HOT AXLE

BY

S.K.SUMAN (CI/C&W)

Hot axle box

- Hot axle box in a railway vehicle occurs when inadequate wheel-bearing lubrication or mechanical flaws (bearing failure) cause an increase in temperature. If undetected, the bearing temperature can continue to rise until there is a bearing “burn-off” which may cause a derailment.
- A hot box is the term used when an axle bearing overheats on a piece of railway rolling stock. The term is derived from the journal-bearing trucks used before the mid-20th century.
- **Hot Axle** is a phenomenon which causes due to breakage of ball bearing of wagons or coaches which is moving on the rail track. It arises due to the overloading and faulty condition of the bearing. During **Hot Axle** the wheel become very hot and the movement or the train stops due to jamming of bearing.

Symptoms of hot axle

- Smell of Burning grease.
- Splashing of grease on wheel disc & Dis- coloring of grease.
- Light smoke from axle box.
- Dis-coloring of face plate.
- Axle box cover cut, bulged missing.
- Hotness of axle box by feeling.
- Axle may get locked and wheel skidding.
- Marks of splashing of grease on wheel and axle box visible at low speed or at stationary.
- Discoloring of paint surrounded the axle box concerned.
- Red glows during the night time only.
- Metallic noise after grease has worked out and roller have seized.
- skidding of wheel at last stage.
- Tilting of Spring.
- Burning out of molten front cover in case of coaches.

Hot box detector

- operation is the infrared “hotbox detector,” which, located at trackside, detects the presence of an overheated wheel bearing and alerts the train crew. The modern hotbox detector identifies the location in the train of the overheating and, employing synthesized voice recording, radios the details to the train crew.
- Hot-Bearing Detector (HBD), sometimes also known Hot Box Detector, is a technology that monitors the bearing temperature as the train passes by. The detection is achieved on real-time basis so a hot bearing can be traced and monitored and alarm can be raised if the temperature exceeds the alarm settings.

Causes of Hot Box

- Defects of Lubricant
- Mechanical disorder
- Irregular loading
- Miscellaneous

Defects of Lubricant

- Bad quality of grease.
- Excessive quantity of grease.
- Non availability / Inadequate quantity of grease.
- Foreign material contained with grease.

Mechanical disorder

- Defects in journal
- Defective bearing
- Defects in Axle box
- Cage broken
- Oozing out of grease due to perished rubber seal

Irregular Loading

- Uneven loading
- Over loading

Miscellaneous

- Derailment
- Defects in rail track
- Excessive speed

Misc. Causes of Hot Axle

- Inadequate and insufficient lubrication
- Incorrect fitment
- Improper mounting
- Improper handling
- Excessive temperature or heating
- Excessive or uneven loading
- Impact loading
- Excessive Vibrations due to component wear and tear
- Contamination (foreign particles, moisture)

Misc. causes of Hot Axle

- Earthing not proper for welding work.
- Poor engineman ship.
- Land slide or stone hitting.
- Sudden change of signal expect.
- Poor maintenance of pathway.
- Wagon involved in Flood.

How Can Detect Hot Axle

- During Rolling in Examination and Axle Box filling
- While in Slow motion / Not in motion

Day time	Night time
1. Smell of burning grease	1. Light smell of burning grease/ EM pad
2. Splashing of grease on wheel disc & discoloring of grease	2. Axle Box cover becomes Red Hot
3. Light smoke from Axle box	3. Glowing of Axle Box
4. Discolouring of face plate	4. Hotness of axle box by filling/Non contact thermometer.
5. Burning of EM pad over Axle Box	
6. Hotness of Axle box by feeling/Noncontact Thermometer	

While Run Through

Day Time	Night Time
1. Screeching sound	1. Screeching sound
2. Axle may get locked and wheel skidding	2. Axle Box cover becomes Red Hot
3. Discoloring of Axle Box face plate	3. Sparks on Rail due to skidding
4. Smell of burning grease	4. Burning of EM pad and flame over Axle Box
5. Vibrations of wagon /trolley	

Temperature on Non Contact Thermometer

CTRB Axle box/Adopter temperature	State of bearing operating conditions	Action to be taken
Up to 38 °C Above ambient	Normal	Wagon allowed
Temp. of bearing above 90°C	Excessively warm/Hot	Wagon to be detached

Special instructions for Axle box temperature of coaches

- If temperature is 80°C or beyond than coach should be detach from the train
- Difference of temperature in same axle

Sl No.	Difference in temperature	Action Taken
1	**Up to 10°C**	**Allowed in same condition**
2	**10°C to 15°C**	**Inform to next C&W Examining point**
3	**16°C to 20°C**	**Accompany with coach by C&W staff up to destination**

Non Contact Thermometer

Preventions to be given during ROH &POH to avoid Hot Axle

1. Earthing in wagons for welding should be done properly and very close to the welding area so that electric current does not pass through bearing, it will cause arcing between the rollers and raceways leading to failure.
2. Work with clean tools in clean surroundings.
3. Keep bearings wrapped in polythene sheet when not in use.
4. Apply clean grease and keep grease in closed container when not in use.
5. Grease seal and locking plate should be replaced by new.
6. RDSO approved brands of grease should be used.
7. Never mix up the different greases of different grades or even different makes of same grade.
8. Don’t reuse locking plate.

Continue---

9. End cap screws properly tighten with the help of torque wrench at specified torque of 40 kg – meter (290 foot-pounds).

10. Each and every time lateral play of bearing must be check and UST of all Axles should be done.

11. Load wear Zone area of bearing must be changed during fitment.

12. All tabs of locking plate are properly bent up against the flats of the cap screw heads.

13. Damaged outer cup bearing should not be allowed in service.

14. It must be ensured by stamping particular of grease seal that the CTRB would not complete more than 72 months by the time it becomes due for next POH/ROH.

15. The dismounting of bearing by oxy cutting strictly prohibited , as above such defects are considered very prone to generation of fatigue during service.

16. Overhauling cycle of new CTRB to take place of 72 months interval.

17. Bearing Mounting force to be maintained 55 ±5 ton.

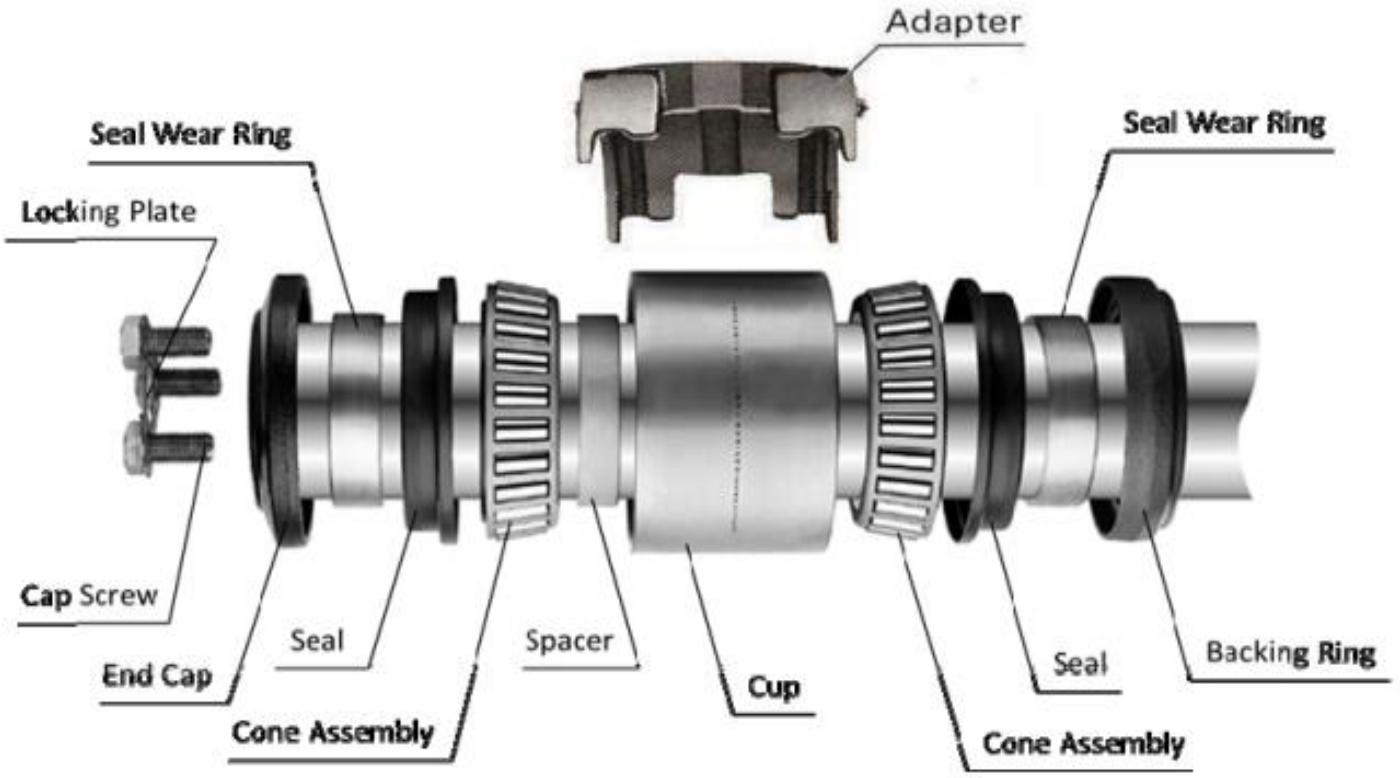
18. Quantity of grease is used 400+30 gms now a days in place of 430 ±30 gms.

19. AAR approved Lithium base quality of grease must be used.

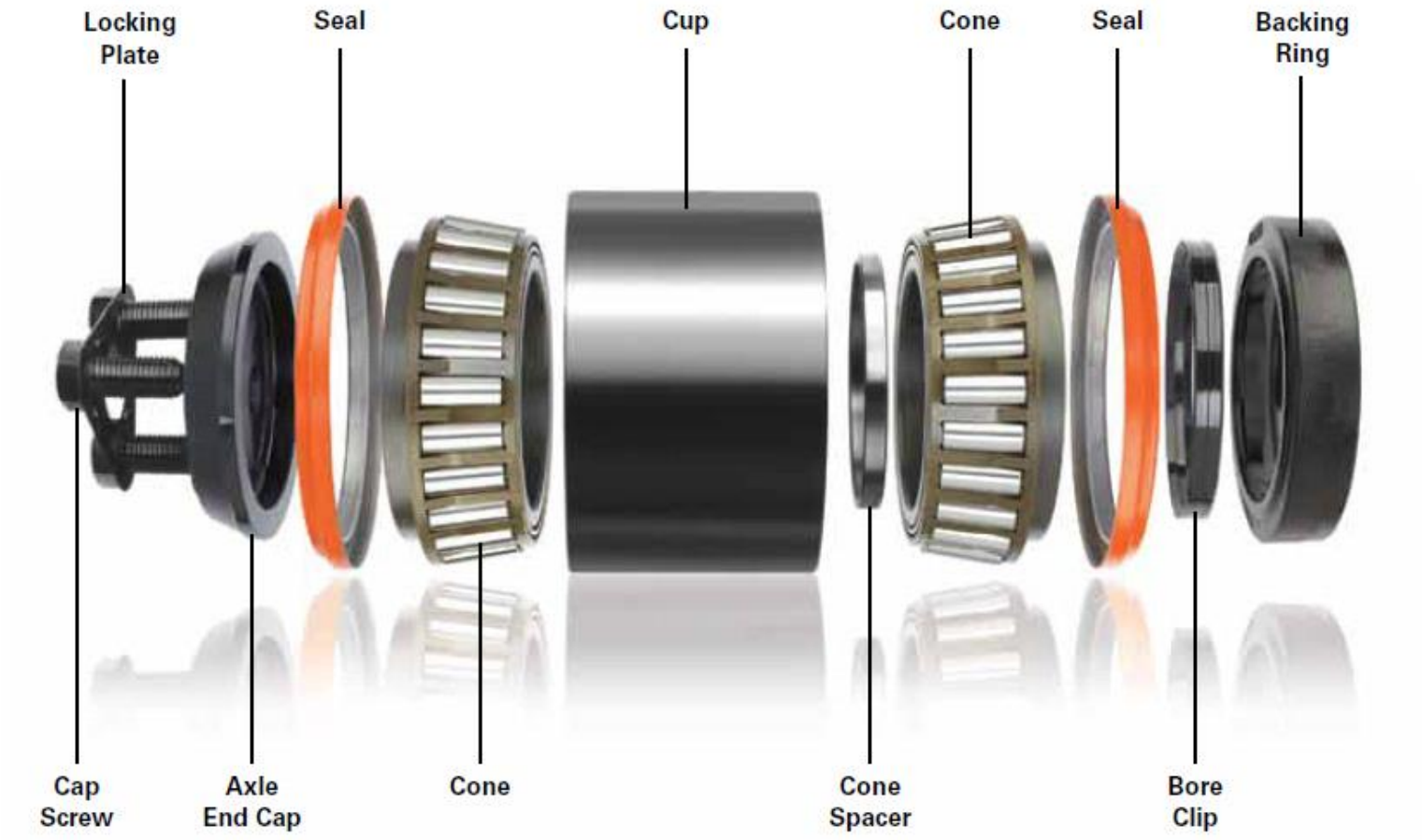
Duties of railway servants in case of Hot Axle/ any unusual condition on Running Train:-

1. Any railway servant, observing a hot axle, any hanging part, broken spring, and load shifting etc. on a running train must do everything in his power to stop the train and warn the train staffs.
2. Take immediate steps to short down the electric supply of OHE in electrified section.
3. If all attempts fail to draw attention of the train staffs, the Station Master/ Cabin Master/ ASM/ Switch Man shall inform the SM of the station in advance to stop and examine the train and shall inform the section controller.
4. On receiving the massage “Stop and Examine the Train” the SM shall not admit the train directly at station unless he is satisfied that the train has come to a stop at the first stop signal. Then only the approach signals shall be taken OFF for admission of train on Main Line.
5. In the event of the main line being not available and the train is to be received on a loop line, the SM, after ensuring that the train has come to stop outside the first stop signal, shall arrange to advise the LP of the train of the reason of the train being so stopped through a Station Staff/Points Man. The speed of train, while admitting on loop line, shall not be more than 10 KMPH.
6. The LP on being so advised shall examine the train to ascertain if it would be safe to work the train up to the station negotiating the crossover for entry into the loop line. The train, thereafter, shall be piloted up to the station after fixed signals have been taken OFF and it has been ascertained by the LP that it is safe to do so. The LP while negotiating the facing points shall observe the speed restriction, which under no circumstances, shall exceed 10 KMPH.
7. The vehicles/wagon with hot axle must not be worked onward with the train, instead they would be detached from the train or repaired.
8. If an axle box is observed to be running hot in the block section the train must be brought to a stand immediately and the axle box is examined by the LP. The LP should exercise his discretion with regard to the restricted speed at which it is safe for the vehicles or wagons to travel. On arriving at the first block station with detaching facilities the vehicles or wagons must be detached from the train.
9. Water must not be poured on the Hot Axle for to cool it but wait until it gets cooled by itself. If there is fire on the hot box then fire extinguisher, sand, soil can be used to extinguish the fire.
10. The vehicles/wagons with hot axle shall be detached from the train on arrival at the station. And it will be entered in the Wagon Exchange Register and the concerned TXR shall be informed about it. BMW-4.10 shall be followed for other instructions.

EXPANDED VIEW OF CARTRIDGE TAPERED ROLLER BEARING



Timken Roller Bearing



STEP WISE PROCESS OF HOT AXLE CTRB FAILURE INVESTIGATION

- Hot axle CTRB received at wheel shop.
- Dismounting of CTRB at wheel shop.
- Cleaning of CTRB components.
- Data recorded as per RDSO format.
- Cleaned CTRB is sent to CMT lab for failure analysis.

CUP:

Brinelling Marks

Cup is inspected visually to detect different defects *i.e.*, dent, flaking, spalling ,brinelling, rust, peeling heat discoloration etc.

Flaking

VISUAL INSPECTION OF CTRB COMPONENTS AT CMT LAB

- SEAL
  - Seal is inspected visually to detect different defects *i.e.*, damage, deformation, rubber seal etc.

DAMAGE SEAL

VISUAL INSPECTION OF CTRB COMPONENTS AT CMT LAB

- SPACER
  - Spacer is inspected visually to detect different defects *i.e.*, dent, flaking, brinelling, rust, peeling, spalling etc.

SPACER

CONE ASSEMBLY

- Consists of cone, cage and rollers.
- Cone assembly is inspected visually to detect different defects *i.e.*, dent, flaking, brinelling, rust, heat discoloration

ROLLER (deformed)

CONE

CAGE (BROKEN)

FAILURE INVESTIGATION REPORT OF CTRB FAILED ON 02.01.2023 OF DHANBAD DIVISION

Wagon No.	SC-10053943393
Rollers/cone Assembly	Damage
Cup	Damage
Grease	Burnt
Grease seals	Damage
End Cup Screws	Not found
Locking plate & Tabs	Not found
How failure detected	Manually

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Longitudinal tearing was observed on the Cup.(Fig. 1)
- Contaminated grease was observed inside the groove of the Cup. (Fig. 1)
- Spalling of metal was observed on the inner surface of the Cup. (Fig. 1)

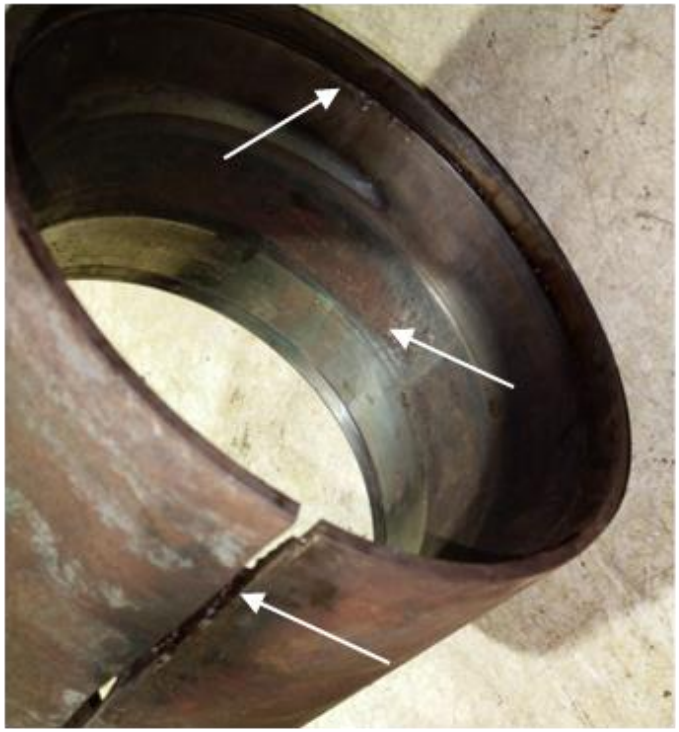


Fig.1- Showing longitudinal tearing , contaminated grease & spalling of metal on the Cup

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- One of the cages was found damaged and broken. (Fig. 2)
- Rollers of the same cone & cage assembly were found heavily deformed with plastic flow.

Fig.2- Showing broken & damaged cage

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Contaminated grease was observed on the inner side of the seal. (Fig. 3)
- Heat discoloration mark was observed on the surface of the rollers of the other cone & cage assembly.
- Circumferential wearing & flaking of metal were observed on outer surface as well as inner surface of the cone.
- Other seal, spacer & both seal wear-rings were not received for investigation

Fig.3- Showing contaminated grease on inner surface of the seal

Failure Investigation of Hot Axle CTRB

Conclusion:

It was damaged in such a condition that nothing was intact. Therefore, it was not possible to reach in final conclusion. So exact cause can not be ascertained.

PREVIOUS FAILURE INVESTIGATION REPORTS

Failure Investigation of Hot Axle CTRB

Wagon No.	ECR 9410132311
Date of Failure	01.12.2021
Bearing Make	TIMKEN
Sr. No. of Cup	135778
Mfg. Date of Cup	02/2008

संदर्भ - Sr. Section Engineer (Wheel Shop)/ER/JMPW L.No. F/WS/OFF/35(01), Dated: 04/03/2022.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Pitting marks was observed on outer surface of the cup. (Fig. 1)
- Spalling of metal, heat discoloration & brinelling marks were observed on the inner surface of the cup. (Fig. 1)
- A crack was observed at the edge of the cup.

Fig.1- Showing pitting marks on outer surface and spalling, heat discoloration & brinelling mark on inner surface of the cup.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Circumferential wearing & scoring were observed on outer surface of one of the cone.
- One of the cages was found broken & damaged. (Fig. 2)

Fig.2- Showing broken & damaged cage.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- One of the seal was found without rubber & damaged at the edge. (Fig. 3)
- Contaminated grease was observed in the grooves of the other seal. (Fig. 3)
- Heat discoloration mark was observed on the inner surface of one of the seal wear ring and on the rollers of the other cone & cage assembly

Fig.3- Showing one seal with rubber & contaminated grease and other seal without rubber.

Failure Investigation of Hot Axle CTRB

Conclusion:

The failure of CTRB is due to overloading and contamination of grease during service.

Failure Investigation of Hot Axle CTRB

Wagon No.	SCR-22091622381
Date of Failure	23.12.2021
Bearing Make	NBC/BRENCO
Sr. No. of Cup	78782
Mfg. Date of Cup	02/2012

संदर्भ - Sr. Section Engineer (Wheel Shop)/ER/JMPW L.No. F/WS/OFF/35(02), Dated: 04/03/2022.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Most of the vital components of CTRB were not received for failure investigation.
- Scoring & flaking of metal were observed on outer surface of the cup. (Fig. 1)
- Wearing, Spalling, flaking & flow of metal were observed on the inner surface of the cup. (Fig. 1)
- Bulging was observed at the edges of the cup.

Fig.1- Showing scoring on outer surface and spalling & flaking on inner surface of the cup.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- One of the received cones was found broken & heavily damaged i.e. bulging, plastic flow, wearing & flaking etc. (Fig. 2)

Fig.2- Showing one of the broken & heavily damaged cone.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Plastic flow of metal, wearing & flaking of metal were observed on outer surface of the other received cone (Fig. 3)

Fig.3- Showing plastic flow, wearing & flaking on outer surface of other cone.

Failure Investigation of Hot Axle CTRB

Conclusion:

The failure of CTRB may be occurred due to overloading during service.

Failure Investigation of Hot Axle CTRB

Wagon No.	WCR-22160975325
Date of Failure	11.01.2022
Bearing Make	BRENCO
Sr. No. of Cup	215755
Mfg. Date of Cup	12/2019

संदर्भ - Sr. Section Engineer (Wheel Shop)/ER/JMPW L.No. F/WS/OFF/35(02), Dated: 04/03/2022.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Scoring mark was observed on outer surface of the cup. (Fig. 1)
- Contaminated grease was observed inside the grooves of inner surface of the cup.
- Heat discoloration was observed on inner surface of the cone.

Fig.1- Showing scoring mark on outer surface of the cup.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- One of the cages was found broken, deformed & damaged. (Fig. 2)
- Other cone & cage assembly was found broken, deformed & damaged.

Fig.2- Showing broken, deformed & damaged cage.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Both of the seals were found without rubber. (Fig. 3)
- Plastic flow of metal & deformation were observed in most of the received rollers.

Fig.3-Showing both seals without rubber.

Failure Investigation of Hot Axle CTRB

Conclusion:

The failure of CTRB is due to overloading and contamination of grease during service.

Failure Investigation of Hot Axle CTRB

Wagon No.	SECR-12140310703
Date of Failure	26.01.2022
Bearing Make	TIMKEN
Sr. No. of Cup	180149
Mfg. Date of Cup	02/2009

संदर्भ - Sr. Section Engineer (Wheel Shop)/ER/JMPW L.No. F/WS/OFF/35(01), Dated: 16/03/2022.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination**:
- CTRB was received in oxy-cut condition.
- One of cage and seal was stuck inside the cup during oxy cut.
- Circumferential scoring marks were observed on outer surface of the cup. (Fig. 1)
- Contaminated grease was found inside the groove of the seal stuck with the cup as well as inside the groove of the cup. (Fig. 1)
- Heat discoloration marks were observed on the inner surface of the cup.

Fig.1- Showing circumferential scoring marks on outer surface of the cup and contaminated grease inside the groove.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- One of the cage was found broken, damaged & deformed. (Fig. 2)

Fig.2- Showing broken , damaged & deformed cage

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Deep brinelling marks with plastic flow of metal were observed on outer surface of one of the cone and heat discoloration mark was observed on the inner surface of the other cone. (Fig. 3)
- Rollers and one of the seal was not received for failure investigation.

Fig.3- Showing deep brinelling marks with plastic flow of metal on outer surface of one of the cone.

Failure Investigation of Hot Axle CTRB

Conclusion:

The failure of CTRB is due to overloading and contamination of grease during service.

Failure Investigation of Hot Axle CTRB

Wagon No.	ECR-22101625708
Date of Failure	28.01.2022
Bearing Make	TIMKEN
Sr. No. of Cup	474131
Mfg. Date of Cup	07/2011

संदर्भ - Sr. Section Engineer (Wheel Shop)/ER/JMPW
L.No. F/WS/OFF/35(02), Dated: 16/03/2022.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Circumferential scoring and pitting marks were observed on the outer surface of the cup. (Fig. 1)
- Spalling of metal and contaminated grease inside the groove was observed on the inner surface of the cup. (Fig. 1)
- Bulging was observed at the edge of the cup. (Fig. 1)
- A groove formation was observed on the inner surface of one of the seal and contaminated grease was observed inside the groove of both the seal.

Fig.1- Showing Circumferential scoring on outer surface of cup. Spalling of metal and contaminated grease inside the groove on the inner surface of the cup and bulging at the edge of the cup.

Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Flaking of metals and pits were observed on almost all the rollers of one of the cone and cage assembly. (Fig. 2)
- Contaminated grease was observed in between one of the cage and cup assembly.

Fig.2- Showing flaking of metals and pits on almost all the rollers of one of the cone and cage assembly.

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Failure Investigation of Hot Axle CTRB

- **Visual-Examination:**
- Pitting & flaking of metals were observed on outer surface of the cone. (Fig. 3)
- Contaminated grease was observed inside groove of one of the cage.

Fig.3- Showing pitting & flaking of metals on outer surface of the cone.

Failure Investigation of Hot Axle CTRB

Conclusion:

- The failure of CTRB is due to overloading and contamination of grease during service.

Hot axle case – Adaptor cause

PARAMETERS OF WIDE JAW ADAPTER

Sr. No.	Description	Measured Value	Actual Value	
			New	Worn
01	Adapter Crown Lugs	157 mm	156 mm	164 mm
02	Adapter Side Lugs - I Adapter Side Lugs - II	141 mm 138 mm	130 mm	136 mm
03	Adapter Side – I	257 mm	268 mm	262 mm

- Name of Manufacturer : EA
- Date of Mfg. : Not Visible

Note: 1. Crown sheet heavily worn out.
2. Colour matching of adapter was done. Only 30 % matching was achieved which is less than RDSO mandated minimum 80 %. The insufficient contact area of the defective adapter caused impact loading on the CTRB, causing cup breakage.

Cause of failure	As per adapter investigation report. 1.Crown Sheet Heavily worn out 2. Colour matching of adapter was done. Only 30% matching was achieved, which is less than RDSO mandated minimum 80%. Insufficient contact area of the defective adapter caused impact loading on the CTRB, causing Cup breakage (crack).

Conclusion-

*CTRB failed due to adapter failure.[insufficient contact area of the defective adapter caused impact loading on the CTRB.]

SSE/INSP/DHD

Hot axle case – Adaptor cause

FT/Insp/06

Check sheet

Wagon No.- 62371002632
Date of failure 11-01-2023
Make MF
Sr.No of Adapter HN-281
Year of Manufacturing 2021
Service Life 01 Year

Sub – Condition report of adapters of hot axle wheel sets.

In reference to above subject inspection report of adapters of hot axle wheel sets are as follow-

Sr.No	Attribute	Reading as per G- 81 manual (in mm)	Measured value (in mm)
1	Side measurements	181-175 (Narrow Jaw Adapters) 268 – 262 (Wide Jaw Adapters)	– 267
2	Side lug	97-103 (Narrow Jaw Adapters) 130 – 136 (Wide Jaw Adapters)	– 130
3	Crown lug	155.5-163.5 (Narrow Jaw Adapters) 156 – 164 (Wide Jaw Adapters)	– 156
4	Shoulder groove	Maximum 0.7 mm groove is allowed	No groove found
5	Machined relief	Minimum 0.8 mm machined relief should be there.	OK
6	Bore radius	$110.50^{+0.015}_{-0.112}$	110·30
7	Adapter bore seat to crown seat	26.2-22.7 (Narrow Jaw Adapters) 48.5 – 45 (Wide Jaw Adapters)	– 48·5

General Remark: Adapter bore radius is less than specified limit in S.N.06.

Conclusion: Adapter is condemned.

SSE / Inspection

Damage Causes – CTRB Failure

- Grease seal damage – In transit or maintenance.
  - Dent of casing
  - Loose grease seal.
  - Cocked out seal.
- Worn Adaptor / wrong adaptor.
  - Non uniform load zone
  - More stress
  - Pinching effect

- Dynamic operating condition – Wheel / rail interaction.
  - Grease weepage
  - Cage damage
  - Wear in bearing components.
  - More load – More stress.

- Bearing misalignment
  - Geometrical stress concentration.
  - Edge loading / stress
  - Increased end play.

THANK YOU