



सत्यमेव जयते

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

**Technical Audit Report of Kanchrapara Workshop, Eastern Railway,
for maintenance of bearings of three phase locomotive Traction Motors
(TM) and Motor Suspension Units (MSU)**

Report No.: RDSO/2016/EL/TAR/0008 Rev. '0'

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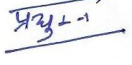
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Status of Revision

SN.	Date of Revision	Page No.	Revision	Reason for Revision
1.		All	0	First Issue

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Technical Audit Report of KPA workshop

1. Railway Board vide letter no. 2015/Elect(TRS)/138/8 dated 8.2.2016 (Minutes of POH Coordination Meeting held at Railway Board on 27.1.2016) had instructed RDSO to audit the maintenance practices adopted for 3 phase TM and MSU bearings at BSL & KPA workshops.
2. Technical audit of KPA workshop for maintenance of Bearings of three phase locomotive traction motors and Motor Suspension Unit (MSU) has been carried out from 10.5.2016 (AN) to 13.05.2016 (FN). Observations are given in the following paragraphs.

3. Observations related to Storage

3.1 Bearing Storage at the KPA Stores Depot

Bearings were stored in a dry room, separated from other components. But bearings were directly kept on floor with stack of more than 5 bearings. Lot of dust and dirt observed on stacked bearing cartons.



Photo 1



Photo 2



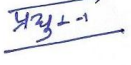


Photo 3

Photo 1 to 3: Bearings stored in KPA stores depot (Not recommended)

Recommendation:

- (i) It is advised to keep the bearings little away from walls to avoid ingress of water/moisture in a stack of not more than 5 bearings.
- (ii) Bearings should also not be stored directly on floor.
- (iii) First In First Out (FIFO) system should be followed to avoid prolonged storage.

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3.2 Storage of Lubricants at Halishahar (HLR) Stores depot

It was observed that transformer oil drums were stored in vertical condition instead of horizontal condition. Oil drums which were stored in horizontal conditions, their barrel bungs were not in clock position at 3 & 9.



Photo 4



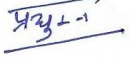


Photo 5

Photo 4 & 5: Oil drums stored in HLR stores depot (Not recommended)

Recommendation:

- (i) All barrels must be stored, preferably indoors; away from extreme heat/cold, dust, acidic fumes and moist atmospheric conditions.
- (ii) 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.
- (iii) Grease barrels must be stored vertically preferably covered with tarpaulin, if not stored indoors.
- (iv) Technical circular No. RDSO/2010/EL/TC/0104 (Rev.0) should be followed for storage & handling of lubricant/greases used for Electric Locomotives.

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3.3 Storage of Insulating Items and Varnishes in KPA stores depot

Air Conditioned (AC) room is used for storage of insulating items and varnishes. No temperature and humidity indicators were provided in the room. It was informed that AC is switched on only during the working hours and during night hours and on holidays AC remains switched off. No deep freezer was available in stores depot for storing of varnishes which requires storage at less than 10^0C . Some rolls of expired Polyimide tape were also available in depot (Manufacturing Feb. 2015, Shelf life 12 months).



Photo 6



Photo 7

Photo 6 & 7: Insulating Items stored in AC room



Photo 8

Photo 8: Expired Polyimide tape available in stores depot (Not recommended)

Recommendation:

- (i) Arrangements to be made for 24 hour working of air conditioners of AC Storage ward.
- (ii) Temperature and humidity indicators to be provided at the far end of AC Storage ward.
- (iii) Deep freezer of adequate capacity needs to be used for storage of items which are to be stored at less than 10^0C .
- (iv) First In First Out (FIFO) system should be followed to avoid prolonged storage.

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3.4 Storage of assembly components in KPA Stores Depot

The suspension tubes and assembly components for Hitachi and 6FRA6068 TMs were lying in open area with dust, dirt and water.



Photo 9



Photo 10



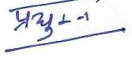


Photo 11

Photo 9 to 11: Assembly components stored in KPA Stores depot (Not recommended)

Recommendation:

Suspension tubes and assembly components must be stored, preferably indoors; away from dust, dirt and moist atmospheric conditions as the tolerances of mating parts are in microns which may be affected by rusting or accumulation of dust/dirt etc.

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3.5 Bearing Storage in Traction Motor Section

Bearings were stored in an air conditioned room in TM section. Shelves were available but bearings were also stored on the floor.



Photo 12



Photo 13



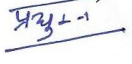


Photo 14

Photo 12 to 14: Bearings Stored in TM Section (Not recommended)

Recommendation:

- (i) It is advised to keep the bearings little away from walls to avoid ingress of water/moisture in a stack of not more than 5 bearings.
- (ii) Bearings should not be stored directly on floor.
- (iii) First In First Out (FIFO) system should be followed to avoid prolonged storage.

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3.6 Storage of MSU Assembly components in section

Large number of assembly components were stacked in bundles. Assembly components are supposed to be procured and used in kit form and hence storage should also be in kit form.



Photo 15



Photo 16



Photo 17

Photo 15 to 17: Assembly Components Stored in Section (Not recommended)

Recommendation:

Assembly components should be procured, stored and used in kit form.



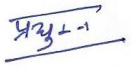
4. Observations related to Motor Suspension Unit Maintenance:

4.1 Measurements taken before mounting:

KPA is not measuring Drive End & Non-Drive End main bore diameter (seating area for Bearings) and it was informed that they are using new assembly components as well as bearing.

Recommendation:

It is recommended to check the actual fit dimensions of MSU & assembly components (mating parts) and axle bearing seating area as specified in paragraph 1.4 of ABB document no. AEB 452511 'Drive 15 AN 21 R1 Instructions for Assembly and Disassembly'.

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4.2 Use of Assembly components along with MSU tube in Kit form:

It is observed that MSU tube and assembly components are not used in kit form. It was observed that one KMRI make MSU tube of 6FRA6068 TM was assembled with KPE make assembly components. It is recommended that the Suspension tube and its assembly components should be used in kit form and should not be mixed or interchanged.



Photo 18



Photo 19

Photo 18 & 19: KMRI make MSU tube assembled with KPE make assembly components (Not recommended)



Photo 20



Photo 21

Photo 20 & 21: Indore Nitride make MSU tube assembled with KMRI make assembly components (Not recommended)

Recommendation:

It is recommended to procure, store and use assembly components in kit form.

4.3 Availability and use of Torque Wrenches:

Torque wrench of 80 Nm & 9.5 Nm are prescribed for use during assembly procedure of MSU. Torque wrench of 9.5 Nm was not available.

Recommendation:

- Sufficient number of torque wrenches of 80 Nm & 9.5 Nm to be procured and used during assembly.
- Torque wrenches should be calibrated periodically.

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4.4 Use of thermoseal compound

KPA is using Resimet thread locker compound instead of Thermocup 1200 or equivalent prescribed in 'WAG-9 Maintenance and Repair Manual Indent Number 3EHW 411416'.



Photo 22: Resimet
(Not recommended)



Photo 23: Loctite 767
(Recommended)

Recommendation: KPA should use the Thermocup 1200 or equivalent. CLW is using 'Loctite Anti seize thread compound 767' for similar application which is a high temperature anti seize thread compound. It may be used by KPA.

4.5 Induction heating of the bearing racer: Induction heater used is not equipped with temperature setting feature. It is used in time mode.



Photo 24: Induction Heater without temperature setting (Not recommended)

Recommendation:

1. KPA should procure sufficient number of induction heaters equipped with essential features like temperature display, temperature hold, auto cut off & de-magnetization.

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2. Induction heating should always be done in temperature mode as same/similar components of different manufactures may have different properties.

4.6 Measurement of MSU Clearance:

KPA is measuring the following clearances:

Name of Clearance	Parameter	Measured By
'C' Clearance	Distance between DE labyrinth ring item 2 and Suspension Tube	By Feeler gauge
'D' Clearance	Distance between inner face of DE side of Suspension tube to the face of main gear	Measured by adjustable gauge
'X' Clearance	Distance between NDE labyrinth ring item 15 and Suspension Tube	By Feeler gauge
'F' Clearance	Distance between the NDE labyrinth ring item 14 and wheel face	By inside micro meter
'E' Clearance	Distance between DE labyrinth ring item 9 and main gear hub.	Not measured by KPA. Measurement process explained.
Lateral Play	DE side	By dial gauge



Photo 25



Photo 26

Photo 25 & 26: Measurement of 'D' Clearance and its gauge (Recommended)

Suggested method for measurement of 'E' Clearance:

Distance between DE labyrinth ring item 9 and main gear hub cannot be measured directly, however it can be measured by measuring the depth of gear hub by depth gauge in respect to labyrinth ring item 9. Difference of depth gauge reading and thickness of labyrinth ring item 9 (to be measured before fitment) will be the value of 'E' clearance.

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Photo 27: Measurement of 'E' Clearance (Recommended)

4.7 Flame heating of MSU bearing seating area:

MSU bearing seating area is directly heated by flame heating whereas induction heating is prescribed as per ABB document no. AEB 452511 'Drive 15 AN 21 R1 Instructions for Assembly and Disassembly'. However, LPG flame heating is also permitted in document no. AEB050483, 'Wheel Set assembly procedure'. It was observed that slight hammering was required during fitment of bearings due to non-uniform heating of bearing seating area. Fitment of bearings by hammering is not desirable.



Photo 28: Direct flame heating of MSU



Photo 29: Bearing Fitment by hammering
(Not recommended)

Recommendation:

1. KPA should procure proper induction heater for heating of the MSU and follow the procedure given in ABB document no. AEB 452 511 'Drive 15 AN 21 R1 Instructions for Assembly and Disassembly'. Induction heating is better than LPG flame heating which may cause change in properties of the

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material and flame heating causes non-uniform heating of MSU, due to which hammering is required during bearing fitment. Induction heating alone is also prescribed in 'Maintenance & Repair Manual of WAG-9 Locomotive' document number 3EHW411416 chapter 2.06.

2. Use of Oxy-actylene flame is prohibited as it can cause distortion in MSU tube. Precaution should be taken while using the flame heating technique that only LPG flame is used and Oxy-actylene flame should not be used.

4.8 Holding of bearing race (DE) and bearing ring (NDE) during fitment

As per chapter 2.06 page 26/36 (rev. 12.2001, Indent No. 3EHW-411416) of Maintenance & Repair Manual of WAG-9 Locomotives for Wheel-set, while assembling DE side bearing following procedure is recommended:

*"Install the bearing race into the DE of the Suspension Tube seat. The serial number on the bearing race must be facing towards the drive end of the suspension tube. **Press the bearing race up against the stop until the suspension tube has been cooled. The bearing race will sit slightly above the lip of the seat and be correctly positioned later in the procedure**"*

Similarly for NDE bearing also following procedure is recommended on page no. 29-30/36 chapter 2.06 page 26/36 (rev.12.2001 , Indent No. 3EHW-411416)

*"Heat the inner bearing ring to 100°C using suitable induction heating equipment. Position the inner bearing ring onto the axle shaft until it stops against the labyrinth ring. **Press the ring against the labyrinth ring and hold until cool.**"*

KPA is following the steps of holding bearing race in case of DE bearing and inner bearing ring in case of NDE bearing till the cool down.



Photo 30: Holding of the bearing race (Recommended)

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Recommendation:

The above mentioned procedure should be followed completely as it is critical for proper assembling of MSU. Earlier also, RDSO vide letter number EL/1.3.10 dated 1.9.2011 had advised CLW and other workshops to follow the correct procedure. CLW and other workshops are requested to follow.

4.9 Fasteners used for MSU



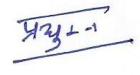
New LPS make Allen bolts were used during assembly procedure. It was informed that new fasteners of approved make are always provided during MSU overhauling. It is a good practice.

Recommendation:

1. It is advised to follow the instructions issued vide RDSO letter number EL/2.2.13 dated 12.2.2016 to use socket head screw of approved makes only in MSU of 3-Phase Locomotives/Conventional Locomotives.
2. In one MSU tube, only one make of fasteners should be used and mixing should not be done.
3. It is preferable to replace the old fasteners of MSU by new fasteners of approved make.
4. If released fasteners are of un-approved make, they must be replaced with new fasteners of approved make.
5. As per CLW Specification No. CLW/MS/3/049 Alt-4, following make of socket head screw shall only be used in the MSU of WAG-9 Locomotives:
 - (a) Un-Brako (Precision Fasteners)
 - (b) G.K.W
 - (c) Laxmi Precision
 - (d) Sundaram Fasteners (TVS)

4.10 MSU overhauling during every Re-discing

It was informed that KPA workshop is carrying out MSU overhauling of every WAG-9/ WAP-7 axle received for re-discing. It is a good practice and other workshops should follow it.

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4.11 Holding of labyrinth ring item 14 during fitment

As per ABB document no. AEB 452511 'Drive 15 AN 21 R1 Instructions for Assembly and Disassembly' clause 3.13 page 8/16, while assembly following procedure is recommended:

"Heat up the ring item 14 inductively to 100°C and slip it over the wheelset axle until it is stopped by the separate thrust collar. Press it down in this position until it is cooled down"

KPA is not following the steps of pressing down the labyrinth ring item 14 till it cool down. This step is followed in CLW, photograph is shown below:



Photo 31: Holding of the labyrinth ring item 14 (Recommended)

Recommendation:

The above mentioned procedure should be followed completely as it is critical for proper assembling of MSU.

5. Observation related to 3 Phase Traction Motor

- 5.1 Three phase traction motors were not under overhauling during the time of audit. Loco no. 31060/GMO was under POH and its outturn was scheduled for June first week, its traction motor overhauling was not started. No other 3 phase traction motors were available in the section for overhauling. The overhauling procedure was seen by way of dismantling and reassembling of one traction motor.

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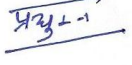
5.2 Compliance of SMI no. RDSO/2013/EL/SMI/0278 (rev `0`) dated 24.12.2013

SMI-278 for fitment of Drive End bearing (NU 2236) in 6FRA6068 TM was issued by RDSO due to large number of bearing seizures. It is observed that this SMI is not followed properly. Following observations are made:

- (i) Dummy pinion was not available.
- (ii) Measurements of mating components like outer diameter of outer racer of the bearing, bore diameter of the bearing bracket, bore diameter of the inner racer and bearing seat diameter were not measured and recorded.
- (iii) Free Radial Clearance of Bearing is not measured
- (iv) Inner racer is provided with actual pinion inserted instead of dummy pinion.
- (v) Ring gauge is not available.
- (vi) Dye transfer test (Colour matching) with ring gauge to check the suitability of pinion not done.
- (vii) Colour matching of pinion with shaft taper is also not carried out.
- (viii) Axial clearance is not measured.
- (ix) Radial clearance is measured but process as per SMI-278 not followed. Dial gauge sensor should be fixed 40mm away from outer labyrinth as specified in SMI_278.

Recommendation:

- (i) It is recommended to procure dummy pinions and ring gauge. These should be used during assembly.
- (i) Measurement of dimensions of mating components is necessary to ensure proper interference.
- (ii) Axial clearance and radial clearance needs to be measured properly and recorded.
- (iii) It is advised to follow the SMI-278 completely to ensure proper fitment of bearings.

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5.3 Use of Induction heater for heating of racer

Induction heater was used for heating of racers. Temperature setting mode was available in Induction heater. It was informed that temperature setting of 130⁰C is used for heating of racers. It was advised that temperature setting beyond 120⁰C should not be used. One NDE side racer was heated with temperature setting of 115⁰C and its fitment was proper.



Photo 32: Induction heater

Recommendation:

- (i) Induction heaters should always be used in temperature mode.
- (ii) Temperature setting should not be more than 120⁰C for bearing assembly components.

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5.4 Heating of End Shields in Oven

For bearing fitment, End shields were heated in electric oven for 3 to 4 hours up to temperature of 170⁰C. Induction heater suitable for heating of end shields is not available.

Recommendation:

Induction heater shown below can be used for heating end frames. Induction heating will be fast (10-15 minutes compared to 3 -4 Hrs. in oven) and energy efficient. It is recommended that KPA workshop may procure induction heaters for heating of end shields.



Photo 33: Induction Heater for End Frame (Recommended)

5.5 Greasing of Bearings

While assembling the new bearing, greasing is done with bare hands. Measured quantity of grease (DE side: 400 gram & NDE side: 130 gram for 6FRA6068TM) is provided. It was observed that grease drum was not kept in proper clean area.



Photo 34



Photo 35

Photo 34 & 35: Grease drum and greasing of Bearings with bare hands
(Not recommended)

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Recommendations:

- (i) Bearings should be handled with protective industrial gloves.
- (ii) Lint free cloth should be used for cleaning purpose.
- (iii) As ABB Manual does not prescribes the initial grease quantity required to be provided in the Traction Motor Bearings, all the Railways are requested to weigh the grease quantity provided in the initial assembling of the bearings, so that RDSO can standardise the grease quantity to be provided.
- (iv) ABB manual (Volume F-5 Propulsion System – Document No. 3EHM620902 Grease instruction for roller bearings with synthetic grease) prescribes greasing by means of grease gun using the prescribed tool. These instruction needs to be followed.
- (v) Re-greasing quantity and schedule prescribed in ABB documents is given below:

WAP-7: DE - 400 gm, **NDE-** 130 gm (0.20 million km or once per year)

WAP-5: DE - 35 gm, **NDE-**25 gm (0.25 million km)

5.6 Availability and use of Torque Wrenches:

M20 screws of DE & NDE End frame are tightened without use of torque wrench during assembly. Tightening Torque of 372 Nm is specified for M20 Coarse thread hexagon head bolts and screws in 'WAG-9 Maintenance and Repair Manual, Indent No. 3EHW 411479 Chapter Preface Page 17/18'



Photo 36



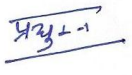


Photo 37

Photo 36 & 37: Tightness of M20 screws without torque wrench
(Not recommended)

Recommendation:

- (i) Sufficient number of torque wrenches to be procured and used during assembly.
- (ii) It is preferable to use torque wrench with fixed predefined torque. In torque wrench with adjustable torque, there is a probability that torque may not be set at required value

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(iii) Torque wrenches should be calibrated periodically.

6. Observation related to HS15250 TM

6.1 Process of Drop test was seen. It is observed that Probe spacing was not proper. Staff was not aware about placement of the current & potential probes. Staff counselled regarding significance of placement of current & potential probes for measurement of very low resistance.

Recommendation: SMI-51 dated 30.4.1979 for 'Bar to bar conductor resistance and equalizer resistance test on Traction Motors' needs to be followed properly.

6.2 It was informed that diamond tool is not available for machining of the commutator and carbide tool is used.

Recommendation:

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.

6.3 Availability of fixtures and gauges as per SMI-243

To minimize the quality related failures on account of improper dimensions of Brush holders and BHRR components, certain jig and fixtures need to be maintained by workshops/loco sheds as specified in Special Maintenance Instruction number RDSO/2007/EL/SMI/0243 (Rev '0') dated 22.3.2007. It is observed that the required gauges and fixtures are not available with KPA workshop.



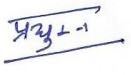
Recommendation:

KPA workshop is advised to procure and use the Jigs & Fixtures as per RDSO SMI-243 Rev '0' for improving the reliability.

7. Other Observations:

7.1 Compliance of TC-125 & TC-127

RDSO had standardized and issued insulating materials for repair/rewinding of TAO-659 TM and TM type 4601 vide Technical circular no. RDSO/2013/EL/TC/0125 (Rev. 0), dated: 25.10.2013 and Technical circular no. RDSO/2014/EL/TC/0127 (Rev. 0), dated: 30.09.2014. It was informed that KPA had not switched over to the new insulation scheme completely. Armatures are still rewound using old insulation scheme also.

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Recommendation:

KPA is advised to expedite the switch over to new insulation scheme.

7.2 Main dimensional checks of Hitachi Suspension Tube as per SMI-207

To improve the reliability of Hitachi Suspension tube, in consultation with Hitachi experts, RDSO had issued Special Maintenance Instruction number ELRS.SMI.0207-99 (Rev '0') for carrying out main dimensional checks of suspension tube and magnet frame. (Rev '0') dated 22.3.2007. It is observed that it is not carried out at KPA workshop.

Recommendation:

KPA workshop is advised to carry out main dimensional checks of Hitachi Suspension Tube as per RDSO SMI-207 for improving the reliability.

7.3 Checking of concentricity and parallelism of Hitachi Suspension Tube as per SMI-226

To improve the reliability of Hitachi Suspension tube, RDSO had issued Special Maintenance Instruction number RDSO/ELRS/SMI/0226/2002 (Rev '0') dated 28.1.2007 for checking of concentricity and parallelism of Hitachi Suspension Tube. It is observed that it is not carried out at KPA workshop.

Recommendation:

KPA workshop is advised to carry out checking of concentricity and parallelism of Hitachi Suspension Tube as per RDSO SMI-226 for improving the reliability.

7.4 It was informed that Becktol Red is used as finishing varnish TAO-659/TM type 4601 .

Recommendation:

Becktol Red is E Class (120°C) Anti-tracking finishing varnish. Prescribed anti-tracking finishing varnish for TAO-659 TM is F-93/RE-118 which is H Class (180°C). Prescribed finishing varnish for Hitachi TM is TVA-1410 which is Class 200°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.

- 8. Interaction with officers & Supervisors:** At the end of audit, interaction with officers and supervisors was carried out and the findings of the audit as well as Dos and Don'ts of bearings were discussed.

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