. Replacements of ZCT of M/s Deesys of Korea by M/s. Broycee Control of England in AAL make SIV.
17. Proper locking of input isolator / Removal of input Isolator in M/s SIEMENS make SIV.
18. Modification of MC card and TDC_IF card in M/s Medha make SIV to be implemented by firm.
19. In M/s Medha make SIV the dv/dt capacitors are to be replaced after service period of 4 to 5 years. If capacitance value is less than 20% of specified value then replacement is to be done by the firm.
20. Dust cover modification in M/s MEDHA make SIV to be carried out by the firm. Condition monitoring of snubber capacitors in Hind Rectifiers make SIV during major schedule.

21. Replacement of the same after a service of 06 years or if the capacitance value deteriorate.
22. Provision of implementation of QCON timer and EAU (Energy absorption unit) in Hind Rectifiers make SIV to be done by the firm.
23. Provision of modified MVSI motor in place of Siemens make cooling fan in Siemens make SIV.
24. Replacement of bearings of cooling fan of SIV in major schedule on proper fixture with special tools.
25. Sound checking of cooling fan using Shock Pulse Meter (SPM) during schedule inspection.
26. Check condition of MCB in Hirect make SIV during every major schedule, replacement of MCB in IOH.
27. Snubber circuit capacitor values to be checked in Medha make SIV during TOH.

1.1.22 **MPCS**

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Reliability Action Plan

1. Replacement of sealing gasket during IOH schedule.
2. Downloading and analysis of recorded fault messages in every schedule for taking the correction action.
3. Ensure proper earthing during welding works in locomotives & to ensure that welding is carried out in Battery OFF condition.
4. To carryout AMC as per SMI No. RDSO/2016/EL/SMI/0288 (REV. '0')
5. Ensure the CPU battery voltage of RTC is in proper condition during TOH and replace whenever required.
6. Ensure the maintenance of dynamic braking excitation contactor C145 as per SMI no. RDSO/2012/EL/SMI/0276 Rev.'0' dated 27.07.2012 in each schedule.
7. Time matching of MPCS digital clock with control office clock during every inspection /loco visit.
8. Real Time Clock of MPCS to be replaced as per OEM guideline.
9. Setting of number of pulses/revolution and wheel diameter in Microprocessor based Control & fault diagnostic System (MPCS) V3 for correct indication of speed in MPCS as per S.M.I. No. RDSO/2018/EL/SMI/326(Rev'0') dated 14.12.2018.
10. Modification of loco control circuit for circuit breaker (DJ) opening and panto lowering by BLDJ and ZPT switch in 25 kV conventional locomotives equipped with microprocessor based control and fault diagnostic system (MPCS) as per Modification Sheet No. RDSO/2009/EL/MS/0384 (Rev-'0') dated 07.10.2009.
11. Modification Sheet No. RDSO/2009/EL/MS/0386 (Rev.1) dated 29.10.2012 for modification in loco control circuit for Multi-Unit operation (MU) max. for three locos for 25 kV ac electric locomotive working with microprocessor based control & fault diagnostic system(MPCS) as per RDSO's specification no. ELRS/SPEC/MPC-FDS/0001 Rev-'2' - August 2005 (ver-2).
12. Modification in electric locomotive control circuit fitted with microprocessor based control system (MPCS) for individual isolation of hard/soft QDs during operation of HMCS programme switch as per Modification Sheet No. RDSO/2011/EL/MS/404 Rev '0' dated 28.12.2011

13. Circuit modification of I-68 branch for C145 operation feedback for 25 kv ac electric locomotives fitted with MPCS as per Modification Sheet No. RDSO/2012/EL/MS/410 Rev '0' dated 04.06.2012.
14. Modification of loco control circuit for LSDBR lamp to avoid wrong indication of working of AC MVRF in MPCS fitted Electric Locomotives as per Modification Sheet No. RDSO/2013/EL/MS/421 Rev '1' dated 25.10.2013.
15. Technical Circular No. RDSO/2012/EL/TC/0119, Rev.1 dated 20.03.2013 for MPCS with Remote monitoring and analysis feature of 25 kV AC Electric Locomotives.
 - (i) Technical Circular No. RDSO/2012/EL/TC/119, Rev-1 dated 20.3.2013, Amendment No.1 dated 25.08.2017 for implementing bilingual display of fault messages in microprocessor based Control and fault diagnostic System (MPCS)
 - (ii) Technical Circular No. RDSO/2012/EL/TC/0119, Rev.1 dated 20.03.2013, Amendment No.2 dated 28.11.2018 for setting of number of pulse/revolution and wheel diameter with Microprocessor based Control and fault diagnostic System (MPCS) Version-3 for correct indication of speed.
 - (iii) Technical Circular No. RDSO/2012/EL/TC/0119, Rev.1 dated 20.03.2013, Amendment No.3 dated 30.04.2019 for provision of VCD counter in MPCS Version-3 fitted locomotives.
16. Proper connection of MU coupler in Microprocessor based Control & fault diagnostic System (MPCS) V3 locomotives to ensure proper working of Vigilance Control Device (VCD) as per Technical Circular No. RDSO/2019/EL/TC/0150 Rev.'0' dated 14.03.2019.
17. Acknowledgement of Vigilance Control Device (VCD) through PVEF in Microprocessor based control and fault diagnostic system (MPCS) version-3 as per Technical Circular No. RDSO/2019/EL/TC/0153 Rev.0 dated 27.08.2019.

1.2 Pneumatic Equipments:

1.2.1 Pneumatic Valves

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Reliability Action Plan

1. Calibration of AFMV during A01-1/10H schedule as per RDSO Letter no. SD/Dev.128 LAV, Dated 19.11.91.
2. C2W and C3W valves to be tested on test bench after overhauling.
3. Provision of 1/2" isolating cock without vent of Legris make identical to the one being used on WAP5 locos during every schedule.
4. D24B to be replaced with Feed Valve (FT 1) during TOH/IOH.
5. Replacement of corroded pipeline coming from under frame to driver cut out cocks to be done during TOH/IOH.
6. Master gauges used for testing of gauges should be calibrated periodically as per TC-066.
7. Overhauling and storage of critical pneumatic valves and their components to be done in a dust free environment. Over hauled valves should be kept after wrapping properly by polythene/bubble wraps. All precautions should be taken for storage of rubber components.

8. Modification to prevent damage/breakage/falling the drain cock of after cooler (EMU type) due to external hitting in all locos as per MS/308 in every schedule.
9. EMU type after cooler inlet/outlet pipe line union joint to be supported by suitable clamp provision in every schedule.
10. Provision of additional BP cock with vent and transposition of BP gauge intake pipe line to avoid failure of loco in case of cattle run over and in case of inadvertent operation as per MS 0349.
11. Cleaning of air strainers to be done in schedule inspections.
12. Overhauling of A9, C2 relay valves and duplex valves for horns to be done in IC.
13. Cam fixing screw of A9 valve to be tightened during overhauling and thread locking. Dog cams of A9 valve of SIL/FTIL make to be ensured during overhaul. Check nut to be provided on adjusting knob of A9 valve.
14. Teflon seating to be provided to horn operating valves in lieu of rubber valve reinforced with brass. Horn diaphragm made out of Hylam sheet of 1 mm thick in place of phosphorous bronze to be provided.
15. Non-return valve has to be provided with union nuts to facilitate their removal for overhauling repairs. Non-return valves with Teflon seating to be provided.
16. Non-returning valve in DJ circuit to be cleaned during IC.
17. Auto drain valve to be overhauled in every major schedule and all rubber components replaced.
18. During overhauling Duplex check valve, check valve stem to be tightened by applying thread locking compound to avoid loosening.
19. Replacement of existing Nylon filter with Sintered bronze filter in ½" & 3/8" air strainer in the pneumatic circuit of conventional electric locomotives as per MS 0359.
20. Procedure to be followed for Dew point Depression temperature measurement of compressed air passing through heat less regenerative twin tower type air dryer being used in electric locomotives as per TC 0139.
21. To standardize the maintenance activities during various schedules of electric locomotives for heat less regenerative twin tower type compressed Air Dryer, the SMI No. RDSO/2017 /EL/ SMI/ 0305 /Rev'0' dated 17.04.2017 to be followed.
22. Provision of Trap chamber for collecting coal/dust particles coming from BP pipe in A9-BP circuit in conventional electric locomotives to be ensured as per MS-0463 dated 08.09.2017
23. Ascertaining the proper functioning including discharge rate of 1-1/4" NRV used in the pneumatic circuit of Electric Locomotive the RDSO's SMI-184 Rev'1' to be followed.
24. Blowing of BP/FP pipelines by opening angle cocks on either ends after building complete pressure to be carried out once in every schedule.
25. Replacement of D-1 auto drain valve in accordance to RDSO bulletin no. MP.IB.BK.05.19.08 Rev. 00 dated 25.06.2008.
26. A9,SA9,C2 braking should be overhauled during IC.C2 charging ,VEPT-1&2,Duplex valve of horn , MR & CPA safety valve ,SMGR PRV should be overhauled during 2nd IC.
27. All non-returning valves to be cleaned during IC.
28. Extended metallic portion of BP/FP pipe upto its angle cock centre to be measured in every schedule.
29. BP/FP hose pipe length to be measured and its pressure test on 10kg/cm² pressure to

be done before fitment in locomotive.

30. Relocation of RS emergency valve handle in the conventional locomotives with modified cab (in which the modification no. RDSO/2014/EL/MS/0433 Rev.0 dated 28.03.2014 has been carried out) and if the existing RS valve position and application is similar to that of 3-Phase locomotives, the modification sheet no. RDSO/2023/EL/MS/0491 Rev.'00' may be implement as per RDSO letter no EL/3.2.19(G) dated 07.06.2023 with subsequent letters no EL/3.2.19/3-Phase/Part-1 dated 05.04.2023 & 12.05.2023.

1.2.2 Compressors& After Cooler Valves

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Reliability Action Plan

1. Overhauling of Compressor should be followed as per OEM maintenance manual
2. Provision of additional 1000 LPM compressor in WAP-4 class of Electric locomotive with segregated pneumatic valves layout arrangement as per modification RDSO/2010/EL/MS/0388/Rev'0' dated 23.07.2010
3. Modification sheet for provision of 2 Nos. of oil free compressors of 1750 LPM each onboard mounting in WAP-4 class of Electric Locomotives with modified cab fed by 180 KVA SIV as per modification RDSO/2016/EL/MS/0451/Rev'0' dated 25.04.2016
4. Provision of Disc type coupling in Main compressor of 1000 LPM capacity in place of resilient coupling as per modification as per modification sheet no. RDSO/2017/EL/MS/0462 Rev'0'
5. Provision of 2 Nos. of lubricated compressors of 1750 LPM each on-board mounting in WAP-4 class of Electric Locomotives with modified cab fed by 180 KVA SIV during POH by Electric Loco Sheds as per modification no. RDSO/2015/MS/0445 Rev'0'
6. Provision of safety sling in all under slung compressors in conventional locomotives.
7. Safety valve in ELGI make compressor to be mounted upwards instead of suspended position on inter-cooler.

1.2.3 Pantograph type AM-12 or similar and High Speed pantograph type AM-92/IR-03H or similar

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Reliability Action Plan

1. Instruction contained in RDSO's Technical Circular No. 19 may be followed to reduce/address the Pantograph OHE Entanglement.
2. Instruction contained in RDSO's Special Maintenance Instruction No. SMI/75 Ensuring proper raising & lowering PT type AM-12
3. Instruction contained in RDSO's Special Maintenance Instruction No. SMI/64 Static balance procedure for panto type AM-12.
4. Instruction contained in RDSO's Special Maintenance Instruction No. SMI/192 may be followed for Periodic maintenance of AM12 type pantographs
5. Instruction contained in RDSO's Technical Audit of Maintenance Practices of Pantograph for Electric Locomotives Report RDSO/2016/EL/TAR/0006, Rev.'0' shall be followed for Lubrication schedule for improving reliability of AM-12 type of pantographs and of similar design.
6. Modification issued by RDSO vide modification sheet No. ELRS/MS/ 0333 Rev'0' may be followed for Standardization of Panto Pan Assembly of AM12 or similar Pantograph

- for Electric Locomotives and EMUs.
7. Modification issued by RDSO vide modification sheet No. RDSO/2011ELRS/MS/0389 (Rev.0) Provision of additional spring catcher to prevent the main raising spring to fly off in case of breakage of spring of AM-12 or similar design pantographs used on electric locomotives and EMU/MEMU.
 8. Visual Inspection on critical components of pantograph (Intactness of split pins & bolts and its tightness, Panto pan, Metallised carbon strips, Main spring, Mechanism assembly & pantograph mounting insulator, top mounting part A + B, cylinder support, support rod and steady link for its cleanliness and crack or spark marks) and ensure proper levelling of the panto pan to be done in every schedule. Proper lubrication must be done. Application of lubrication should be carried out after proper cleaning.
 9. Provision of rubber bush inside the open end of longitudinal tube of AM-12 type pantograph to avoid ingress of water in TOH/IOH during every overhaul as per RDSO modification sheet No. RDSO/WAG-5/29(New No. ELRS/MS/WAG5/242).
 10. Changing of Servomotor Piston Packing ring in TOH(as per TC/0094)and use only LIPEX T2GreaseBalmerLawrie or Servogem 2 grease of M/s. IOCL so as to avoid servomotor piston jamming. Do not intermix above greases. During prewinter precaution, the packing ring to be checked.
 11. Cleaning of roof insulators in every schedule and application of silicon oil as per RDSO special maintenance instruction No. RDSO/2012/EL/SMI/0274 Rev. '0' dated 29.03.2012.
 12. Rubber stopper should be provided to minimize jerks in the panto assembly during lowering
 13. Items must be changed during Schedules as per RDSO technical circular No. RDSO/2007/EL/TC/0094 for AM-12 type pantographs.
 14. RDSO special maintenance instruction No. RDSO/2016/EL/SMI/0292 should be followed maintenance of AM-92 or IR-03H type pantographs.
 15. To reduce failures recommendation of RDSO Investigation Report No. RDSO/2011/EL/IR/0147 Rev. '0' should be followed. Transverse rigidity of pantograph must be checked as defined in Report No. RDSO/2011/EL/IR/0147 Rev. '0' as well as SMI No. No. RDSO/2016/EL/SMI/0292.

1.2.4 High Reach Pantograph type WBL-85HR and LX 3600

SN Reliability Action Plan

1. To improve the performance & reliability of High Reach Pantograph, maintenance activities are to be strictly followed as per maintenance manual of respective manufactures issued vide RDSO letter No. EL/2.2.1/High Reach Dated 20.02.2023.
2. Operation of pantograph shall be followed as advised RDSO letter No. EL/2.2.1/High Reach Dated 16.06.2022.
3. Zonal Railways to ensure the implementation of modification issued vide RDSO letter No. EL/2.2.1/High Reach Dated 09.09.2021 in M/s Schunk Make High Reach Pantograph type WBL-85HR supplied as per RDSO specification No. RDSO/2007/EL/SPEC/0054 Rev. '2'.

1.3 Mechanical Equipments:

1.3.1 Wheel Sets (TAO/HITACHI)

SN	Reliability Action Plan
1.	Implementation of RDSO/ELRS /SMIs during overhauling and wheel, axle box, MSU & other bogie equalizer. SMI/183 (Tightness of suspension tube fixation bolt), SMI/207 (Main dimension check of suspension tube of fixation bolt), SMI/216 (Maint. Practice Sch., Do's & don'ts, measuring and recording of dimensions to be followed for Axle box assembly of WAP-1/4 & WAG-7) , SMI/217 (Remedial measure to arrest failure of MSU of Hitachi TM), SMI/221 (Maint. Practice during TOH sch. of MSU of Hitachi TM)
2.	The diameter of front & rear racers/racer seats to be recorded in two perpendicular directions before dispatching and after receipt of the wheel sets to & from workshops, to identify any swelling during Re-discing.
3.	Induction heater to be used for fitment/removal of racers.
4.	Ultrasonic test of Axles to be done during axle overhauling & IC inspection. In no case the time interval for ultrasonic testing of locomotives axles should be more than 12 months.
5.	Wheel gauge to be measured during every IC/TOH/IOH and during axle changing.
6.	RDPT of bull gear to be done in TOH/IOH.
7.	Wheel gauge to be measured in every IC schedule as per RDSO MP-MI-90/80- 1993
8.	Locos whenever visited shed to be checked for wheel skidding.
9.	Distance between axle collars of wheel to be ensured as 915 mm.
10.	Ellen screws to be provided on split gear plain sleeve Suspension bearings during TOH to avoid loosening on run.
11.	Fixing of Gear case should be done in such a way that it touches TM collar without any tension to avoid crack in TM collar/Gear case.
12.	Non gear end cover bolts are to be replaced with bolt & nut arrangement to avoid dropping of adjustment washer.
13.	Pressure pipe line for greasing MSU/Axle box should have air dryer. Before releasing the pressure, water should be drained out.
14.	TM fixing bolt (M36 x 110) to be tightened with torque wrench at 140 kg M torque & thread locking compound to be provided during TOH/IOH/ unscheduled lifting.
15.	Clearance of 0.2 to 0.5 mm to be confirmed in between outer thrust collar & outer distance piece.
16.	Welding of liner to be continuous type instead of tag welding with Mn. Electrode.
17.	Before fitment of TM, MSU to be rotated manually for free movement checking.
18.	Checking of Allen screw tightness to be ensured during major schedule and during axle changing.
19.	Checking of bull gear after thorough cleaning during major schedule.
20.	'P' & 'K' value of bull gear to be checked during changing of TM and overhauling of wheel sets.
21.	Welding work with proper earthing to be ensured strictly.
22.	After Wheel Re-Profiling (WPR), checking of wheel profile with master gauge to be done and record to be maintained.
23.	Use of snap gauge for measurement of Racer journal dia and swell of journal.

24. Procedure of pressing-in of wheels on axles in Electric Locomotives as per TC RDSO/2015/EL/TC/0132, Rev '0' dated 05.10.2015.

1.3.2 Loco Body & Bogie

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Reliability Action Plan

1. Readjustment of sander pipe nozzle height fitted on WAG7 loco. (SMI-215)
2. Provision of stopper plate for preventing falling off of centre pivot assembly of CO-CO high adhesion bogie. (MS-1)
3. Removal of side stops from existing 4 Nos per bogie to 2 Nos per bogie. (MS-6)
4. Side stopper arrangement in lieu of tie bar arrangement for WAG-7, WCAM-3 & WCAG-1 class of locomotives. (MS-281)
5. Modification in the arm of friction piston device in cast steel bolster of WAP1/WAP4 Electric Locomotives. (MS-354, Rev. 0)
6. Use & Maintenance/Fitment Practices of Equalizer & Compensating Beam Pins, Bushes & Cotters in WAG-7 Locomotives. (SMI-264, Rev. 0)
7. Utilization of imported centre pivot rubber bush in WAG-7 locomotives provided with pivot pin having uniform dia of 246 mm.(MS-338)
8. Provision of sleeve on centre pivot pin in WAG-7 locomotive. (MS-316)
9. Provision of modified equaliser compensating beam & links. (SMI-227)
10. Change in material of brake rigging components of flexi coil mark-1 bogies in WAP1/4. (TC-48 Rev '0')
11. Change in material of brake blocks for electric locomotives. (TC-49)
12. Critical geometry features of helical springs to be given special attention. (TC- 50)
13. Critical clearance in flexi coil mark-1 bogies in WAP-4. (TC-59)
14. Comprehensive guideline for improving wheel life. (TC-63)
15. Procedure for welding of centre pivot WAP4/7. (TC-74)
16. Instruction of colour coding of coil spring fitted on WAP-4 locomotive. (TC-75)
17. Electrode and welding procedure as recommended by RDSO to be followed (MC—44 dt. Aug. 01); CGS-680 x-upper electrode size 3.15 mm EAT make to be used for Mn liner welding.
18. Washers to be provided on brake hangars of all WAP 1/4 locomotives during TOH/IOH.
19. A gap of 31.5 mm between outer brake pull rod & wheel and 21.5 mm between inner brake pull rod & wheel to be maintained in all WAP1/4 locomotives.
20. Safety slings to be provided on outer brake hangers in WAP1/4 locomotives during TOH/IOH.
21. Vertical play in WAP1/4 locomotives in between pin & bush of outer brake hanger to be checked.
22. Modified guides as per RDSO latest Drg. No. SKEL-4559 ALT.'0' to be provided along with nylon liners. MS-283.
23. Modified light weight trunnion to be provided in WAP1/4 locomotives (ELRS/MS/284 Rev. '0' 2000).
24. Sleeve to be used on inner brake hangars of WAP1/4 locomotives (ELRS/MS/285 Rev.'1' 2000).
25. Design of outer brake hanger and inner brake hanger have been modified as per RDSO Modification No. ELRS /MS/0284, 0285, 0286.

26. The vertical play of outer brake hanger to be checked during every scheduled and it should not be more than 10 mm. in any case.
27. Adequate clearance to be maintained in connection strap (outer & inner) from the wheel face to avoid its rubbing with wheels.
28. Manganese pins and bushes to be provided at outer brake hanger locations in bogie & brake hanger as per RDSO recommendation.
29. Provision of modified slack adjuster upper.
30. Replacement of all welded bolsters in service, in a phased manner.
31. Repair of side bearer and centre pivot showing crack/ breakage in the weldments to be carried out by use of electrode and procedure as laid down by RDSO (SMI 57).
32. RDPT of centre pivot of WAP-1/4 loco during TOH/IOH to be done.
33. Effective sealants (i.e. RTV or equivalent) for roof, elliptical glass, front glass and round glass) to be used to prevent rainwater ingress inside loco.
34. Ultimate vinyl to provide on WAP-1/4 loco floor.
35. All WAP locos more than 10 years old to be surface refurbished, in a phased manner.
36. The alignment of brake hanger to be ensured.
37. All brake rigging must have locking plate on brake adjusting screw and to be checked.
38. To avoid falling of liners, welding to be done on complete edge of liners with manganese electrode.
39. Visual checking of bogie frame after cleaning to be done during Major schedule.
40. RDPT and re-welding of Gear case breather to be done.
41. Clearance between bogie, loco body U-bracket and bolster to be ensured in WAP4 locos during schedule inspection.
42. Bogie liners welding electrode to be preheated at 250⁰C-300⁰Ctemperature.
43. Maintenance Instructions in regard to link compensating & equalising beam of WAG7, WCAM3, WCAG1 loco bogie as per SMI ELRS/SMI/0227 dated- Aug 2022.
44. Modification from conventional hand brake to modified hand brake (Gear type) arrangement for WAP-4, WAG-7, WAP-7 and WAG-5 electric locomotive application as per RDSO/2014/EL/MS/0440/Rev'1' dated 16.9.2015.
45. Material for pins & bushes in the brake rigging.(TC-11)
46. Final checking and adjustment of piston travel after loco movement to be done.
47. Measurement of Longitudinal and Lateral clearance after lowering of bogie to be taken & corrected as per requirement.
48. Either double check nut or Loctite to be provided after adjustment of brake cylinder piston to keep intactness of BC piston.

1.3.3 Loco Suspension

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Reliability Action Plan

1. Spring seat and equalizer tiepin to be checked regularly and to be replaced if found worn out beyond limits (SMI 194), during TOH/IOH.
2. Anti -vibration pads on primary springs of WAP1 locomotives to arrest spring failures, to be provided during TOH/IOH (RDSO letter No. S.V. WAP4 dt. 21.06.2000)
3. Thorough checking of PHS for tip thickness,surface deformity and painting during TOH/IOH + new provision.
4. To reduce breakage of main shaft of SB oil pump, lightweight pinion machined out of

the existing pinion to be provided, during TOH/IOH.

(ELRS/MS/0313)

5. Mating surfaces of magnet frame and SB head to be cleaned by thinner/kerosene prior to application of adhesive, especially in those cases where head has been disassembled after test run.
6. M12 bolt holes in axle caps to be got repaired from trade.
7. Replacement of oil pumps to be done on condition basis. Oil pumps are tested for discharge in IC and overhauled in TOH/IOH.
8. The free rotational clearance between split gear and axle cap to be ensured in every IC schedule to be 5 to 7 mm. SB to be changed if gap is less than 3mm (SMI 7).
9. Tightening of axle cap bolts of TAO 659 TM to be done crosswise and with torque value 121-145 kgm (SMI 205) during assembly.
10. Suspension tube bolts of TAO 659 and HS 15250A TMs to be tightened with a torque wrench of 121 to 145 kgm (SMI 183) during assembly.
11. To make use of the lubricating oil for SB from the lowest available level in the sump modified oil pump to be used (ELRS/MS/303 - 2000 Rev '0').
12. Matching of split gear & pinion to be ensured in IC.
13. All deformed magnet frames to be weeded out and got repaired through trade.
14. Procurement of fasteners should be of reliable make.
15. Measurement of backlash and ensuring it properly during OH and whole TM/Wheel set changing

1.3.4 Other Mechanical

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Reliability Action Plan

1. Testing of loco brake power as per parameter given in RDSO SMI 197.
2. Measurement of backlash of traction motors. SMI-160
3. Tightness of enclosure ring fixed on main gear wheel of Hitachi Wheel Set. SMI-229
4. Improvement in the performance of centre pivot rubber bush fitted in WAG-7 locos. RDSO/WAG-7/04
5. Apply Loctite 222 ANR 124 on the threaded portion of adjustment washer fixation socket head cap screw 12X70. RDSO/WAM-4/167
6. Modification to gear case assembly of WAG7 Locomotive. MS/248
7. Improvement in the performance of side bearer assembly fitted in WAG7 locomotives. MS/0277
8. Modification to the bottom plate of centre pivot pins on WAG-7 loco. MS/309
9. Fitment of lubricating pins for WAG7/ WCAM3/WCAG1 class of Electric Locomotives as per MS-0331.
10. On gear case joint, through nut bolt system to be adopted instead of bolt.
11. Metallic felt to be provided in Hitachi gear case.
12. Modified sander bracket assembly to be provided to increase the height of sander from rail level and to prevent it's falling on run, in all locos in every schedule.
13. Sander bracket assembly along with sanding hose connection to be intact. In case of all WAP-1/4 loco the sander bracket should be on double support.

14. Rubber sandwich of TMs to be replaced during TOH/IOH as per TC-29 Rev-1, TC-31 Rev-1 Amendment-1, TC-123 Rev-0 amendment-2.
15. All fasteners to be fitted at prescribed torque values (SMI 1).
16. To avoid theft cases of earthing assembly on HS 15250A TM, being non-ferrous, modified earthing assembly to Drg. No. SKEL 4566 Rev. '1' is provided (ELRS/MS/300 Rev. '1').
17. Run testing of assembled TM to be done after adding cardium compound.
18. Monitoring of gear case oil level using dipstick while in and out of loco and record maintenance to be done.

1.3.5 CBC, Buffer, Screw coupling

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Reliability Action Plan

1. Buffer length to be measured in IC/TOH/IOH to maintain a length of 615 to 635mm.
2. RDPT/Magnaflux of buffers to be done in every overhaul schedule.
3. Ensure yoke pin support for any crack.
4. RDPT/Magna flux checking of D-shakles & knuckles.
5. Checking of TS coupling /CBC with RDSO specified set of Go-NO GO gauges.
6. Provision of top operated CBC operating handle in all locos as per RDSO MS 454.
7. Screw couplings, which have long shackle above the nut surface to be weeded out.
8. Checking of CBC operating handles in every visit of the locomotive as per RDSO/ELRS/SMI/0213-99 Rev 0,
9. Checking of Knuckle nose wear in every IC as per RDSO/ELRS/SMI/0213-99 Rev 0.
10. Working of CBC locking key to be ensured during every inspection schedule.
11. Only 60T screw couplings to be used. Testing & crack detection through RDPT/Magnaflux in every TOH/IOH to be done.
12. All locos to be equipped with CBC operating handle during TOH/IOH and the same to be checked for proper operation during any visit of the loco.

2. Reliability Action Plan For Three Phase Electric Locomotives

2.1 Electrical Equipments:

2.1.1 IGBT Traction Converter

SN	Reliability Action Plan
1.	Software Ver.53 or latest ver.to be uploaded in all locos fitted with M/s ABB make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
2.	JTAG modification to be completed in CC1500 redesign IGBT based traction converter for A & B series GD cards fitted in M/s ABB make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
3.	Replacement of main line contactor in redesign SR to be carried out with modified contactor for affected batch which was supplied 2017 onward fitted in M/s ABB make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
4.	Software ver. 786 or latest ver.to be downloaded in all locos fitted with M/s BHEL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
5.	Modification for Provision of RC filter add-on kit across the relay contacts in VIU card to be completed fitted in M/s BHEL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
6.	Software ver.2.9 or latest ver.to be downloaded in all DCU Cards fitted in M/s BHEL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
7.	M/s BHEL implemented increased delay timing for feedback from 1s to 2s in their software for Harmonic Filter Contactor stuck ON/OFF fatal.
8.	Coolant Gauge glass to be replaced with Hydax makes gauge glass in all locos fitted in M/s BHEL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
9.	SW. Ver. 1.4.0.5 or latest ver. to be downloaded in all locos fitted with M/s BTPIL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
10.	Special formatting processes of DCU card to be carried out to prevent transient failures in DCU card vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
11.	Optocoupler (U11) to be replaced in all Power Supply card fitted in M/s BTPIL make traction converter vide BT letter no. IR.RDSO.20230323.932 dated 23.03.2023 in compliance of RDSO Letter no. EL/3.1.35/17/BT dtd 17.02.2023.
12.	Baumer make pressure sensor to be replaced with Jumo Gmbh make pressure sensor fitted in M/s BTPIL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
13.	Air gap between speed sensor and ring to be maintained by measuring it with the help of air gap measuring tools supplied by BT fitted with M/s BTPIL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
14.	SW Ver.28 or latest ver.to be downloaded in all locos fitted with M/s CGL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.

15. Replacement of Duagon Card to be carried out with modified card as firm replacing optocoupler in defective batch Duagon cards fitted in M/s CGL make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
16. Replacement of GDU card to be done with modified GDU card as failure prone MLCC capacitor in GD card has been replaced with electrolytic type capacitor fitted in M/s Medha make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
17. Replacement of gauge glass to be carried out with modified Medha makes gauge glass as Medha increased thickness from 1.5mm to 3.0 mm with polycarbonate material in modified gauge glass fitted in M/s Medha make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
18. Greasing to be done for Micro Electrica make line contactor at yearly once. For Telarc make line contactor, replacement of relay to be carried out with Siemens make contactor provided in Telarc make line contactor fitted in M/s Medha make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
19. Replacement of faulty Jaquet make speed sensors to be carried out with Medha make speed sensor against failures fitted in M/s Medha make traction converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
20. Flushing, filling and testing of coolant used in IGBT based WAP5, WAP7, WAG9 and WAG9-H locomotives to be followed as per RDSO/2018/EL/SMI/325(Rev 0).
21. Modification in cooling circuit of M/s BHEL make IGBT based traction converter to prevent air locking, spillage of coolant and fluctuating in coolant level as per RDSO/MS 457 Rev'0' dt:12.01.17.
22. The capacitance of combined DC link capacitor as well as combined resonant capacitor should be measured in every TOH. In case of abnormal variance in the combined capacitance value identify the faulty capacitor by measuring the capacitance value of individual capacitor and change the capacitor accordingly as per RDSO Letter No. EL/3.1.35/17 (BHEL) dt.16.12.16.

2.1.2 IGBT Auxiliary Converter

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Reliability Action Plan

1. Replacement of Duagon card to be carried out in particular batch which is already identified and manufactured between mid of 2019 to early 2020. Also new firmware d-058639-063261 or latest ver.to be uploaded in all the devices fitted in M/s ABB make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
2. Battery Charger modification rework for screw mismatch to be carried out in all locos and Software ver. 95 or latest ver. to be downloaded in all locos fitted with M/s ABB make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
3. Modification for replacement of the washer adjacent to resister R329 in inverter GD card to be carried out in all locos fitted in M/s ABB make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
4. Modification for heat sink material pasting in rectifier module to be carried out in all locos fitted in M/s ABB make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
5. ALL under warranty Elettromill choke to be replaced with SALZER makes choke fitted in M/s BHEL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
6. It is to be ensured that BUR fan on temperature setting has been changed from 60°C to

- 25°C. Further, modification for provision of heat sink in AMC card to be carried out in all locos fitted with M/s BHEL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
7. Modified software Ver. (Propulsion software version – 1405; BUR software version – 1829,2829,3829ba) or latest ver. to be downloaded in all locos fitted with M/s BTIPL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
 8. It is to be ensured that firm interchanging the pin configuration of pin no 1 and 5 in x1 connector of 1945 card. Also 1945 card to be replaced with modified card as firm modifying 1945 card by providing Zener Diode across relay coil and resistor in series of the MOSFET fitted in M/s BTIPL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
 9. Replacement to be done with modified Inverter Driver Card (TT 1669) as firm replacing solid type tantalum capacitor with polymer type tantalum capacitor and removing miller capacitor between gate and emitter in existing 1669 cards fitted in M/s BTIPL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
 10. Replacement to be carried out with modified card as firm modifying card by replacing MFR make resistance with Vishay makes resistance in 2015 & 2036 cards fitted in M/s BTIPL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
 11. Replacement to be carried out with modified card as firm replacing optocoupler in defective batch Duagon cards fitted in M/s BTIPL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
 12. Replacement to be done for defective batch from 1905 to 1927 DC-DC Converter with alternate makes IntreXis power supply. Also it is to be ensured that firm is replacing with InterXis power supply against failure of M/s Demke make DC-DC Converter power supplies cards fitted in M/s BTIPL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
 13. One cycle to be initiated for checking of sine filter capacitor value and to be replaced if found less fitted in M/s BTIPL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
 14. Replacement of GDU for defective batch to be carried out fitted in M/s CGL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
 15. Modification for fixed bus bar type assembly connection to be carried out instead of detachable design of Harting Coupling out fitted in M/s CGL make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
 16. Replacement of MVS800 card to be carried out with Medha make modified card as version MVS800 BW-05 fitted in M/s Medha make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
 17. Modification of DC link Capacitor to be carried out by providing isolation between the capacitor body w.r.t loco body fitted in M/s Medha make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
 18. Replacement of Semikron make diodes with higher rating (from 80A to 110A) diodes of M/s IXYS make to be carried out in battery charger fitted in M/s Medha make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
 19. Duct modifications to be carried out in all locos to avoid heating issue of M/s Siemens make auxiliary converter vide RDSO Letter no. EL/11.5.5/21 12.05.2023.

2.1.3 TCN VCU

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Reliability Action Plan

1. 2A fuse to be replaced with higher value of 4A fuse of DIO cards in all locos fitted in M/s ABB make CDAC VCU vide RDSO Letter no. EL/11.5.5/21 dated 11.11.2022.
2. Damaged control cable in VCU or any converter of Eldra make to be replaced fitted in M/s BHEL make TCN VCU or converter vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
3. Phytex card to be replaced and SW version 1.26 or latest ver.to be updated in all ARC makes display fitted with M/s BHEL make propulsion locos vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
4. Modified software Ver. 50 or latest ver. for RBU card to be downloaded in all locos fitted with M/s BHEL make TCN VCU vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
5. 2A fuse to be replaced with 4A fuse in all DIO cards fitted in M/s CGL make CDAC VCU vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
6. MVB Coupler firmware Ver. 1.5 or latest ver.to be uploaded in all WAP7 locos and SW Ver.115C or latest ver.to be uploaded in all passenger locos as FLG and OFC redundancy have been achieved in this software version fitted with M/s CGL make CDAC VCU vide RDSO Letter no. EL/11.5.5/21 dated 25.08.2022.
7. Replacement of DIP & DOP Card coupler to be carried out with modified coupler with increased pin length fitted in M/s Medha make TCN VCU vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
8. Modified VCU software version 2.02 or latest ver.to be downloaded in all the locos fitted with M/s Medha make TCN VCU vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
9. Modified software versions 2.01 or latest ver.to be downloaded in all the locos fitted with M/s Siemens make TCN VCU vide RDSO Letter no. EL/11.5.5/21 dated 12.05.2023.
10. Churning fan to be provided in Driver Display Unit fitted with M/s Siemens make propulsion system vide RDSO Letter no. EL/11.5.5/21 dated 12.05.2023.

2.1.4 Hotel Load Converter

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Reliability Action Plan

1. Replacement of all old blower fan to be carried out with modified fans from M/s Southern Magnetics , M/s Eyyani and M/s Rosenberg make blower fans fitted in M/s BHEL make hotel load converter vide RDSO Letter no. EL/11.5.5/21 dated 22.04.2022.
2. Replacement of GDU card to be done with modified GDU card as failure prone MLCC capacitor in GD card has been replaced with electrolytic type capacitor fitted in M/s Medha make hotel load converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
3. Replacement of EMKP type Vishay make capacitors to be done with Vishay make ACMKP type or Electronicon make capacitors fitted in M/s Medha make hotel load converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
4. Modification to be carried out by providing additional protection coil locking clamp in output contactor fitted in M/s Medha make hotel load converter vide RDSO Letter no.

- EL/11.5.5/21 dated 31.03.2023.
5. Cleaning of suction filters to be done fitted in M/s Medha make hotel load converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
 6. Modification for provision of rain protection guard to be initiated in all HOG Locos fitted in M/s Medha make hotel load converter vide RDSO Letter no. EL/11.5.5/21 dated 31.03.2023.
 7. Display software Ver. UAT2Y4440.012 or latest ver.to be uploaded in all locos running in the field and display keys to be replaced in all old HOG supplied by M/s Siemens vide RDSO Letter no. EL/11.5.5/21 dated 12.05.2023.
 8. Replacement of faulty EPI make input choke to be carried out with M/s SALZER make input choke fitted in M/s Siemens make hotel load converter vide RDSO Letter no. EL/11.5.5/21 dated 12.05.2023.
 9. Replacement of fuse from 6.3A to increased rating of 15A for control electronics to be carried out in all locos fitted with M/s Siemens make hotel load converter vide RDSO Letter no. EL/11.5.5/21 dated 12.05.2023.
 10. Heat sink cleaning for one cycle in schedule maintenance at shed and cleaning of air filters and OFC and other connectors to be carried out continuously in M/s Siemens make hotel load converter vide RDSO Letter no. EL/11.5.5/21 dated 12.05.2023.
 11. M/s Siemens has provided filter cover to loco sheds for fitting upon filter in HLC during loco washing in sheds.
 12. HLC software ver. W812N04V.005 or latest ver.to be uploaded in all Siemens make HLCs for neutral section negotiation vide RDSO Letter no. EL/11.5.5/21 dated 12.05.2023.
 13. Specification for IV coupler RDSO/PE/SPEC/AC/0177 (Rev.01)-2013 has been revised vide RDSO Letter no. EL/3.7.108/ZS dated 29.11.2021. As per the revised specification, firms already started to supply SS type IV couplers as a part of accessories along with HLCs.
 14. Modification in existing hotel load scheme by removing irrelevant protections provided in WAP-7 locomotives. (RDSO/2018/EL/MS/0468 (Rev 0))
 15. Provision of Blocking Diode in HOG control circuit (in series of MCB 129.2/1) of HOG compliant WAP7&WAP5 three-phase electric locomotives as per modification sheet no. RDSO/2022/EL/MS/0488 (REV. '0') dated 22/07/2022.
 16. Provision of HOG indication lamp in driver desk for HOG ON Command from Power Car as per modification sheet no. RDSO/2022/EL/MS/0489 (Rev. '0') dated 26/07/2022.
 17. SMI for Operational, Maintenance and Troubleshooting of 2x500 kVA, IGBT based hotel load converter (SMI No. RDSO/2016/EL/SMI/0297, Rev. '0')
 18. Technical Circular for 'Trouble shooting of different make 2x500 kVA, IGBT based Hotel Load Converter of WAP-7 locomotives (TC No. RDSO/2017/EL/TC/0141, Rev. '0').

2.1.5 GTO based Traction converter

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Reliability Action Plan

1. Installation and implementation of testing set up of gate unit of Traction Converter for 3-Phase electric locomotives. (RDSO/2010/EL/SMI/0263 , Rev.'0' dtd.27.07.2010)
2. Replacement of ECSX make 24 MHz crystals by FOX make crystals in electronic cards of three phase electric locomotives (MS no. RDSO/2010/EL/MS/0391 (Rev.0), Dated

- 04.02.2011) PPA 988, PPB471 & PPB622.
3. Installation and implementation test set up for SAP cards and sensors (SMI 260).
4. Checking of Gate Unit cards by measuring dBm level of QFBR-1478C transmitter (component no.151). (RDSO/2009/EL/SMI/0257,dated 22.05.09)
5. Replacement of 1mW crystal of 24 MHz by Zauch make 0.5 mW in PPA988 cards and PPB622 cards (RDSO's letter no. EL/11.5.5/5 dtd. 13.04.12).
6. Testing of URB512 D15 (Digital I/O Board Computer) and URB177 D15 (Digital I/O Board Computer) used in VCU & SR (SMI no. RDSO/2013/EL/SMI/0277, Rv. 0 Dated 02.01.14).
7. Improved Grounding of ALG rack in Traction Converter of 3phase electric locomotives as per MS/365.
8. Checking of waveforms of gate unit of converter with the help of GUSET in case of valve set failure / false alarm of GBC as per SMI-263.
9. Checking of gate unit GK cable, optic fibre cable losses, downloading of software PPA 988 card in case of GTO failure.
10. Improvement of reliability of LWL cards (AFB635A01) and bus coupler cards (UFB 660 A01 & UFB 701A01) of three phase locomotives by testing QFBR 1478 C and 2478C transmitter & receivers as per SMI/258.
11. Checking of valve set GTO values in MOH with multi-meter and in IOH schedule with IC variable meter as per SMI-247.
12. Draining of traction converter oil in GTO based loco and filtration of oil to be done in TOH.
13. Calibration & Testing of Wandler module as per SMI 260.
14.
 - (i) **By PUs:** Earthing of screening of TM temperature sensors to avoid spurious message of "Error PS hardware" (MS-347)
 - (ii) **By Shed:** Earthing of temp sensor shielding with end-bell at both ends.
15. Repair and maintenance instructions of GTO valve sets as per RDSO Technical report No. RDSO/2016/EL/IR/0176(Rev'0'), Oct'2016.
16. No valve set should be kept without oil either in the locomotive or as a spare unit.
17. SR oil DGA, BDV checking in IA, IB, IC & major schedules as per SMI No.138, 158.

2.1.6 GTO Based Auxiliary converter

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Reliability Action Plan

1. Knife contactor (female) position on its base plate in WRE module (1, 2, 3 & 4) and (3, 4, 5 & 6) in GG modules to be ensured (RDSO RAP Rev'10 May'14).
2. Modification to address failures of Auxiliary converter cards. (MS no. RDSO/2010/EL/MS/0389 (Rev.0), Dated 22.11.2010).Vide RDSO's letter no. EL/11.5.5/5 dtd. 12.04.12 the MS is to be read as RDSO/2010/EL/MS/0393 (Rev.0)
3. Replacement of 1mW crystal of 24 MHz by Zauch make 0.5 mW in PPB 471 cards having intermittent message (RDSO's letter no. EL/11.5.5/5 dtd. 21.08.12).
4. Replacement of 1mW crystal of 24 MHz by Zauch make 0.5 mW in all PPB 471 cards having indigenized BAP ASIC during major schedule or whenever card is taken out (RDSO's letter no. EL/11.5.5/5 dtd. 26.03.13).
5. KUC153 card should be checked for leaky electrolytic capacitors after 5 years of operational life and capacitors should be replaced if found leaky. 100% replacement of electrolytic capacitor of BUR power supply card (KUC 153) after completion of 6 years operational life.
6. Tightness of the tap connection in the transformer of battery charger in Auxiliary Converter – 3 of GTO based locos in every IC schedule.
7. Interchanging of BUR2 GG and WRE modules with BUR1 and BUR3 to enhance life of

- modules during major schedule.
8. Provision of CG71 grease to male and female contacts to enhance life of contacts of WRE and GG modules of BURs.
 9. Repairing & testing of WRE module of BUR for 3-Phase electric locomotives as per RDSO/2009/EL/SMI/0261 Rev. 0 dated 15.12.09.
 10. Modification to address failures of DC link capacitors of 3x100 KVA, GTO based auxiliary converter as per RDSO MS-436 Dt. 11.07.14.
 11. Modification in Aux. converter of 3 Phase Electric locos to improve reliability as per RDSO MS No. 372.
 12. Pulse transformer has to be checked in the failed GG module.
 13. Checking of waveform of WRE gate card of Aux converter as per RDSO SMI No. 256 dt 19.05.09.
 14. Replacement of Knife contacts of BUR 2 GG module during IOH.

2.1.7 Sensors

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Reliability Action Plan

1. Pre-testing of speed sensor as per SMI-252.
2. Pre-testing of temperature sensors, pressure sensor, and current sensor and Wandler module on interconnected bus station as per SMI-260.
3. Pre-testing of Master Controller as per TC-134.
4. Ensure proper crimping of temperature measurement cable with temperature sensor resistance element cable inside Aluminium ferrule & its covering with heat shrinkable sleeve during TOH/IOH or change of temperature sensor.
5. Ensuring proper shielding of TFP/SR/TM temperature sensors cables at SR rack.
6. Interchangeability and Maintainability of Hall Effect Speed Sensors provided in IGBT based 3-phase electric locomotives as per TC No. RDSO/2018/EL/TC/0145 (Rev'0).

2.1.8 Electronic Cards, Central Electronics (MICAS)

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Reliability Action Plan

1. Checking the tightness of screws of electronic cards in every schedule.
2. Check the condition of DC-DC Converter in suspected PPA988 Processor cards.
3. Fibre optic cable tip to be dipped in Acetone to remove the dust which scatters the signal and may lead to communication failure. Alternatively a drop of acetone may be added on lens cleaning paper which may be gently rubbed on the connectors' end of OFCs.
4. Checking of temperature sensor (thermostat) for Control electronics during IC0 and Calibration during major schedule.
5. Ensuring availability of earth shunt connection for all concerned equipment.
6. Use of 8 Amps rating reed relay as per RDSO letter no. EL/11.5.5/5 dtd. 28.12.12.
7. Avoiding low pressure zone above hood ventilator as per MS-304.
8. Measurement of dB level of output of fibre optic transmitters as per SMI-257
9. Provision of Modified cooling radiators for SR as per RDSO letter no. EL/11.5.5/5 dtd. 15.02.10.
10. Rehabilitation of PCB cards as per RDSO guideline no. EL/G/2008/01, Rev. '4' dated June'2019 circulated vide letter no. EL/11.5.5/8 dated 21.06.2019 or latest guideline.
11. Availability of Loco Diagnostic System (LDS).
12. Dedicated computer system for storage of DDS and PCB database: All the sheds holding 3-Phase locomotives to have dedicated computers for the storage of DDS and PCB History with connectivity to Railnet.
13. Availability of setup of Interconnected Electronic Bus Stations as per TC/134.

14. Standardization of electronic labs infrastructure as per TC/135.
15. Implementation of TC/091 to ensure the proper handling and upkeepment of PCB cards.
16. Identification and replacement of PCB cards with the leaky capacitors.
17. Repeated failed card (3 or more than 3 times) to be removed from system and should be planned for repair/rehabilitation. Bad history card should not be put in service.

2.1.9 Software & other measures

SN	Reliability Action Plan
1.	Removal of interlocks of control ckt contactor no.126 from MCPA ckt. RDSO/2011/EL/MS/0399 Rev '0' dated 9.8.11.
2.	Blocking of leak holes in the machine room.
3.	Provision of the rehabilitated URB 512 cards on critical circuits to take advantage of the 2 NO interlocks on such cards.
4.	During re-downloading of the software, apart from *.hex code of the concerned processor *.chk/*.os file of concerned processor will also be downloaded in the card through LDS. Downloading only of application software may not be helpful.
5.	Replacement of EPROM in the processor cards of CEL, BUR and SR racks of three phase locomotives after 6 years of operational life as per ToT guidelines.
6.	Checking the working of the churning fan of electronic racks during every schedule inspection & unscheduled visit.
7.	Checking the working of DC-DC (48V) converter during every equipment temperature high case to ensure working of cooling fans.
8.	Checking of crystal in processor cards in case of life sign missing messages
9.	Modification in existing Control Electronics (CE) resetting scheme of 3-phase electric locomotives as per MS No. RDSO/2018/EL/MS/0475 (Rev 0).
10.	Modification to avoid Speedometer OFF & ON during running of train/locomotive due to VCU reset in three phase electric locomotives as per MS No. RDSO/2022/EL/MS/0490 (Rev. 0)
11.	Ensuring proper cleaning of heat sinks of VCU, SR and BUR in MOH/IOH.
12.	Checking of condition of churning fans in SR, BUR and VCU in every schedule.
13.	Provision of cab redundancy in WAG9/9H and WAP7 as per MS/0459, MS/0435 and vide CLW letter no. C-D&D/T/42 Date March 13, 2018.
14.	Dust removal from Machine Room by Industrial Vacuum Cleaner in each schedule.
15.	Measuring the capacitance values of BUR DC link capacitors to detect defective capacitors during major schedules.
16.	Setting of wheel diameter in the loco to avoid the wheel calibration error as per RDSO letter No. EL/11.5.5/1/IGBT dated 23.05.2017.

2.1.10 Flasher Light, Head light & Marker Lights

SN	Reliability Action Plan
1.	Modification in control circuit of Flasher light & Headlight of 3-phase electric locomotives.(RDSO/2008/EL/MS/0357 Rev 0 dated 20.02.08.
2.	Modification to be carried out to ensure the working of marker lights even if BL is in de-activated condition and Battery MCB (110) in off through battery supply for dead engine movement.(Disconnection of 2095 wire i.e. incoming feed to 310.7 MCB and provision of loop from 110 MCB (2021) to marker light MCB.(RDSO/2006/EL/MS/0344 Rev-0

dt.28.04.2006)

3. Modification to avoid simultaneous switching ON/OFF white and red marker light in 3-Phase locomotives. (RDSO/2012/EL/MS/0411 Rev.'0' dtd.5.6.12
4. Modification sheet for improving illumination of Head Light in Dimmer mode in 3-Phase electric locomotives (MS no. RDSO/2013/EL/MS/0425, (Rev. '0') dated 22.05.13)
5. Focusing of head light bulb.

2.1.11 Cab AC

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Reliability Action Plan

1. Ensure maintenance of CAB AC unit as per SMI No. RDSO/2016/EL/SMI/0293 Rev-0 dated 29.07.2016.
2. Modification for providing dummy plate in cab roof in place of Air Conditioning unit as per MS RDSO/2017/EL/MS/0461 (Rev 0).
3. Modification for providing cab AC unit in Electric Locomotives by Zonal Railways as per MS RDSO/2018/EL/MS/0469 (Rev 0).

2.1.12 Traction Motor

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Reliability Action Plan

1. Implementation of modification sheet no. RDSO/2017/EL/MS/466 (Rev 0) dated 15.11.2017 for modification in drawing of Outer bearing cap DE to achieve adequate lateral thrust in Traction motor (TM) assembly of 6FRA6068 TM in WAG9/WAP7 class of locomotives.
2. Use of Bore Gauge for measurement of internal diameters of End Shield/ Racer during bearing fitment in traction motors for Electric Locomotives as per SMI no. RDSO/2017/EL/SMI/0318 (Rev '0') Dated 16.10.2017.
3. Use of Dial Snap Gauges for measurement of shaft diameter of traction motor for Electric Locomotives as per SMI no. RDSO/2017/EL/SMI/0314 (Rev '0') Dated 29.9.2017.
4. Magnetic Particle Testing (MPT) of Traction motor (TM) nose stay in conventional locomotives, TM suspension holder support and motor support in WAG9/WAP7 locomotives and traction motor support arm in WAP5 locomotives as per SMI no. RDSO/2017/EL/SMI/0311 (Rev '0') Dated 25.8.2017.
5. Implementation of Modification sheet No. RDSO/2017/EL/MS/460 (Rev 0) dated 12.6.2017 for modification in drawing of bearing cap NDE to achieve adequate lateral thrust in Traction motor (TM) assembly of 6FRA6068 TM in WAG9/ WAP7 class of locomotives.
6. Implementation of SMI no. RDSO/2017/EL/SMI/0307 (Rev '0') Dated 5.6.2017 for periodicity and for re-greasing "full greasing in the traction motor type 6FRA6068 in alternate schedule (1st IB, 2nd IA, 2nd IC) to be done as per 40th MSG (Electric Loco) circulated vide RDSO's letter no. EL/2.1.8 dated 07.06.2023".
7. Measurement of dimensions of various assembly components and ensuring adequate interference as per Modification Sheet no. RDSO/2017/EL/MS/0415 Rev. '0' with amendment-1 dt.24.02.2013, amendment-2 dt. 18.05.2017 & amendment-3 dt.

- 02.07.2019 during replacement of TM bearings.
8. Use of Induction Heater for heating of Bearing seating area of Suspension tube instead of flame heating for fitment of MSU Bearings in WAG-9/WAP-7 locomotives as per SMI no. RDSO/2016/EL/SMI/ 0306 (Rev '0') Dated 17.04.2017.
 9. Implementation of Modification sheet No. RDSO/2017/EL/MS/ 0456 (Rev '0') dated 09.01.2017 for modification in drawing of supporting ring to achieve adequate 'C' Clearance in MSU assembly of 6FRA-6068 TM in WAG9/ WAP7 class of locomotives.
 10. Use of Induction Heater for heating of End Shields/End frames of traction motors for bearing fitment as per SMI no. RDSO/2016/EL/SMI/ 0301 (Rev '0') Dated 8.11.2016.
 11. Following the periodicity of overhauling of MSU of WAG9/WAG9H/WAP7 locomotives to prevent premature MSU failures as per SMI no. RDSO/2016/EL/SMI/ 0300 (Rev '0') Dated 2.11.2016.
 12. Maintenance of TM mounting arrangement for 6FRA6068 type traction motor as per SMI no. RDSO/2011/EL/SMI/269 Rev 1 dated 16.03.2016.
 13. Implementation of Modification sheet no. RDSO/2015/EL/MS/443 (Rev 0) dated 17.9.2015 for improving the reliability of Motor Support in Locomotives type WAP7/WAG9.
 14. Ensuring adequate radial clearance between resistance ring and end ring in Scheme-II design of rotors for traction motor type 6FRA6068 as per Modification sheet No. RDSO/2015/EL/MS/438 (Rev 0) dated 27.8.2015.
 15. Ensuring proper fitment of Traction motor bearings in 6FRA6068 TM following the procedure specified in SMI no. RDSO/2013/EL/SMI/0278 (Rev. '0') dated 24.12.2013 and it's Amendment-1 dt. 08.03.2021 and Amendment-2 dt. 29.03.2022. Colour matching, measurement of dimensions of matching components, use of modified ring gauge and plug gauge, measurement of pinion travel etc. to be done as per SMI.
 16. Implementation of SMI no. RDSO/2011/EL/SMI/ 0273 (Rev '0') Dated 23.12.2011 for detection of rotation of outer racer of bearing and assembly components by checking metal content in grease sample 3 Phase traction motors type 6FRA6068 and 6FXA7059.
 17. Implementation of SMI no. RDSO/2011/EL/SMI/ 0272 (Rev '0') Dated 2.12.2011 for use of extreme pressure lubricant paste for shafting of rotors of traction motors type 6FRA6068 and 6FXA7059 to prevent damage to stampings and scoring of shafts at the time of removal of shaft
 18. Ensuring availability of Grease outlet channel at NDE side of TM type 6FRA 6068 used in WAG-9 and WAP-7 locomotives as per Modification Sheet No. RDSO/2010/EL/MS/0387 dated 7.7.10
 19. Implementation of Technical circular no. RDSO/2010/EL/TC/104 (Rev. 0) dated 16.7.2010 for storage & handling of lubricant/greases used in Electric locomotives. All barrels must be stored, preferably indoors; away from extreme heat/cold, dust, acidic fumes and moist atmospheric conditions. Lubricating oil barrels should be stored horizontally preferably on wooden rails dunnage to avoid contact with ground. The barrel bungs should be in the clock position at 3 & 9. Grease barrels must be stored vertically preferably covered with tarpaulin, if not stored indoors.
 20. Detection of rotor bar crack & stator defect for traction motor type 6FRA6068 used on WAG9 / WAP7 locomotives as per SMI no. RDSO/2010/EL/SMI/262 (Rev 10) dated 10.06.2010 by measurement of inductance.

21. Implementation of Modification Sheet No. ELRS/MS/0355 Rev2 dated 18.11.2010 for provision of double support at connection end and single support at non connection end of winding overhang.
22. Ensuring availability of proper size of TM cables in WAP-5 locos as per Modification Sheet No. RDSO/2008/EL/MS/0370 dated 26.11.08.
23. Ensuring Modification in fixing arrangement of temperature sensor in TM type 6FRA6068 as per Modification Sheet No. RDSO/2007/EL/MS/350 Rev'0' dated 1.11.2007 to enable replacement of temperature sensor without lifting of locomotive.
24. Modification of Drive End - Outer Labyrinth of WAG9/WAP7 Traction Motor type 6FRA 6068 as per Modification Sheet No. ELRS/MS/314 dated 12.7.2002.
25. Condition monitoring of bearings by SPM Meter as per SMI no. RDSO/EL-RS/SMI/58 of July 1979.
26. To follow the prescribed replacement schedule for traction motor bearings. 3-phase traction motor bearing is must change item during IOH & POH.
27. Carrying out Growler test of rotor bars during overhauling to detect rotor bar cracks.
28. Bearings should be handled with protective industrial gloves. Lint free cloth should be used for cleaning purpose.
29. Use of induction heaters equipped with essential features like temperature display, temperature hold, auto cut off & de-magnetization. Induction heating should always be done in temperature mode as same/similar components of different manufactures may have different properties. Temperature setting should not be more than 120°C for bearing assembly components.
30. Storage of TM/MSU bearings in horizontal condition, away from wall/floor in a stack of not more than 5 bearings and following First-In-First-Out (FIFO) system for storage.
31. Ensuring 24 X 7 working of air conditioners provided in air conditioned storage wards. Temperature and humidity indicators to be provided at the far end of AC Storage ward.
32. Use of prescribed torque wrench for tightening of bolts etc.
33. Use of Cleaning agent Xylol-CHR (Chemically pure) cleaning agent as prescribed in ABB manual (Volume D-2 Maintenance and Repair manual – Indent No. 3EHW 411433 Page 7/60).
34. Area for blowing and cleaning activities should be separate from TM assembly area.
35. Use of Assembly components in kit form vide RDSO's letter No. EL/3.2.182 dated 31.07.2007.
36. Application of sealant in the terminal box of traction motor to avoid ingress of dust
37. RDSO/2012/EL/MS/0485(Rev0)dated 17.03.2022 for Issue of Modification Sheet for increasing grease outlet hole on End Frame DE side from 9 mm to 12 mm in Traction motor type 6FRA6068
38. RDSO/2012/EL/MS/0478(Rev0)dated 30.07.2019 for Adoption of Traction motor labyrinths of TM type 6FRA6068 as per original dimensions given by ABB to eliminate problem of gear case oil ingress in TM
39. Implementation of Modification Sheet no. RDSO/2019 /EL /MS/0476 (Rev0) dated 22.01.2019 for Modification in Mounting arrangement of Leather Bellows of Traction Motors type 6FRA6068
40. Use of Portable oil dust checker (Metal content checker) for condition monitoring of Gear case oil to detect defects in bull gear, pinion and Motor Suspension Unit (MSU) in WAP7/ WAG9/ WAG9H class of locomotives as per SMI No. RDSO/2018/EL/SMI/0324 (Rev. '0') dated 24.08.2018

41. Procedure of measurement of axial clearance and limit of axial clearance for Traction motor type 6FRA6068 used in WAG-9/WAG-9H/WAP-7 class of locomotives as per SMI No. RDSO/2018/EL/SMI/0323 (Rev. '0') dated 20.08.2018
42. Use of grease gun equipped with digital grease meter for greasing of rollers bearings of Traction motor and MSU bearings of electric locomotives as per SMI No. RDSO/2018/EL/SMI/0322 (Rev. '0') dated 27.04.2018
43. Improving reliability of Armature shafts of Traction motor by not building Armature shaft by welding for conventional as well as three phase locomotives as per SMI No. RDSO/2018/EL/SMI/0321 (Rev. '0') dated 28.03.2018
44. RDSO/2012/EL/MS/0423(Rev0) dated 21.02.2013 for Use of 5 mm solid end plates in place of existing 5 x 1 mm thick spot welded laminated end plates assemblies in stators & rotors of TM type 6FRA6068.
45. RDSO/2012/EL/MS/0422(Rev0) dated 21.02.2013 for Use of 5 mm solid end plates in place of existing 5 x 1 mm thick spot welded laminated end plates assemblies in stators & rotors of TM type 6FXA 7059
46. Condition monitoring of TM & Auxiliary motors bearings through SPM as per Special Maintenance Instructions no RDSO/EL-RS/SMI/58 of July 1979
47. Must Change Items in WAP5/WAP7/WAG9 Locomotives, issued vide RDSO's letter no. EL/3.1.28 (DML) dated 13.01.2023.
48. Technical circular on Year of manufacturing codification on traction motor & MSU Bearings used in Electric Locomotives as per TC No. RDSO/2012/EL/TC/0117 dated 28.09.2018.
49. Instruction for improving the reliability of motor supports in bogie of WAP7/WAG/9 locomotives as per Technical circular no. RDSO/2015/EL/TC/0130 Rev. '0' dated 29.05.2015
50. Status of approved Lubricants used on WAP5/WAP7/WAG9 Locomotives as per Technical Circular no. RDSO/2006/EL/TC/0034 dated 21.07.2008 with it's all amendments.
51. Follow compendium of instructions on Traction motor, MSU and Axle box bearings given document no. RDSO/2016/EL/PUB/0003 of December 2016.

2.1.13 Control Circuit Cables

SN

Reliability Action Plan

1. Cleaning of male and female contacts of blocking diode during every inspection schedule.
2. Replacement of unapproved make of Fast-ON lugs used in paralleling of auxiliary intact locks of EPCs in the past.
3. Re-routing of cables with Fast-ON lugs to avoid tension in the connection.
4. During testing, the working of non-tripping VCB after tripping the MCB112 is being ensured.
5. Provision of insulating paper between electrical connections and cover of VCD paddle switch.
6. Provision of HRC fuse in PT circuit of SB-2 panel.

2.1.14 HT/LT Cables/Contactors/Relays

SN

Reliability Action Plan

1. Replacement of 10mm² cable of OCB with 16mm².
2. Replacement of 120mm² cable of traction motor in WAP5 loco with 150mm² cable.
3. Measurement of cable continuity for all four earthing brushes during every schedule.

4. Paralleling of interlocks of EP contactors and relays to improve the reliability of three phase locos (RDSO/2010/EL/MS/0390 Rev.0)
5. Modification in loco ckt for multiple unit operation for microprocessor based control and fault diagnostic system of 25 KV AC electric locos. RDSO/2010/EL/MS/0386 Rev '0' dated 18.01.10.
6. Modification sheet for shifting the termination of 4GKW, 1.8kv, 70 Sq.mm. RDSO/2011/EL/MS/0400 Rev '0' dated 10.8.11
7. PT fuse modification as per RDSO/2009/EL/MS/0377 Rev '0' dated 22.04.09.
8. Modification sheet for shifting the termination of 4GKW, 1.8 kV, 70mm² cables and 2X2.5mm² cables housed in lower portion of HB2 panel and provision of SRBGF sheet (RDSO/2011/EL/MS/0400 Rev'0' dtd.10.8.11.)
9. Standardization of power selection switch position in flasher units provided in three phase electric locomotives. (RDSO/2012/EL/MS/0407 Rev.'0' dtd.29.02.2012)
10. Modification in blocking diode fixing arrangement as per MS-467 and one time checking of blocking diode pins. Checking of blocking diode for any slackness/looseness during every TOH.
11. Removal of shorting link provided at c-d terminal of over current relay (MS no. RDSO/2014/EL/MS/0432 rev. 0 dated 12.03.2014)
12. Modification for relocation of each fault relays for Harmonic filter and Hotel load along with its registers (MS no. RDSO/2014/EL/MS/0428 Rev. 0 dated 10.12.2013)
13. Maintenance of earthing system as per SMI/248.
14. Auto switching of machine room / corridor lights to avoid draining of batteries in 3-phase electric locomotives (MS no. RDSO/2011/EL/MS/0403 Rev'0' dtd. 30.11.11).
15. SMI for measurement of Millivolt drop of contactor no.218 & 126.SMI no. RDSO/2012/EL/SMI/0275 Rev'0' dtd 22.03.12.
16. Paralleling of auxiliary interlock of Filter Contactor 8.41 and Auxiliary contactors (RDSO/2012/EL/MS/0413 Rev'0'dated 28.09.12)
17. Modification to provide rubber sealing gasket in master controller of 3-phase locos. (MS no. RDSO/2012/EL/MS/0419 Rev.0 dated 20.12.12.
18. Modification Sheet to provide mechanical locking arrangement in Primary Over Current relay. MS. No. RDSO/2013/EL/MS/0420, Rev.'0' dated 23.01.13.

2.1.15 Auxiliary Motors

SN	Reliability Action Plan
1.	Replace MS impeller with Aluminum impeller. (Ref. CLW's letter no ELDD/3743/CRH dated 08/05/09. For OCB).
2.	To provide water discharge outlet in TM Scavenge Blower on WAG9, WAP5 & WAP7 class of locomotives.(Ref ELRS/MS/0328 Rev.'0' dtd 29.10.03. For SCTM).
3.	Rewinding of all Aux. motors by Corona resistant wire (Ref. Amendment no.06 to Spec no. E-10/3/09 (Motor)-Aug1997 issued vide EL/3.2.176/1 dated 22.12.2021.)
4.	All new motors procurement for indigenous sources must be with corona resistant wire only. (Ref. Amendment no.06 to Spec no. E-10/3/09 (Motor)-Aug1997 issued vide EL/3.2.176/1 dated 22.12.2021.)
5.	Measurement of current & bearing sound of machines during schedule inspection.
6.	RDPT of OCB impeller in 3-phase locomotives during TOH Schedule.

7. Interchangeability for Motor, Impeller and Casing with other make was included in the RDSO specification no. RDSO/2016/EL/SPEC/0123, (Rev.0) to ensure flexibility & ease of maintenance. The dimensions of OCB are to be followed to ensure interchangeability purpose.
8. Impellers of OCB Unit must be dynamically balanced when it is interchangeable with other makes

2.1.16 Transformer LOT 6500/7500kVA

SN

Reliability Action Plan

1. Shifting of conservator from OCB dome to an independent stand provided adjacent to OCB dome in 3-Ph drive locomotives as per RDSO Modification Sheet No RDSO/2008/EL/MS/0360, Rev 1 , Jan,2011.
2. Replacement of phosphor bronze washers with spring steel conical M-30 Belleville washers in core coil clamping tie rod in 2019 series of BHEL make transformer as per RDSO's letter no. EL/3.2.1/3-Phase dated 27.12.12.
3. Implementation of Minutes of Meeting (MOM) dated 11.06.2014 circulated vide letter no. EL/3.2.1/3-Phase dated 27.06.2014 for preventing circulating current in transformer.
4. All the OEMs are advised to share the DGA report of newly supplied /Repaired/Rehabilitated transformer so that same report shall be treated as reference by Pus/Sheds for interpretation of subsequent DGA.
5. All the OEMs are advised to start pre-dispatch inspection of transformer tank at their works to arrest the tank problem i.e mounting issue and shall be made part of routine inspection i.e 100% tanks to be inspected.

2.1.17 VCB

SN

Reliability Action Plan

1. Up-gradation/conversion/modification of single bottle VCB type BVAC 25.10 of M/s AAL. Railway Board's letter No. 2007/Elect./ (TRS)/441/10 dt.06.02.08.
2. Replacement of metallic corrugated steel pipe/outside steel braided flexible pipe by flexible reinforced rubber pipe connected in between VCB and Air drier and main air pipe line to Air drier. (ELRS/MS/0340(Rev.'0') dt. 29.06.05).
3. Modification in BT make VCBs supplied after Dec, 2007. RDSO's letter No. EL/3.2.61/BT dt. 30.07.2009.
4. "Up-gradation/modification of single bottle VCBs type 0BVAC 25.10(old version) and BVAC 25.10 MO7 (old) of M/s BTIL to BVAC 25.10 MO7 (New) as per Railway Board's letter no. 2007/Elect (TRS)/441/10 dtd. 3.5.10.
5. Implementation of modification No. RDSO/2006/EL/MS/0345, Rev'0' dt. 08.05.06 for interchangeability of VCBs between 3-phsae locos & conventional locos.
6. Development of maintenance infrastructure in sheds/workshops (Letter No. EL/3.2.61 dated 24.02.12)
7. Replacement of defective auxiliary switches and suspected CMDEs (with 12 terminals) by corrected auxiliary switches and modified CMDEs (with 14 terminals) (Letter No. EL/3.2.61/BT dated 30.12.11)
8. Provision of Air dryer in pneumatic circuit of VCB of 3-phase locomotives to arrest moisture ingress in VCB by amendment of specification of VCB and air dryer has been reintroduced in the scope of supply of VCB in the spec no CLW/ES/C-47 with Alt-I, issued on 09.09.2021.

9. Provision of Bellow (Nitrile Rubber) by M/s SEIL free of cost on their own in VCBs being serviced by their engineers on account of any fault to arrest ingress of moisture. New supplies of VCB will have provision of bellow.
10. The openings on base plate (holes/louvers) to be removed by application of RTV sealant 1080. New supplies of VCBs to be without louvers.
11. Groove size of 'O' ring reduced from 5mm to 4mm in new supplies with 6.99mm 'O' ring and for existing groove size i.e. 5mm, increased size 'O' ring of 7.5 mm is recommended in order to have a better compression leading to leak proof arrangement which will be provided by M/s SEIL free of cost as per demand from ZRs.
12. To perform insulation resistance check before onset of rainy season in addition to the scheduled maintenance to avoid any out of warranty VCB flashover (criteria is > 200 Mega ohm) for healthy operation in-situ position of VCB between outgoing terminal & earth point on the base plate.
13. If weight of air-dryer increases by 0.8 kg then the molecular sieves/ desiccants of the air dryer to be regenerated as per the method suggested in SMI no. RDSO/ELRS/SMI-137.
14. The updated VCU software shall be uploaded to address the problem of VCB Stuck in 'ON' & 'OFF' position in line with CLW letter no. C-D&D/T/21 dated 21.01.2022 & advised to use software 0202/0203 in all locomotive equipped with Micas VCU and advised propulsion manufacturer to modify their VCU software to address the aforesaid issues.
M/s MEDHA updated their VCU software to address the issue of VCB STUCK ON /OFF problem.

2.1.18 Gapless Lightning Arrester (GLA)

SN Reliability Action Plan

1. The insulation resistance to be measured with the help of 5.0 kV Megger. IR value of lightning arresters should be measured during annual maintenance and it should be above 1.0 G ohms.
2. LAs with third harmonic resistive leakage currents in between 350-500 μ A should be closely monitored and beyond 500 μ A should not be permitted & should be removed from service.

2.2 Pneumatic Equipments & Brake Systems

2.2.1 Air Dryer

SN Reliability Action Plan

1. Provision of 3 A MCB (128.1) in Air Dryer circuit of three phase locos as per modification sheet no. RDSO/2009/EL/MS/0375 Rev '1' dated 28.09.12 to be followed.
2. Replacement of existing PCBs of air dryer to modified (opto coupler) PCBs in M/s FTIL make air dryer to avoid failure as per RDSO letter no SD.DFM.A 4.7.1.3 dated 13.02.09
3. Procedure to be followed for Dew point Depression temperature measurement of compressed air passing through heat less regenerative twin tower type air dryer is

being used in electric locomotives as per TC139.

2.2.2 Compressor

SN	Reliability Action Plan
1.	Use of Stainless Steel drain plug (After cooler & Inter cooler) in place of brass drain plug in ELGI compressor issued vide letter no. EL/3.2.15/3-Phase dated 02.05.2022.
2.	Use of re-modified rear fan guard in regular production of compressor model RR20100 CG (M) of M/s ELGI in 3-Phase loco advised vide letter no. EL/3.2.15/3-Phase dated 27.11.2019.
3.	TOH Overhauling kit for Compressor model RR20100CG(M) as per RDSO's letter No. EL/3.2.15/3-Phase dt. 21.04.2016
4.	Maintenance Practices of Under slung Compressor mounted on WAP-5, WAP-7 & WAG-9 class of Electric Locomotive to avoid falling down of the compressor unit on line. Standardization of safety sling arrangement of under slung compressor mounted on WAP-5, WAP-7 & WAG-9 class of Electric Locomotive as per RDSO SMI No. RDSO/2006/EL/SMI/0242 Rev. '3' dated 02.02.2023.
5.	Changing of CP delivery pipe in ELGI make compressor type RR20100 by Rubber hose SAE-100 –R 1 pipe as per letter no. EL/3.2.15/3-phase dated 01.04.2019.
6.	Standardization of scheduled maintenance practices for 1750 lpm capacity lubricated reciprocating compressors for Electric Locomotives. SMI NO. RDSO/2016/EL/SMI/0296 Rev.'0' Dated 02.09.2016.
7.	Provision of clamp with rubber on copper pipe from HP head to after cooler in compressor model RR20100 M under slung mounting in 3-phase electric locomotives by M/s ELGI. (Vide RDSO's letter no. EL/3.2.15/3-phase dated 19.06.2015.
8.	Replacement of mounting bracket on compressor side of air compressor model RR20100 CG (M) by M/s ELGI in under slung. (Vide RDSO's letter no. EL/3.2.15/3-Phase dated 11.08.2014)
9.	Modification for MCP control circuit as per MS no. RDSO/2014/EL/MS/0427 Rev. 0 dated 23.10.2013.
10.	Changing the orientation of suction filter in ELGI compressor wherever applicable in old design compressor. (RDSO/ ELRS / MS/0352 dtd 07.01.08).

2.2.3 Brake System E-70 (FTRTIL)

SN	Reliability Action Plan
1.	Provision of System Operated Auto Emergency Braking (SOAEB) as per RDSO letter no. EL/3.2.19/3- phase dated 19.04.2022.
2.	Provision of imported potentiometer in place of Pankaj make potentiometer in DBC (A9) to be followed
3.	Replacement of Teflon nut on isolator assembly on C3W manifold.
4.	Changing of the stem of restricting valve assembly of E-70 control unit.
5.	Imported sleeve/ Imported EP-Valve to be provided in all EP valve of E-70 brake system.
6.	Replacement of Metal seated NRV by PU seated NRV provided after compressor (Ref- RDSO's letter no EL/3.2.19/3-Phase dated 11.09.2012).
7.	Replacement of existing PRVs of polycarbonate body by high flow pressure limiting valve of metallic body in E-70 brake system during IOH & POH or whenever defective PRV is to be replaced. (Ref. RDSO letter no. EL/3.2.19/3- Phase dated 14.06.13.

8. Replacement of defective plunger of Driver's Brake valve in M/s FTIL make. Rehabilitation of those E-70 tri-plate panels which have completed 9 years and not have been rehabilitated during POH of the locomotive.

2.2.4 CCB (Knorr)

SN

Reliability Action Plan

1. Implementation of modified software of CCB in all 3-phase locomotives as per RDSO letter no. EL/3.2.19/3-Phase/CCB dated 14.06.2022.
2. Provision of shim(s) between CCB panel (WAP-5) and its frame if required to avoid high BC in TRAIL mode of EBV as per RDSO letter no. EL/3.2.19/3-Phase/CCB dated 07.02.2022.
3. Provision of Terminal cover (Acrylic sheet) in wiring junction box to avoid infringement of cable with TM Blower screw as per RDSO letter dated 25.03.2019 & 09.04.2019.
4. Provision of change pneumatic supply for ULV, TC1&2 and FC Cock in CCB panel as per RDSO letter no. EL/3.2.19/3-Phase/CCB(1) dated 20.02.2020.
5. Provision of moisture drains arrangement of auxiliary reservoir using Cu pipe and drain-cock from Brake panel (Old) shall be carried out as per RDSO letter no. EL/3.2.19/-Phase dated 10.10.2017.
6. One cycle replacement of Lead-trail function selector switch in all locomotives having CCB version 1.5.
7. Provision of BP feedback during banking operation has been done through ZBAN switch in all units.
8. Modification to protect water entry in EBV (A-9) (to be done with the help of M/s KBIL).
9. Software modification to remove interlock of parking brake with BP reduction/ charging.
10. Installation of upgraded software in WAG9 locos with existing choke and in WAP7 with choke size 6.5 mm to reduce the brake application time through SA9. (RDSO letter no. EL/3.2.19/3-phase/CCB dated 20.06.2017)
11. Installation of upgraded software in WAP5 to reduce booting time from 40- 60sec to 20 seconds.
12. BPCP strainer provision to be done and cleaning of strainer to be ensured during every schedule.
13. Provision of new type Unloader valves of KBIL to be ensured.

2.2.5 E-70 Brake Electronics

SN

Reliability Action Plan

1. Refurbishment/rehabilitation of Electronic cards (PCB) of E70 brake system as per Technical Circular no.148 issued on 23.03.2018.
2. Provision of spacer and insulation strip in indigenous cards/electronic rack respectively to ensure interchangeability as per RDSO Report No. RDSO/2013/EL/IR/0159 (Rev'0') Jan' 2013, Annexure-12.
3. Change of Regulator L7805 with LM140 in VCD card.
4. Change of EC make electrolytic capacitors by Kemmet make in LPO card.
5. Change of EC make electrolytic capacitors by Kemmet make in Controller card.
6. Testing of electronic card on Test Rig as per SMI-298.

2.2.6 Brake System (E-70/CCB) & Pneumatics

SN	Reliability Action Plan
1.	Relocation of RS emergency valve handle for ease operation of ALP as per RDSO Modification Sheet no. 491 dated 27.03.2023 and subsequent letters no EL/3.2.19/3-Phase/Part-1 dated 05.04.2023 & 12.05.2023.
2.	Use of 1-1/4" cut off cock (BP/FP angle cock) with 3-part design as per RDSO letter no. EL/3.2.19/3- Phase dated 24.05.2023.
3.	Replacement of metallic Diaphragm of horn by Hylum sheet as per MOM 08.10.2020.
4.	Setting & locking of pressure switch make m/s Eaton shall be carried out as per SMI-327.
5.	MS-412 with Amendment-1 shall be followed for relocation of unloader valve cock for ease of Operation.
6.	Pneumatic tube connection at various locations in locomotives shall be done using double ferrule fitting as per SMI-313.
7.	Standard maintenance activities to be followed as per SMI-298.
8.	Setting of MR pressure switch is being ensured to cut-in at 8.5 kg/cm ² and cut out at 8.0 kg/cm ² and cut out at 10.0 kg/cm ² as per TC-113.
9.	Replacement of Metal seated NRV by Teflon seated NRV in compressor.
10.	Overhauling of un-loader & NRV in every IC schedule.
11.	Troubleshooting instructions for the loco pilots to be pasted in cabs of locos equipped with CCB system.
12.	Replacement of AFI gauge glass with 12mm thick polycarbonate.
13.	Blowing of BP/FP pipelines by opening angle cocks on either ends after building complete pressure once in every schedule as per MS-0465.
14.	Overhauling of A9 in 3-phase locos during TOH/IOH/POH as per SMI-298.
15.	Replacement of old PVC pipe in the pneumatic gauges in those 3 –phase locos which have completed more than 6 years in service.
16.	Provision of Trap Chamber for collecting coal/dust particles coming from BP Train Pipe during emergency brake application as per MS 0465.
17.	SMI-313 to be followed for pneumatic tube connection to electro pneumatic contactor of harmonic filter/hotel load convertor of 3-phase locos.
18.	To address the issue of S/R interlock loco brake, the BC pressure switch (IBSPS & both BC-PS) setting lower limit existing 0.2±0.1kg/cm ² to 0.30kg/cm ² to be ensured. Now the standard setting will be from 0.30 kg/cm ² to 0.65kg/cm ² as per RDSO letter no EL/3.2.19/3-phase dated 17-12-2017.
19.	Provision of isolating cock for unloader valves (12) in E-70 brake system as per RDSO's Modification Sheet No. RDSO/2012/EL/MS/0412 Rev. '0' dated 22.08.2012.

2.3 Mechanical Equipments

2.3.1 Traction link, housing and Elastic Ring

SN	Reliability Action Plan
1.	Provision of modified traction link flange & mounting bolts in WAG-9 & WAP-7 3-Phase loco. RDSO/2006/EL/SMI/241 dated 24.10.06 & RDSO/2009/EL/SMI/0259 dated 09.12.09.
2.	DPT of traction bar in every schedule.
3.	Ensure Intactness and tightness of traction bar flange fixing bolts during all

- schedules. Ensure availability of safety slings at either ends of the traction link and also additional safety sling.
4. Provision of additional safety sling as per RDSO/2023/EL/MS/0493 rev.0.
 5. 2.0 mm or more shim plate to be provided as per requirement in between pivot head and the retaining plate of alcathan ring to avoid breakage of retaining plate fixing bolts.
 6. Check for any cracks by way of RDPT/MPT on Housing flanges & Push pull rod flanges
 7. Check the Elastic 'V' ring for any bulging and shifting down.
 8. Replace Traction link flange bolts during every Major schedule along with steel lock nuts. And tighten to the torque of 273NM
 9. Replace all inner & outer retaining ring fixing bolts M12x35 mm with new and 8.8 Property Class. Replace all locking plates fixing bolts & tighten the bolts to the torque of 80 NM
 10. Replacement of Elastic ring of three phase locos in every IOH schedule as per RDSO letter no. EL/3.1.28 (DML) Dated 13.01.23.
 11. Fitment procedure/Replacement schedule of Elastic ring as per RDSO SMI no. RDSO/2017/EL/SMI/316 Rev '0'

2.3.2 Bogie

SN

Reliability Action Plan

1. Zonal Railways/PUs have been advised vide letter no. EL/3.1.35/2 (3-phase) dated 31.3.11 that in WAP-7 locomotives only imported hydraulic dampers should be used. For WAG-9 locomotives indigenous/imported dampers will continue to be used.
2. RDSO letter No. EL/3.1.35/2 (Brake Liver) dated 05.07.2018 issued for conversion of brake rigging in WAG-9/9H locomotives as per MS 381.
3. Fitment of Tie-Bars in WAP7 locomotives (Letter No. EL/3.1.35/2 (3-phase) dated 10.01.12 & 24.08.2023)
4. Modification in brake hanger mounting bracket (Holder & Support) of WAP7/WAG9 locomotive (RDSO/2011/EL/MS/0396 Rev'0' dated 17.10.11)
5. Use of all FS locknuts (Report RDSO/2011/EL/IR/0150 Rev'0' of Aug'12)
6. Ensure availability of safety slings for traction bar, traction motors, brake hanger, TBU & PBU and Tie bars.
7. Check the bogie frame visually for any cracks particularly at under mentioned locations during all schedules and by way of doing RDPT/MPT test during all schedules.
 - At Traction Link pivot post welding portion on both body side & bogie side. On bogie side frame welding portion also to be tested.
 - At axle guide fixing post.
 - All brake hanger fixing brackets.
 - Damper fixing Brackets welding portion.
 - Torque arm supporting brackets MPT to be done.
8. Implementation of Modification sheet no. RDSO/2015/EL/MS/443 (Rev 0) dated 17.9.2015 for improving the reliability of Motor Support in Locomotives type

- WAP7/WAG9.
9. Check for any cracks on TM supporting brackets & at curvatures portion by way of doing MPT till the modification is completed.
 10. Check for any cracks on TM supporting brackets & at curvatures portion by way of doing RDPT/MPT.
 11. Ensure maintenance of brake hangers for WAG9/WAG9H locomotives as per RDSO SMI No. 251 Rev. 2 or latest.
 12. In WAP7 locos, Provision of Head type pins in place of Headless pins on hanger no 5, 6, 19 & 20. and provision of É' type clamps for Brake hangers top mounting pins head locking arrangement. All are Head type pin provided.
 13. Closely observing the spheri-block for any cracks in every schedule. Axle guide sphere-blocks to be replaced if rubber crack is more than 270 degrees. Torque arm sphere-blocks to be replaced if rubber crack is more than 180 degrees. Replacement of spheriblocs in TOH/IOH/POH as per RDSO letter no. EL/3.1.28/ (DML) dated 13.01.2023.
 14. Proper testing of primary and secondary helical springs as recommended by OEM during IOH. Grouping of springs on the basis of loaded height and giving colour codes.
 15. Provision of happy pads on top & bottom of Secondary Helical Spring. No happy pad being provided in 3 ph loco.
 16. To avoid PHS breakages in WAG 9 locos, Provision and ensuring of 6mm thick liners under end Axle Box Primary Helical Springs and 2mm thick liners under middle Axle Box Primary Helical Springs.
 17. Technical Circular for repair of crack in welding of plate (Drg. No. 1209-01-312-145) of Pivot Transom sub assembly of bogie frames for WAP7/WAG9 locomotives as per RDSO/2018/EL/TC/0149 Rev 0 dated 27.08.2018.
 18. Special Maintenance Instruction for Axial Wear of serviceable Spheriblocs used in WAP5/WAP7/WAG9 Locomotives as per RDSO/2011/EL/SMI/0270 (Rev '0') dated 17.11.2011.
 19. Special Maintenance Instruction to prevent failing of brake hanger in middle axles of WAP-7 Locomotives as per RDSO/2015/EL/SMI/0282(Rev.0) dated 16.09.2014.
 20. Special maintenance instruction for Mounting/dismounting of spheriblocs on components used in three phase Electric Locomotives as per RDSO/2021/EL/SMI/330(Rev 0) 07.07.2022.
 21. Modification from conventional hand brake to modified hand brake (Gear type) arrangement for WAP-4, WAG-7, WAP-7 and WAG-5 electric locomotive application as per RDSO/2014/EL/MS/0440/Rev'1' dated 16.9.2015.
 22. Modification to brake lever for WAG9/9H Electric locomotives to improve reliability and ensure interchangeability as per MS RDSO/2016/EL/MS/0455(Rev.0) dated 22.12.16.
 23. Modification in vertical damper fixing Arrangement of WAP-7/WAG-9 locomotives as per MS RDSO/2021/EL/MS/0483 (Rev 0) dated 25.8.21.
 24. Modification in underslung compressor mounting legs at Electric Locomotives as per RDSO/2022/EL/MS/0484 (Rev 0) dated 24.01.2022.
 25. Maintenance instructions to prevent crack/ breakage of TM mounting bogie nose in WAP7/WAG9 locomotives as per RDSO/2014/EL/SMI/0280 Rev.0 dated

05.05.2014.

26. Modification to avoid dropping of slack adjuster assembly (bottom) in case of breakage of its split pin in WAP7/WAG9HC type of three phase Electric Locomotives to MS No. RDSO/2015/EL/MS/0441 Rev. 1 date: 31.10.2018.

2.3.3 MSU

SN

Reliability Action Plan

1. Ensuring of lateral play of MSU with in 1.0mm.
2. Checking of temperature of MSU's bearings during all trip schedules, minor and major schedules and ensuring temperature rise below 25°C above ambient temp.
3. Testing of grease samples of MSU's bearings at NDE side by Re-greasing of NDE side MSU bearing till grease comes out from outlet.

2.3.4 Wheel set (Wheel, Axle, Axle Box, Axle Box bearing)

SN

Reliability Action Plan

1. Greasing of axle box bearing in WAP7/WAG9 locos by removing loose lip instead of grease nipple as per RDSO SMI 246.
2. Ensure quantity and schedule of greasing of axle box bearing for WAP7/WAG9/WAG9H locos as per RDSO SMI No. 246 and grease samples to be checked for metal content.
3. Checking of axle box rear ring for any loose/ breakage of bolts during every IC/MOH schedules.
4. Measurement of radial clearance during major schedules or during Axle Box changing.
5. To detect the inner racer crack UST to be done in mounted position
6. Ensure intactness of earth brush assembly on axle boxes 1, 6, 7&12 and ensure healthiness of three nos. Carbon brushes and its proper spring pressure on each axle box with earthing assembly during MOH/IOH. Replacement of springs on condition basis during IOH.
7. Procedure of pressing-in of wheels on axles in Electric Locomotives as per TC RDSO/2015/EL/TC/0132, Rev '0' dated 05.10.2015.
8. Provision of washer in tie rod to avoid overriding of brake block on flange. (Letter No. EL/3.1.35/2 (3-phase) dated 24.08.2023)
9. Ensure close monitoring of wheel flange wear. (Ref. RDSO letter No. EL/3.2.108(wheel) dated 28.07.23)
10. One round checking of all wheels for any sharp edges or dent mark.
11. Checking of various measurement of bogie frames of WAP7 locos like trammelling of bogie frame, alignment of hole centre of H section of axle guide post etc. during lifting or in major schedules. (Ref. RDSO letter No. EL/3.2.108(wheel) dated 28.07.23)

2.3.5 Gears, Gear Case, Hurth coupling

SN

Reliability Action Plan

1. Use of safety device as an emergency support to prevent falling of aluminium gear case in WAP-5 class of electric locomotives, during run in the event of breakage of its

- mounting lug (of aluminium gear case) due to sudden impulse loading (MS no. RDSO/2013/EL/MS/0424 (Rev. 0) dated 21.03.13)
- 2. Hurth coupling membrane is being replaced in TOH/IOH schedule
- 3. Training to all staff regarding correct procedure for checking of levelling of Hurth coupling.
- 4. Assembly of Aluminium gear case/Hurth coupling as per RDSO SMI no. RDSO/2017/EL/SMI/309 Rev '0'
- 5. Maintenance of Hurth coupling in WAP-5 locomotive as per RDSO SMI no. RDSO/2017/EL/SMI/310 Rev '0'

2.3.6 Rotary switch

SN

Reliability Action Plan

- 1. Modification sheet of Bogie isolation rotary switch (SCH.POS.154 Cut out switch) MS no. RDSO/2013/EL/MS/0426, (Rev. '0') dated 18.07.13.

2.3.7 Radiators/Filters/Machine room

SN

Reliability Action Plan

- 1. Cleaning of radiators with recommended water jet nozzle as per SMI-287.
- 2. Cleaning of Filter (MRB, TMB & OCB) and replacement of gasket in case of air leakage/gap, if any as per SMI/287.
- 3. Availability of Industrial type vacuum cleaner to ensure the machine room cleaning in every schedule.
- 4. Improvement measures to maintain pressure in the machine room and make it dust free as per RDSO guideline circulated vide letter no. EL/3.1.35/10 dated 11.04.16.
- 5. Assuring air delivery: Implementation of SMI/255 for Measurement of air delivery at specified location.
- 6. Provision of inspection window on the side of filter cubicle. (RDSO/2008/EL/MS/0366 Rev '0' dated 29.08.08)

2.4 Others

SN

Reliability Action Plan

- 1. Partial blocking of opening duct of back side of auxiliary converter of three phase electric locomotives. (MS no. RDSO/2009/EL/MS/ 0385 (Rev.0), Dated 15.12.2009)
- 2. Modification sheet (No. RDSO/2014/EL/MS/0434 'Rev-0 dated 28.03.2014) to create low pressure zone above hood ventilator in order to make machine room pressurized and free from dust to avoid failure of electronic cards in three phase locos.

2.5 Harmonic filter

SN

Reliability Action Plan

- 1. Replacement of FB cubicle pneumatic pipes with double ferrule
- 2. Replacement of FB cubicle pneumatic pipe in locos more than 6 years old.
- 3. Procedure of pneumatic tube connection to electro-pneumatic contactor of harmonic filter/hotel load converter in three phase locomotives. RDSO/2017/EL/SMI/0313(Rev.0), File No. EL/3.2.19/3-Phase, Dated 30.08.2017.
- 4. Modification sheet for relocation of earth fault relays for harmonic filter and hotel load

- along with its resistors in three phase locomotives. MS No. RDSO/2013/EL/MS/0428 Rev'0'. File No. EL/3.1.35/2/Elect Dated 10.12.2013.
5. Provision of auxiliary interlock for monitoring of A2-B2 system of Harmonic filter ON (8.1)/adoption (8.2) contactor in GTO/IGBT based locomotives. MS No. RDSO/2017/EL/MS/0464 (Rev 0), File No. EL/3.1.35/2 (Elect) Dated 25.09.2017.
 6. Ensure proper tightness of cables, lugs and capacitor connections.
 7. During each minor and major schedule Harmonic Filter Capacitor Bank value to be measured along with individual capacitor and ensured that capacitor value should be within tolerance range (+/-5%) from 66.6 μ F.
 8. In case, any capacitor value found out of above range, then it should be replaced with same make within range such that the overall capacitor bank value remains within tolerance range.
 9. Intermixing of different make capacitors in capacitor bank shall be avoided.
 10. All capacitors must be with pressure disconnecter and the capacitors without pressure disconnecter should be gradually phased out.
 11. If there is bursting of capacitors in a bank then complete Harmonic Filter Capacitor bank to be replaced with new capacitor bank all the capacitors in the bank should be discarded.
 12. As discussed during 40th MSG meeting, MS413 Rev' 0' to be followed in passenger locomotives (WAP5/WAP7) for paralleling of interlocks of EP contactors and auxiliary contactors of three phase locomotives to improve reliability vide MS No. RDSO/2012/EL/MS/0413 (Rev'0'), File No. EL3.1.35/2/Elect Dated 28.09.2012.
 13. MS413 Rev' 1' to be followed in freight locomotives (WAG9) for paralleling of interlocks of EP contactors and auxiliary contactors of three phase locomotives to improve reliability vide MS No. RDSO/2012/EL/MS/0413 (Rev'1'), File No. EL3.1.35/2/Elect Dated 25.04.16.

(Arvind Pandey)

for Director General Std. /Electrical

Encl: Nil

Copy to:

1. Secretary (Electric Traction), Railway Board, Rail Bhawan, New Delhi- 110 001
(Kind Attn.: DEE (RS)/Railway Board)
सचिव (विद्युत), रेलवे बोर्ड, रेल भवन, नई दिल्ली-110 001
(निदेशक विद्युत (चल स्टॉक) के ध्यानाकर्षण हेतु)

2. As per Standard Mailing List No. EL-M-4.2.3-19 Latest Revision.

(Arvind Pandey)

for Director General Std. /Electrical

Encl: Nil