GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

सत्यमेव जयते

INVESTIGATION REPORT

ON

AXLE LOCK OF LOCO NO.33282/WAG-9/BSL/CR

No. RDSO/2021/EL/IR/0196 REV. '0'

NOVEMBER, 2021

BY

COMMITTEE COMPRISING OF

1. **DSE/TM/RDSO(CONVENOR)**
2. **DY.CME/TMS/DMW**
3. **Sr. DEE/TRS/BSL/CR**
4. **Sr. DEE/OP/BCT/WR**

(Ref: RB's LETTER No. 2008/Elect(TRS)/441/5pt dated 03.11.2021)

Issued by

Electrical Directorate
Research, Designs and Standards Organisation
Manak Nagar, Lucknow-226011

JOINT INVESTIGATION REPORT DATED 09/11/2021 & 10/11/2021 OF FAILURE OF BEARING OF TM-4 OF LOCOMOTIVE 33282 OF ELS/BSL

Ref:- Railway Board letter No. 2008/Elect (TRS)/441/Spt dt 03.11.2021

Brief details of the failure:

On 02.11.2021, Loco No 33282/WAG-9 of ELS/BSL /CR while working Goods train No TMBY/DHO (Load- 43/3784) was failed between VR-VTN section. LP shri Suresh Kumar S (HQ-BSR) reported smoke emission from TM-4. On further checking, axle-4 found in locked condition. ART was ordered.

Repercussion: - 22 Trains

Chronology of events:-

08:03 - Train stopped at Km 64/08 due to smoke emission from TM4 and found wheel No4 locked.
08:36 - BDTS ART ordered
09:02 - ART departed from BDTS
09:06 - Relief engine 31573 departure from BSR to site
09:52 - Relief loco attached to clear load from rear and load clear at 10:59 hrs.
11:01 - ART site arrival and work started at 11:30hrs
13:45 - Wheel floated with the help of trolley.
13:56 – LELA departed to VR.
17:52 – Loco arrived at VR yard.
Total section blocked from 08:03 hrs to 17:52 hrs

Details of failed Traction Motor:-

TM no 4 Sr.no. 2208000-1429 (DMW834) having both side bearing of M/s SKF make. DE side Bearing Sr. no. 01-103 T (manufacturing in April 2021) & NDE side bearing Sr. No. 047 T (manufacturing Feb-2021). This traction Motor was received from DMW/Patiala with new Bogie ECBT-1131 on 25.09.2021 & same was commissioned in loco 33282 on 21.10.2021. Rotor scheme-II, manufactured at light machine shop at DMW/Patiala & stator is of M/s CGL make. TM was assembled by DMW with associated components supplied by M/s Simplex Engineering Foundry Works, Bhilai. Pinion is of M/s GGAG (04/21).

DE end frame- SE - H1070
NDE End frame - SL 40 Mfg 01-21 H0825

Loco Schedule details:-

Loco No- 33282 WAG-9 was commissioned by ELS/BSL/CR on 21.10.2021, received from CLW/CRJ. ELS/BSL removed the existing motorized bogies for light run test of traction motors & provided the new Bogies (ECBT 1123 and 1131) in the locomotive received from DMW/Patiala.
IA due- 17.01.2022

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Measurement of Traction Motor Sr.no. 2208000-1429 (DMW834):-

At DMW-

1. DE side radial clearance was 0.185mm (0.185*0.86=0.159mm) after fitment.
2. Axial Play- 240 micron
3. Pinion make: GGAG (21 teeth)
4. Measurement of pinion shaft with ring guage- Done at DMW with rotor shaft. 94% matching.
5. Pinion Travel- 12 mm
6. Gap (pinion & shaft)- 3.75 mm at DMW. However at KYN/Shed it was found 3.38 mm
7. Outer labyrinth seat OD- 179.850 mm (Std. value 179.843-179.868mm)
8. Shaft OD at inner racer seat- 180.055mm (Std. value 180.043-180.068mm)
9. ID of Outer labyrinth (DE side)- 179.783mm (Std 179.748-179.783mm)

At BSL-

1. Run test performed on traction motor in bogie assembled condition for four hours (2hrs forward & 2hrs reverse direction). Maximum temperature rise is 24 degree C (within limit) on DE side.
2. Grease sample was taken from grease hole & metal content checked found 0.074 % which is within limit (max permissible limit- 0.25%).

Obsevations

ON site Observation :

1. grease spread on DE end frame net.
2. After Gear case uncoupled and it was seen that Outer labyrinth had come out .
3. Gear case oil was available
4. Pinion to rotor shaft gap found 3.4 mm

Observation at ELS/KYN on dt. 09/11/2021 & 10/11/2021:-

1) Loco placed dead condition at ELS/KYN shed for TM replacement and Joint investigation of TM.
2) TM-4 visually check found Pinion in cut condition and outer labyrinth -DE came out.
3) Outer labyrinth-DE removed from end frame with bearing outer cap.
4) Outer labyrinth -DE (SL-427 make Simplex Engg.) found crack at two place diagonally.
5) Outer bearing cap found overheated and make and serial were not visible.
6) DE side Rotor outer labyrinth seat diameter found scoring marks due to rotation of outer labyrinth.
7) DE side end frame was removed from motor. One crack (through) was found on bearing inner racer.
8) Bearing cage found deformed and ribs (Brass Separator) found melted and its roller covered with thin layers of brass melted material.
9) Bearing inner racer track having indentation marks of rollers.
10) After removing the Bearing inner racer it is found material deposited on rotor shaft.

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11) Scoring mark observed on rotor shaft thoroughly
12) Bearing along with outer racer easily came out from end frame housing and bearing outer race has heating marks and scoring with slightly rotated.
13) NDE side bearing condition absolutely Normal
14) There are no rubbing marks observed on Stator & Rotor.
15) IR test conducted on stator & IR found 1000 megaohm with1KV megger.

Dimensional Measurement

Description	Standard dimension	Measured Dimension
Outer Labyrinth- DE inner dia - ID	179.748 - 179.783 mm	178.923, 179.082, 178.975 mm
Outer labyrinth seat dia of shaft (OD)	179.843- 179.868 mm	179.538,179.545,179.496 mm
Outer racer dia of bearing (OD)	319.960 - 320.00 mm	319.920, 319.995, 319.922 mm
Bearing housing bore dia on end frame (ID)	319.950 - 319.990 mm	319.980, 320.010, 319.995 mm
Bearing racer seat dia (OD)	180.043 - 180.068 mm	180.010, 180.008, 179.985 mm
Bearing inner racer bore dia (ID)	179.975 - 180.00 mm	179.414,179.307,179.369 mm
Inner labyrinth-rotor shaft seating dia (OD)	184.050-184.079 mm	183.996, 184.002, 184.015 mm

Note : As there were heavy scoring marks on outer labyrinth ID, rotor shaft OD (through out the width), & inner racer of bearing of DE side, so these dimensions could not be considered for reaching any conclusion.

Photographs of various components have been attached as Annexure-1.

Probable Causes of Failure

1. Bearing Inner Racer found cracked at one location. Initially hair crack might have developed due to excessive interference between inner racer & shaft. This may restrict rotation of rollers & heat will be generated. Grease dried out. This may result into failure of bearing.
2. Lack of Lubrication: DMW reported that 950 grams of grease was filled in DE side bearing. Moreover, ELS/BSL mentioned that during testing of traction Motor at BSL, grease sample was taken from grease hole. It means there is sufficient grease in the Traction Motor. During such type of cases of bearing seizure, due to heat generation, all the grease gets burnt out inside the bearing which results into lack of lubrication.
3. Brass Cage Broken: In this particular case, cage ring is deformed & ribs are melted due to generation of heat.

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4. DE side end frame Bore dia was checked & ovality found in measurement. Failure of bearing might have initiated from end frame & bearing outer racer interface.
5. Outer labyrinth was having two cracks at diagonally opposite locations. It is important to mention here that outer labyrinth is not a load bearing part. Crack may be developed due to excessive interference because of ovality or under size ID. Same is made evident by rotating scoring mark on rotor shaft and as well as on labyrinth ID side.

Conclusions :

In such type bearing failure cases, it is very difficult to establish the root cause of failure as most of associated components (assembly commponents, rotor shaft & bearing components) get damaged & actual measurements are not possible. However, based on the available facts, following conclusions may be drawn :

1. There is no sliding marks on inner labyrinth ID. Inner racer did not left its seating on rotor shaft OD. So, the possibility of failure of inner racer due to excessive interference is ruled out.
2. Lack of Lubrication: Since sufficient greasing was done at DMW. ELS/BSL also took the grease sample from grease hole by pushing additional grease, it seems that grease starvation is not the initiating point of bearing failure.During such type of cases of bearing seizure, due to heat generation, all the grease gets burnt out inside the bearing which results into lack of lubrication. So lack of lubrication as a cause of failure is ruled out.
3. Brass Cage Broken: Cage as well as supporting ribs were not broken, they were melted due to heavy heat & get deformed. Cage is the weakest part of the bearing & likely to damage during such type of bearing failure cases. So this possibility of Cage breakage as a cause of failue is also ruled out.
4. No major scoring marks/rotation marks observed on the DE side end frame Bore dia. Bearing outer racer was having heating marks on its OD & did not has major rotation/scoring marks. So possibility of failure due to rotation of outer racer inside endframe is ruled out.
5. **Since Outer labyrinth does not bear any load on it, still two cracks develop on it at diagonally opposite positions. This can happen due to excessive interference between outer labyrinth ID & Shaft OD. This excessive interference may be due to ovality in labyrinth ID or may be due to under size ID. DMW has submitted the measurement sheet in which measurement of ID of outer labyrinths of four TMs were mentioned. Outer labyrinth ID measurements of all four TMs are same (i.e, 179.783 mm). This is a rare possibility. So it seems that**

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bearing failure might have initiated due to excessive interference between outer labyrinth & rotor shaft OD.

Responsibility:

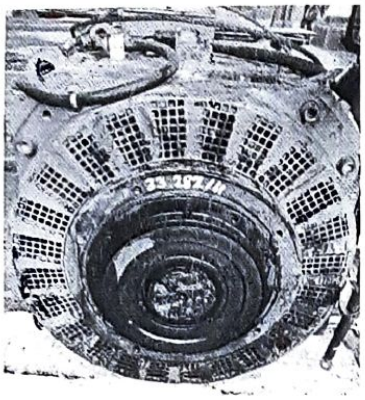
1. Either ovality or improper size of outer labyrinth seems to be the Reason of failure. Labyrinths are supplied by M/s Simplex Engineering foundry works Bhilai.
2. Proper measurements of labyrinths has to be ensured at the time of assembly of TM at DMW. As per record of check sheet, it seems that outer labyrinth measurements were not taken properly.

Recommendations :

1. Dimension of labyrinths are very critical. These labyrinths has to be machined on CNC & 100 % measurements has to be done by vendor on CMM. RDSO has advised that inspecting agency must inspect 20% quantity on CMM. These instructions has to be strictly followed to avoid occurrence of such failures. During assembly of TMs at PU/workshop/Sheds, measurements (rotor shaft OD, Labyrinth ID Bearing racers) has to be taken with proper tools.
2. RDSO have issued MS-478 in which clearances between bearings have been adopted as per original dimensions given by ABB to eliminate problem of gearcase oil ingress in TM. Since as per original ABB dimensions, radial clearances between labyrinths is in the range of 0.25mm to 0.43mm, and any non concentricity of 0.2 mm to 0.3 mm may cause rubbing of labyrinth which may result in bearing seizure. Hence measurement of labyrinth on CMM is essential to avoid such failures.
3. RDSO have issued various SMIs for use of proper gauges for measurement of critical dimensions during traction motor assembly. These are as follows :
   i) SMI-314 : Use of Dial snap gauge for measurement of shaft OD
   ii) SMI-318 : Use of bore Gauge for measurement of ID of End shields & racer
4. RDSO had issued drawings for ring gauge & plug gauge by SMI-278 Amendment-1 dt 08.03.21. Pus/Workshops/Sheds should have ring gauge & plug gauge to ensure use of proper pinion & correct taper of rotor shaft.

(Anurag Agarwal)	(Mukhtiar Singh)	(Himanshu Ramdeo)	(Yogesh Antil)
DSE/TM/RDSO	**Dy.CME/TMS/DM**	**Sr.DEE/TRS/BSL/CR**	**Sr.DEE/OP/BCT/WR**

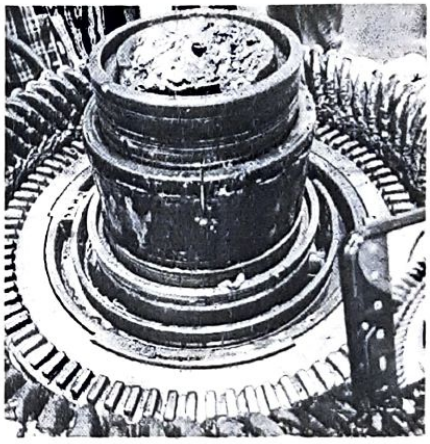
Annexure-1



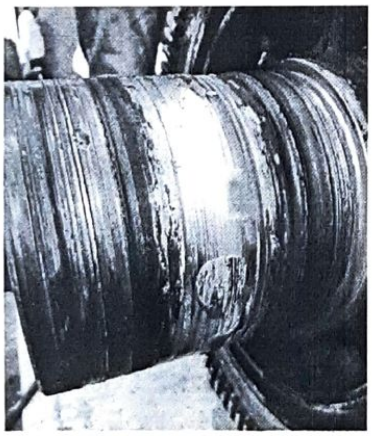
Failed TM No. DMW-834

Deformed Bearing Cage

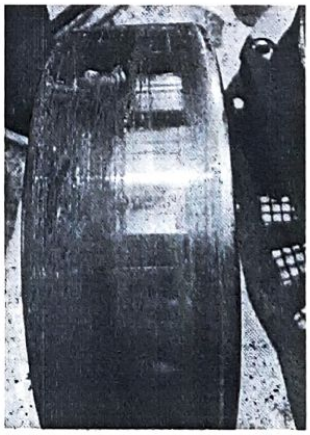
Cracked Outer Labyrinth DE



Cracked Bearing Inner Racer DE



Metal Deposit & Rubbing marks on Shaft OD



Rubbing marks on Outer race DE

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Jy CME) DMW

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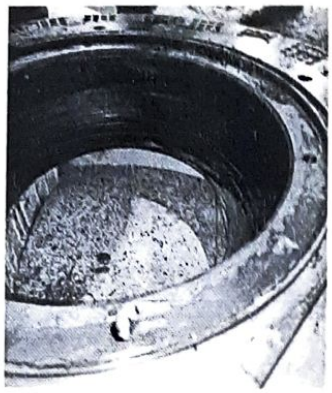


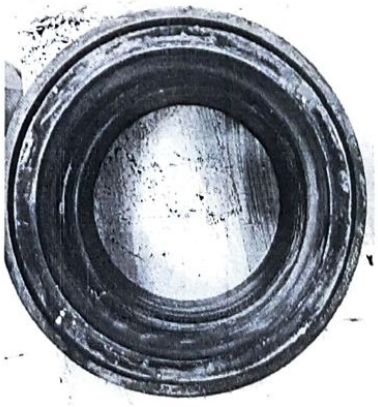
Little rotation/Heating marks on End Frame

Rotation marks on shaft at Outer/Inner Labyrinth Seating Area all around

Bearing Cage Ribs (Separators) melted

Cracked Inner Racer of DE Bearing

Excessive heating marks on Outer Bearing cap DE



Rotation of Inner labyrinth DE

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रेलमंत्रालय **MINISTRY OF RAILWAYS**
(रेलवेबोर्ड **RAILWAY BOARD)**

2008/Elect(TRS)/441/Spt **New Delhi, dated:03.11.2021**

Director General (Elect.)

RDSO
Manak Nagar
LUCKNOW

Sub: Axle Lock of Loco No.33282/WAG-9/BSL/CR.

On 02.11.2021, loco no. 33282/WAG9 of ELS/BSL/CR while working train no. TMBY failed in VR-VTN section. Loco Pilot reported smoke emission from TM-4. On checking found TM-4 axle locked. Loco was commissioned on 21.10.2021 with Motorized Bogies received from DMW/Patiala in RSP on 15.09.2021. The loco was failed within 12 days after commissioning, a committee comprising of following officers is nominated to investigate the failure:

1. Sh. Anurag Agarwal, DSE/TM/RDSO (Convener)
2. Sh. Mukhtiar Singh, Dy.CME/TMS/DMW
3. Sh. Himanshu Ramdeo, Sr.DEE/TRS/BSL/CR
4. Sh. Yogesh Antil, Sr.DEE/OP/BCT/WR

Committee may carry out detailed investigation and identify the root cause of failure. Committee may also fix up the responsibility for negligence and suggest remedial measures to avoid recurrence of such failures.

The committee shall submit report by 13.11.2021

(किशोर कैभव) 03/11/2021
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Copy for information and necessary action to:

1. Principal Chief Electrical Engineers,DMW
2. Principal Chief Electrical Engineers, CR
3. Principal Chief Electrical Engineer, WR