VEHICLE FACTORS GROUP CHAIRMAN'S

Vehicle Attachment – Motorcoach Steering Gear Inspection Report

Mount Pleasant, Pennsylvania

HWY20MH002

(12 pages)

Procedure Servocom

8098.955.508

Manufacture Date: 10 – 04

Serial Number: 001838

Investigation Date – 6.23.2020

Receiving area

- documentation of the customer complaint – Request from NTSB, Jerome Cantrell
- mileage 751,637 miles estimated
- months in service – 10.04 > 1.5.2020
- visual check of package – Good

Test level 1

Visual inspection:

- external damages – *None to Steering Gearbox*.
- visible leakage - *No*
- sealing plug present - *No*
- measurement of residual dirt – Expected amount based on manufacture date of steering gearbox (refer to pictures)
- customer influence/misuse - Two mounting bolts on the drop arm damaged by third party, weld also apparent on head of bolt

Bench tests:

→ read out the corresponding drawing from Axalant – *Yes Referenced Axalant*
→ checking the parameters according to the drawing - *Yes Referenced Axalant*
→ in parallel with the following tests: subjective noise assessment

- maximum pressure – *150 bar*
- leakage oil measurement – *Inspected, refer to attached report*
- Failure criteria:
- *test result(s) out of specification – All within specification*
- *visible leakage - None*
- *unusual noise - None*

Follow NTSB unofficial request for investigation:
If no trouble is found:

- *documentation of the test results and proceeding with the test according to customer complaint – Inspected, refer to attached report*

[redacted]

	Function:	Leakage:	Acoustic:
Test level 2	→ *Selection of the possible tests depending on the information from the customer as well as the created fault tree.* - Stiffness - *None* *NA – Passed Test*	→ Leakage test on test bench: - dynamic test with 50 °C oil temperature *Failure criteria:* - *visible leakage - None*	→ Noise test on test bench: - noise characteristic measurement – *no abnormal noises noted*
	If no trouble is found: - *documentation of the test results – Refer to test report* - *disassembly + single part assessment of all units which are not intended for a verification or system test – Inspected, refer to attached report*		

[redacted]

Additional Information

Steering gear received in well packaged condition at Bosch [redacted], residual oil from the steering gearbox had leaked into the internal packaging but not the externally

External condition of steering gearbox is very good considering the manufacture date 10/04 (October 2004).

Note; the steering drop arm retaining nut which is connected to the steering gearbox sector shaft had been removed by a third party, however, the drop arm itself had not been removed.

The Bosch Technician was unable to remove the drop arm from the sector shaft during the investigation. Note this was not detrimental to the functional test and inspection.

Only a very small amount of oil was captured (10 milliliters), dark in color with no metallic particles.

Steering gear lash was measured .020mm – [redacted]

Mechanical lock to lock (no assist) shows no sign of uneven feel.

Functional test:

Refer to attached test report;

Internal leak within specification, no external leak, and maximum flow [redacted] was achieved with maximum pressure of [redacted] set at the pump, also achieved. No external leaks

Internal inspection of Steering Gearbox:

- Small amount of residual oil within steering gearbox
- Unable to remove drop arm from gearbox (suspect owner couldn't either)
- Tightening torque for the six rear steering box cover screws were measured prior to disassembly. [redacted]
- Upper (input shaft side) bearing, washer and housing bearing surface show signs of impact
- Worm shows signs of impact in two areas; Refer to pictures
- Piston shows sign of impact; Refer to pictures
    - Impact to all parts are light and suspect occurred to the left of center position

Conclusion:

Following the Bosch AS test and detailed inspection, we find no defects with the performance of the steering gearbox.

Note, whilst slight impact marks were evident on the piston, worm, upper bearing and washer, we cannot determine if this occured prior to or during the accident.

Test Report

Servocom/Servosino

[redacted]

BOSCH

Analysis report

Servocom/Servosino

Complain.Cust. [redacted] **Cust. ref.-no.:** Accident# HWY20MH002

Notification- & customer information

Warranty engineers:	[redacted]	[redacted]			
Notification:	230005810550			Vehicle Ident No.:	Not provided
QI-Notification:	200000293022	MIS:		Platform:	
Shelf number:		Mileage:	M	Project:	
Material:	8098955508	Claim:	0005		
Customer complaint:					
Production Plant:	[redacted]				
Serial-No.:	001838	Complaint mode:	field product	Brand/Tier:	[redacted]
ProdDat:	10/15/2004	Warranty decision:			

Further information / remarks:

[redacted]

Visual check (prior test bench check)

	Yes	No	Note
Visible damages	X		
Visible leakages		X	
Sealing plug existing		X	Did not have sealing plug. the customer left their hose connections on
Misuse/External damage visible	X		
Oil sample	X		

Test bench results

Standard tests					Measured value/s
Test level 1				OK / NOK	[redacted]
Tested on test bench	Yes	X	No		
Leakage oil, regular Q*				X	
Leak tightness during test bench				X	
Stiffness				X	

* Parameters specified in drawing are only valid for new parts in delivery condition. Exceeding of these parameters for a field claim does not imply that this claimed part is out of specification. In case of a complaint the claimed parts have to be checked for fault individually. The claim can be only accepted if this analysis confirms a defect.

Visual Inspection - single part assessment

	OK	NOK	Note
Housing	x		
Sealing surface	x		
Threaded hole	x		
Housing cover (l & r)	x		
Shaft seal	x		
Sealing ring	x		
O-Ring	x		
Washer	x		
Threaded hole	x		
Sealing track	x		
Piston	x		
Ball circuit	x		
Steering stop	x		
Worm		x	Indentation on bearing surface and slight impact damage in ball recess
Bearing surface		x	Indentations
Washer		x	Indentations
Piston		x	Indentation on the Bearing surface
Other		x	Dust cup damaged

[redacted]

Based on the measurement taken during tear-down (from the end of the worm to the impact damage in the ball circuit of the worm (109 mm), the piston was 18 mm out of middle position in direction to the input shaft.

This is approximately one complete turn of the steering wheel (direct 1:1 from the input sline of the gearbox).

With this 18 mm we have at the sector shaft, the drop arm angle is 21° out of the middle position during this impact (turning left from center position)

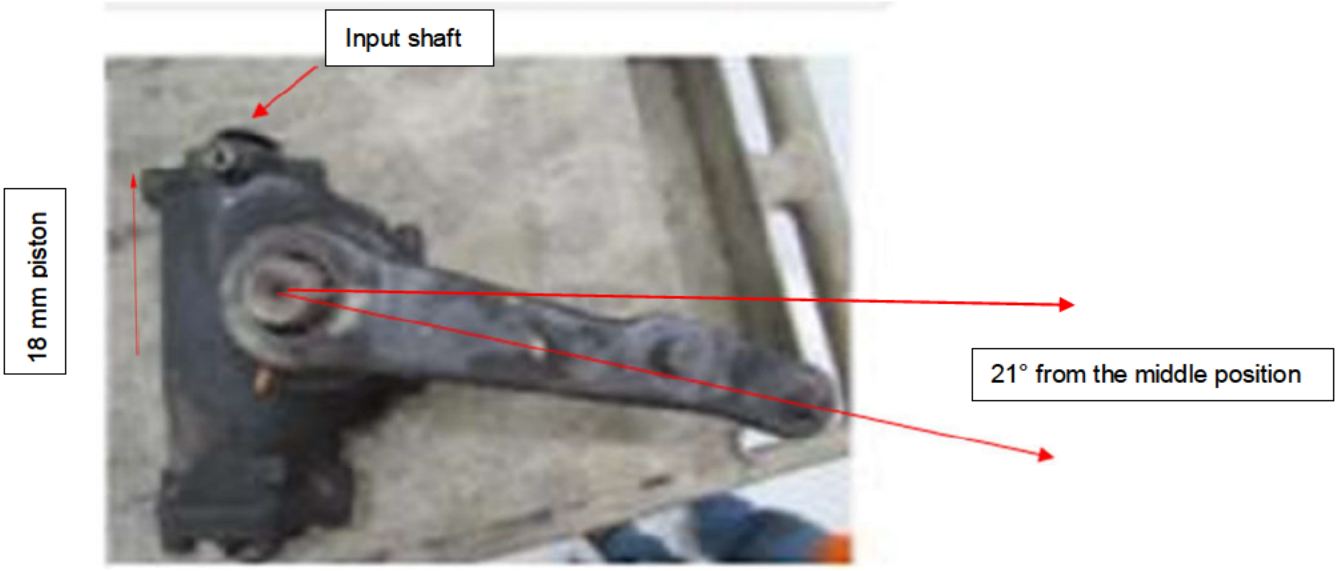


Bild 2

Bild 4

Bild 6

Bild 7

Bild 8

Bild 10

Bild 12

[redacted]

[redacted]

[redacted]

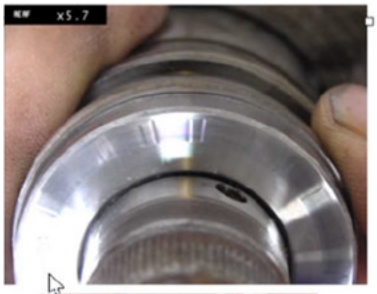


Bild 15

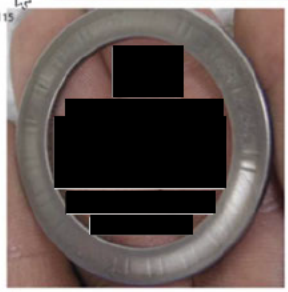


Bild 16

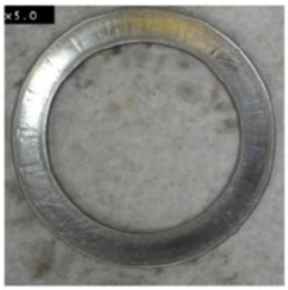


Bild 17

Bild 18

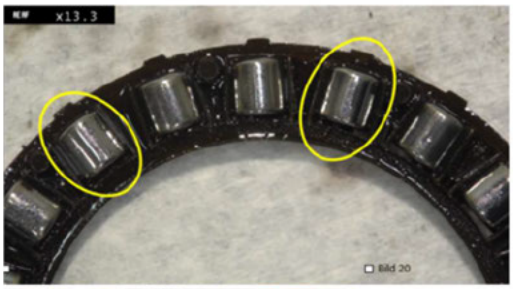
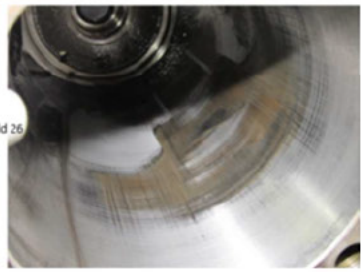


Bild 20

Bild 26



[redacted]

Additional Photos

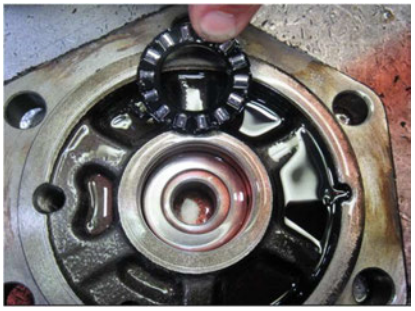
Drop Arm

Measure Lash

Dissasebly:

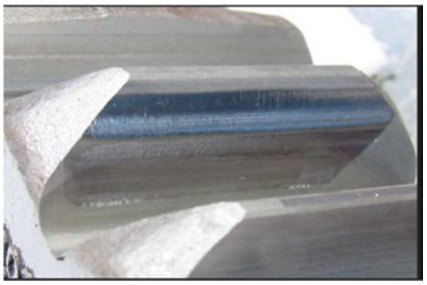
Rear End Cover



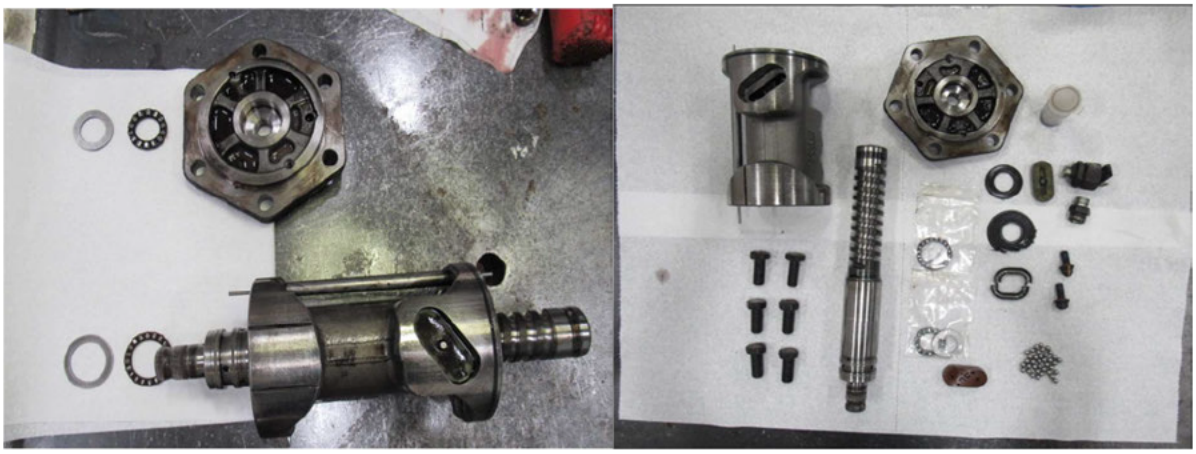
Piston *– Light Impact to upper bearing, washer. Middle Piston tooth show wear mark only, no impact damage*



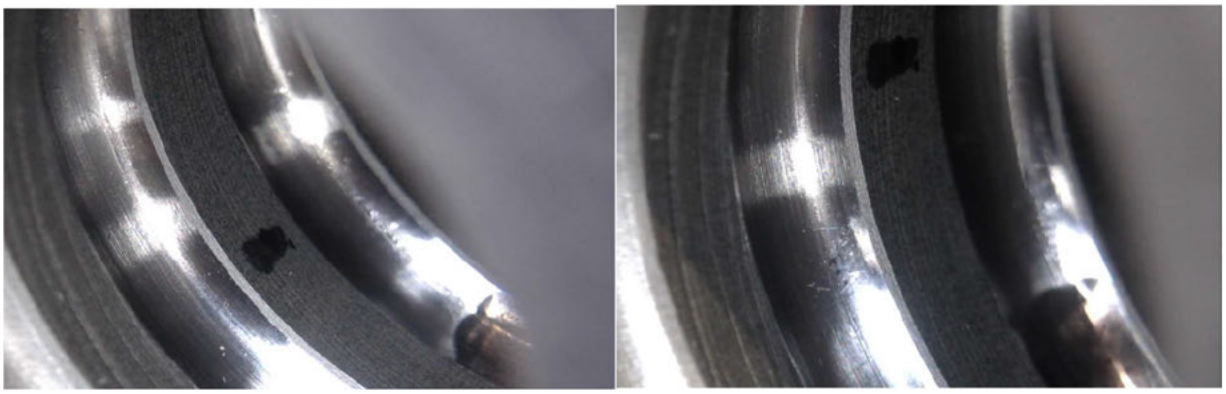


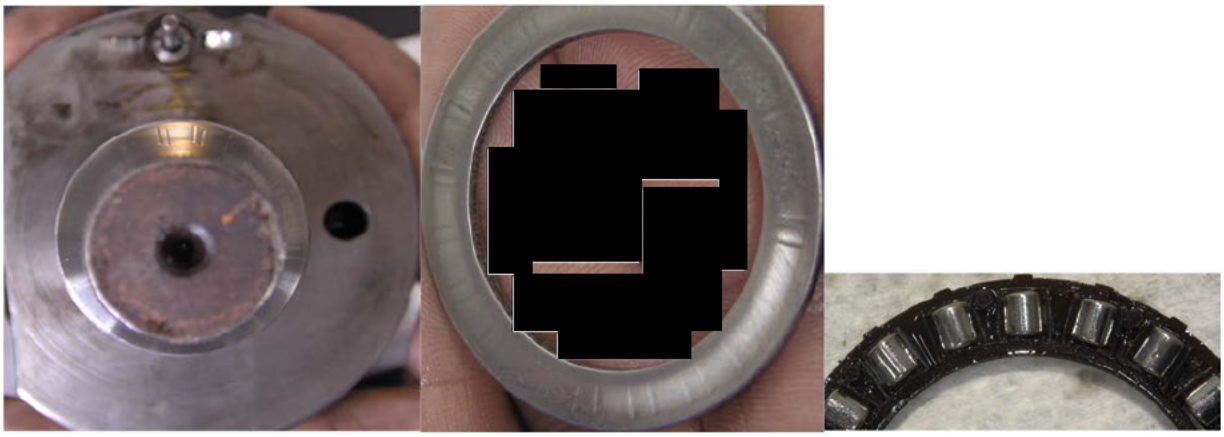

[redacted]

Piston and Rear End Cover



Piston





Worm: *Light impact*

Measurement - *from end of worm to impact area*