VEHICLE FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

Vehicle Attachment – MCI Steering Gear Examination Report From ZF-TRW Commercial Steering

Palm Springs, California

HWY17MH005

(16 pages)

MOTION AND MOBILITY

Accident Gear Inspection MCI Bus – 23FEB 2017

Bruce Noah
27 FEB 2017

ZF Friedrichshafen AG

SETA	N/A	**DATE**	23 FEB 2017	**LAB TECHNICIAN**	Patrick Jones
TASK	N/A	**GDPIM**	N/A	**PRODUCT ENGINEERS**	Bruce Noah

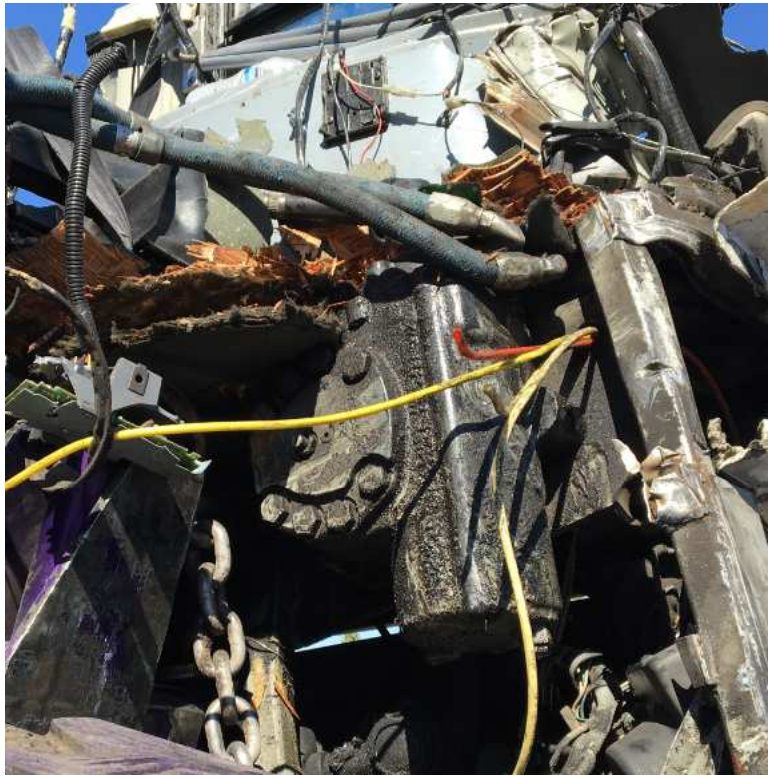
DISTRIBUTION: Dave Huddleston; Jonathon Gerke;
Non ZF attendees: Robert Accetta, Jerome Cantrell NTSB

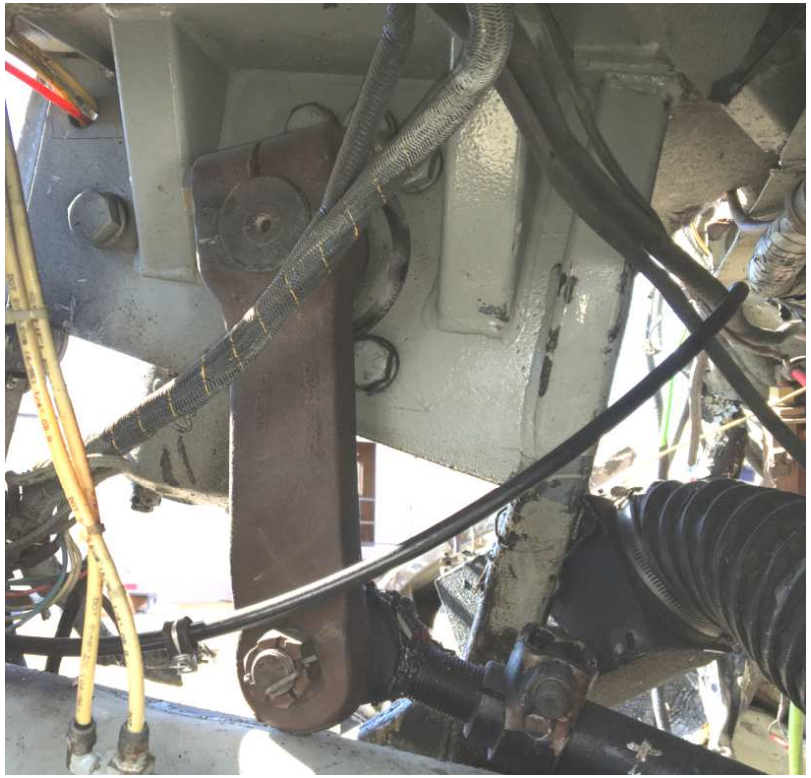
PART DESCRIPTION: TAS85029A steering gear; date code 115-96; serial number S16A14

PURPOSE AND DATE OF TEST: Evaluate steering components condition after the accident. Parts evaluated on 23 FEB 2017 at GCSS R&D lab, Lafayette, IN.

OVERVIEW: Accident involving an MCI resulted in multiple fatalities. NTSB requested ZF analysis of steering gear from this bus. There were no driver claim of steering problems. Gear analysis is a due diligence investigation into all aspects of the bus condition.

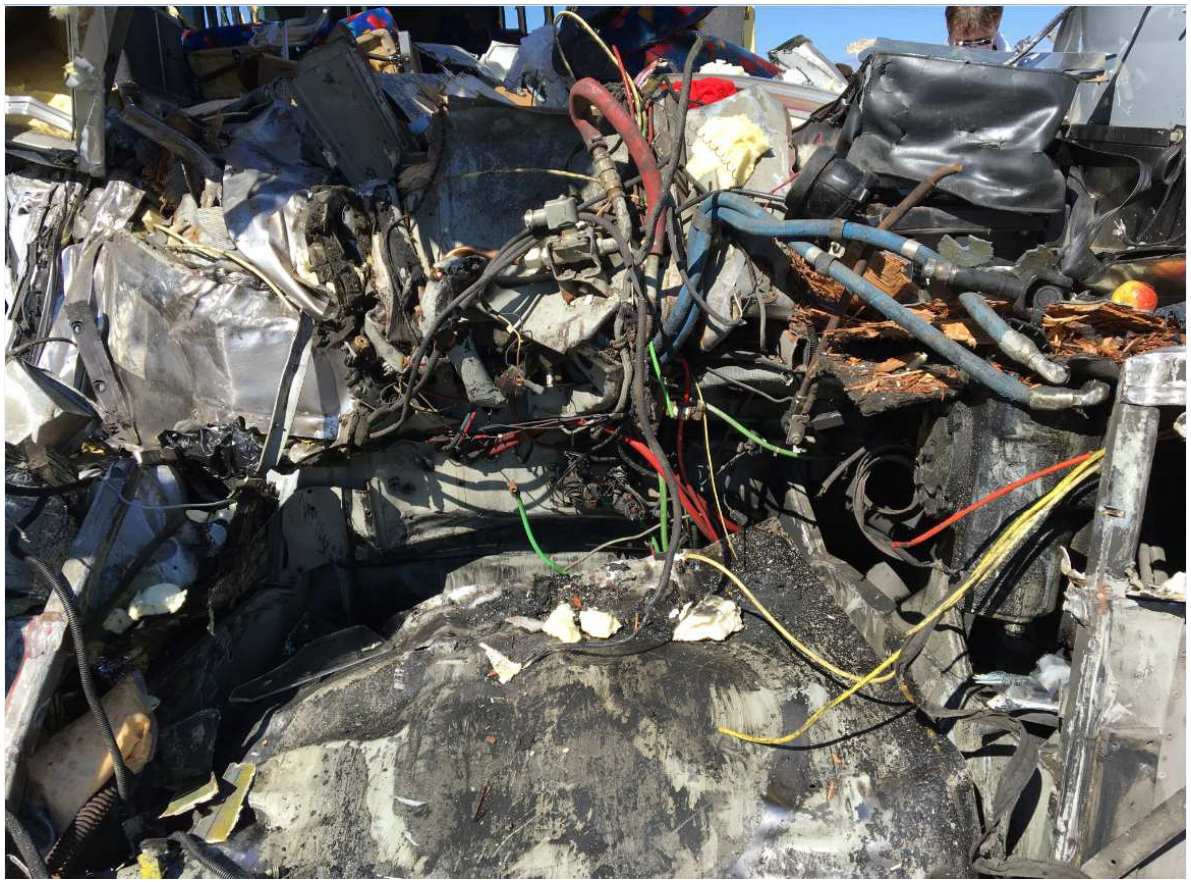
CONCLUSION: This TAS85029A was fully functional. The steering gear sustained no damage from the accident. Internal component condition was good showing very little 21 years in service. The test and evaluation of the parts indicate that this steering gear was completely functional at the time of the accident.





Gear on vehicle post accident
(photos courtesy of NTSB)

Bus:
VIN:
Make: MCI
Model:
Model Year: 1997
Company Unit #:
Manufactured:
Placed in service:
Mileage: unknown
GVWR:
GAWR – Axle #1: .
GAWR – Axle #2:
GAWR – Axle #3:
Engine:
Transmission:
Steering Gear: TAS85029A
Brake Type: Air



Vehicle post accident
(photo courtesy of NTSB)

Steering Gear – As received at TRW

Input Shaft Splines intact but damaged from tensile load forcing u-joint pinch bolt against groove during accident Output Shaft Splines are undamaged and in good condition.

Adjuster nut shows no signs of broken paint indicating no servicing of the lash adjuster.

As received the gear output shaft was in about 35 degrees right turn position.

Lab Test data –

Technician installed gear on a test stand and supplied hydraulic power. Gear functioned normally and built rated pressure against a dynamic load. No rough spots or stiction noted during subjective test.

Did not complete PT1064 performance test because fluid was leaking from the end of the input shaft. A leak from that area indicates a damaged torsion bar o-ring. It is unknown whether the leak resulted from the accident or started prior. The gear was full of power steering fluid, and NTSB reported the fluid reservoir was full following the accident.

Teardown Inspection

Steering Gear

The sector teeth were intact and no brinell marks noted on the trunnion surface. This indicates no impact load into the output shaft.

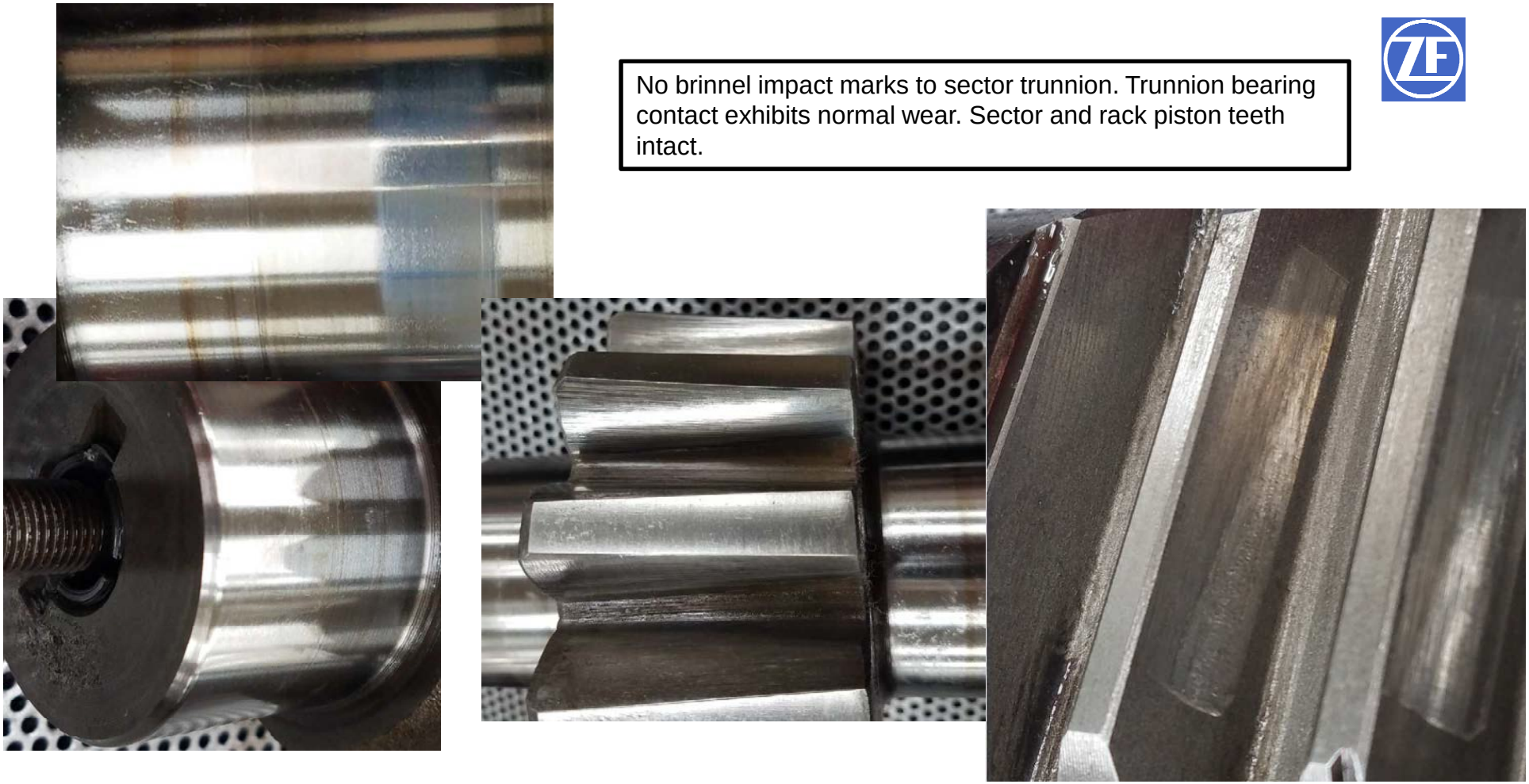
The rack teeth were intact.

All of the recirculating ball bearings (34) were present and still within the rack piston assembly.

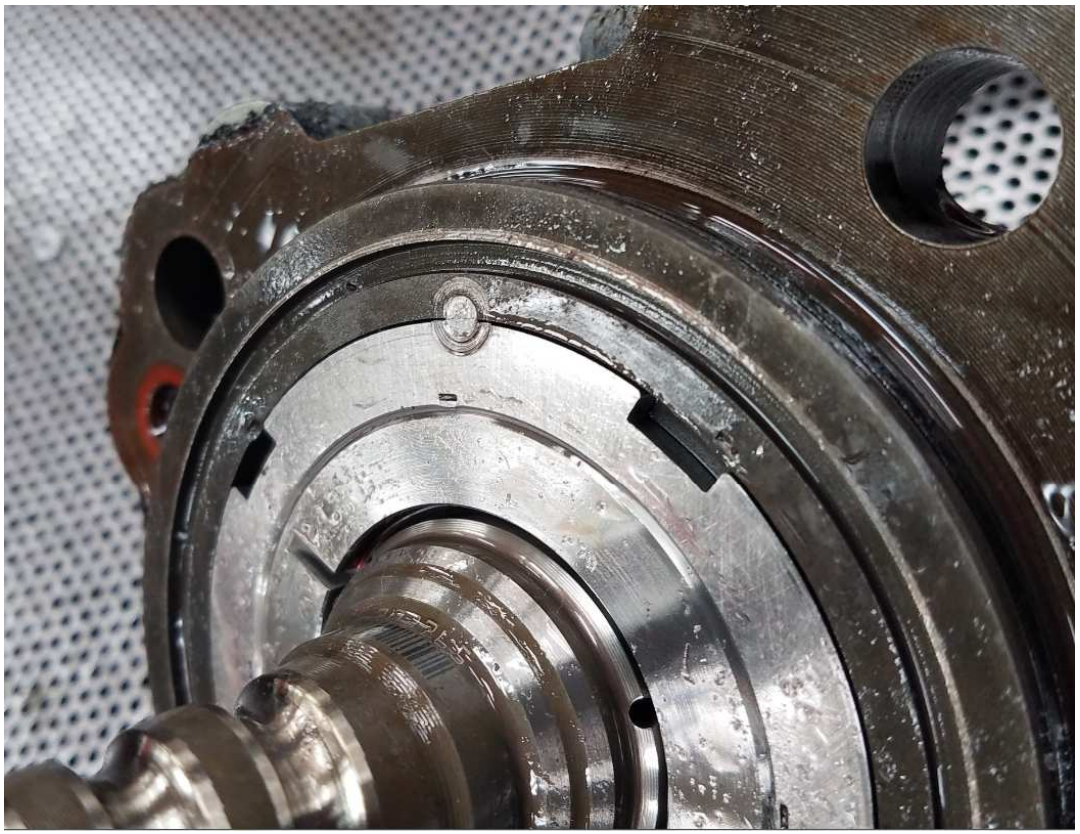
The recirculating ball bearings did not generate brinell marks (indents) on the worm helix indicating no impact driving the rack piston against the worm.

The valve surface adjacent to the needle roller bearings had no impact imprints (no brinelling).

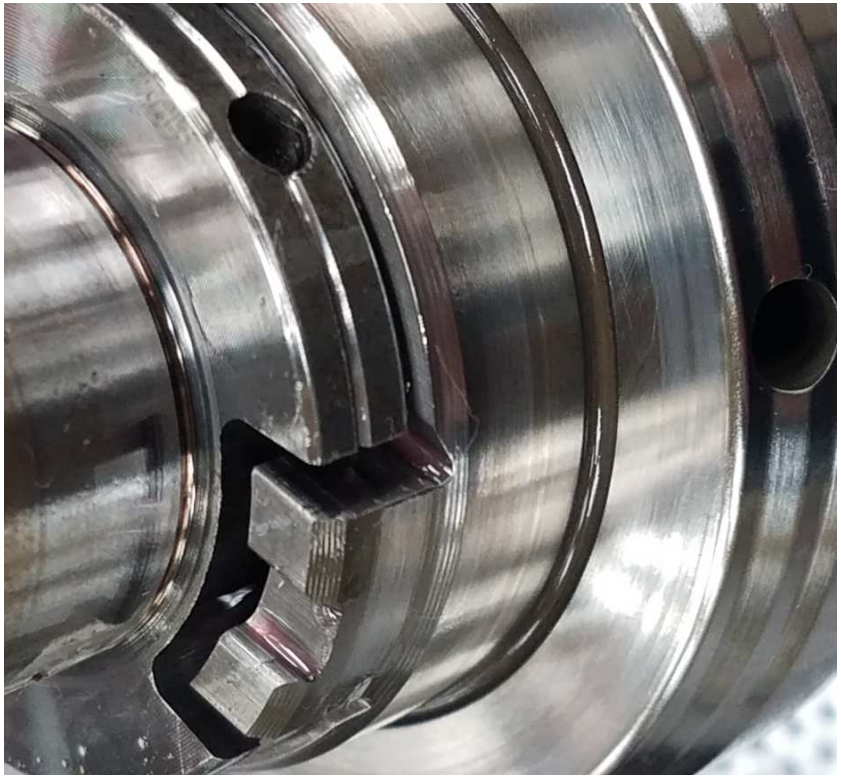
No brinnel impact marks to sector trunnion. Trunnion bearing contact exhibits normal wear. Sector and rack piston teeth intact.



No brinnel impact marks from the balls to the worm.



Valve housing adjustment intact with no damage.



No damage to valve housing thrust bearings. Wear appears normal age.

Conclusions

The steering gear was fully functional.

Tear down and inspection showed no internal damage with normal wear for the age.

The evidence from the subjective test and parts shows the gear was functional at the time of the accident.