This file represents a consolidation of multiple files sent by the manufacturer. Please use the bookmarks to navigate to each file. (Each bookmark label is the name of the original file.)

Methodology Step:- D M A I C R

Separation of 6-panel document on the 15th of September 2017 in two parts for better handling:

Slide 1-130 see file: *20170915_6Panel_Will_not_latch_excerpt slide 1-130*

6-panel in progress: *20170915_6Panel_Will_not_latch*

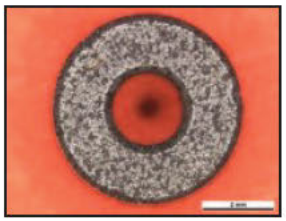
Both documents were sent out on the 15th of September 2017

Intermediate result of KV actuator analysis

[redacted]

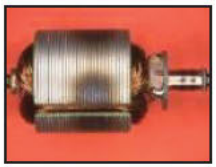
Slight residues of water visible, coming through KV lid and KV housing in area of the rivet bolt

Slight corrosion of motor housing in the area of KV housing fixing and corrosion of motor bearing

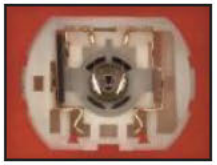


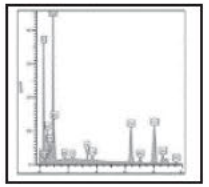
Visual inspection of sinter bearing and EDX analysis shows known material mix.

No further unusual parts or areas of the KV motor detected during the investigation.



Investigation of commutator, motor housing, magnets, brushes
→ no unusualness detected





EDX analysis of bearing surface shows no unusual materials

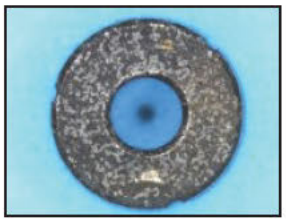
Black residues on motor shaft and washer
Surface of washer rough.

Intermediate result of KV actuator analysis

[redacted]

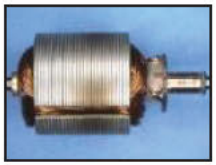
Slight residues of water visible, coming through KV lid and KV housing in area of the rivet bolt

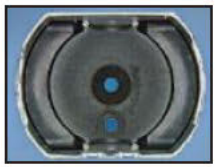
Corrosion of motor housing concentrated in the area of KV housing fixing and corrosion of motor bearing. Also pink residues visible, if these are organic can not be confirmed. EDX mapping shows no concentration of special chemical elements. Residues were found nowhere else.

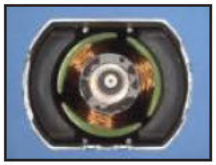


Visual inspection of sinter bearing and EDX analysis shows known material mix.

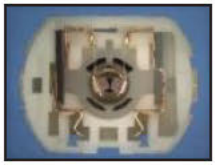
No further unusual parts or areas of the KV motor detected during the investigation.

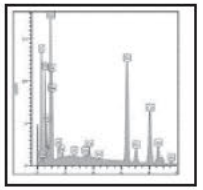






Investigation of commutator, motor housing, magnets, brushes
→ no unusualness detected





EDX analysis of bearing surface shows no unusual materials

Slight black residues on motor shaft and washer.
Surface of washer more clean.

Intermediate result of KV actuator analysis

[redacted]

Disassembly of motor postponed.

In the first step motor will be assembled back in the failed latch for further testing's.

Motor on the way back to Wuppertal.

Methodology Step:- D M A I C R

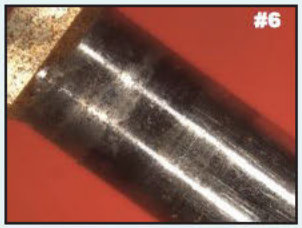
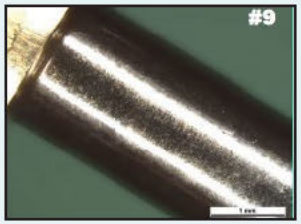
Scope and Prioritise Potential Causes

Comparison of residues

[redacted]

US vehicle (July 2015)	US vehicle (July 2015)	Dubai vehicle (Dec 2014)	Dubai vehicle (Dec 2014)
			
			

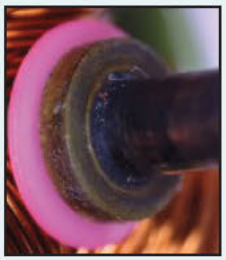
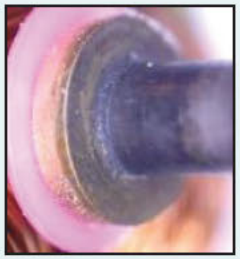
[redacted]

UK vehicle X351 (Jan 2015)	UK vehicle (Jan 2015)	UK vehicle X351 (Jan 2015)	UK vehicle (Jan 2015)
			
			

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Comparison of residues

JLR Corrosion Test sample A3	JLR Corrosion Test sample A4	JLR Corrosion Test sample A5	JLR Corrosion Test sample A6	JLR Corrosion Test sample A8
NTF latch from Dubai (LW351442) BROSE REF: 44a Build date: 14.01.14 Old KV spring, no grease, no tape 480h JLR corrosion Test KV function unwinding without short circuit → **ok**	NTF latch from Dubai (LW351442) BROSE REF: 44b Build date: 14.01.14 Old KV spring, no grease, no tape 720h JLR corrosion Test KV function unwinding without short circuit → **ok**	NTF latch from Dubai (LW351442) BROSE REF: 44c Build date: 13.01.14 Old KV spring, no grease, no tape 480h JLR corrosion Test KV function unwinding without short circuit → **ok**	NTF latch from Dubai (LW351442) BROSE REF: 44d Build date: 10.01.14 Old KV spring, no grease, no tape 480h JLR corrosion Test KV function unwinding without short circuit → **ok**	Build date: 19.05.15 New KV spring, no grease, no tape 840h JLR corrosion Test KV function unwinding without short circuit → **ok**
				
				

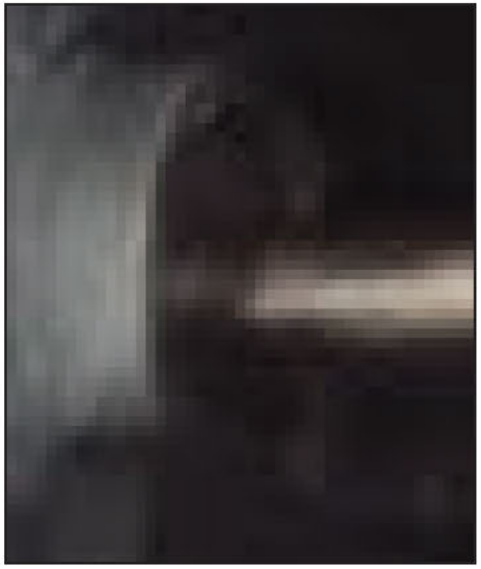
Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

Colour comparison of KV sinter bearing

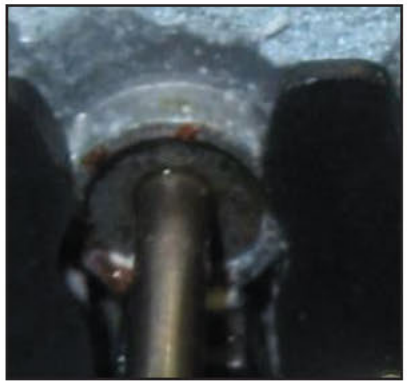
[redacted]

JLR corrosion test sample A3 after 480h



sample A5 after 600h

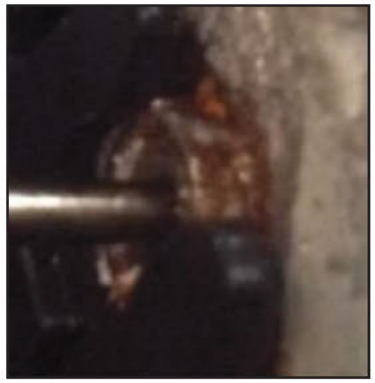
OK without short circuit



sample A 6 after 480h

OK without short circuit

OK without short circuit

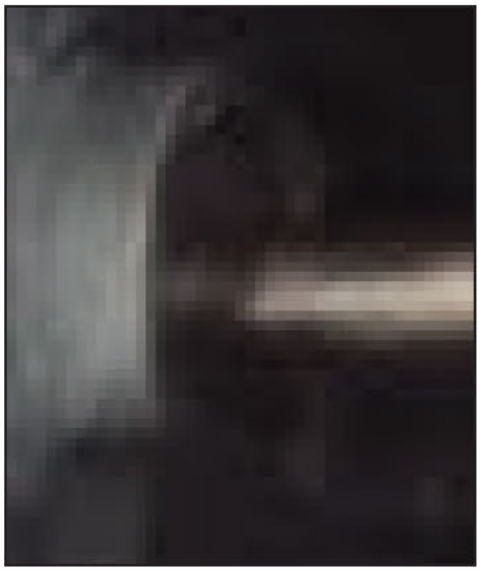


sample A8 after 720h

OK without short circuit

Colour comparison of KV sinter bearing

[redacted]



Brose corrosion test (1176h) all ok without SC

OK without short circuit

OK without short circuit

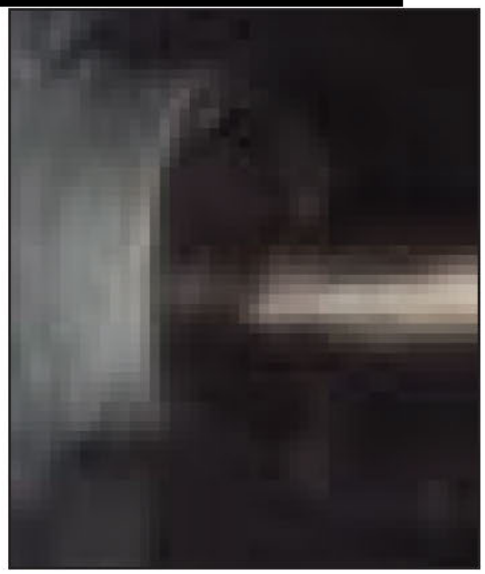
OK without short circuit

OK without short circuit

Colour comparison of KV sinter bearing

[redacted]

X260 corrosion test



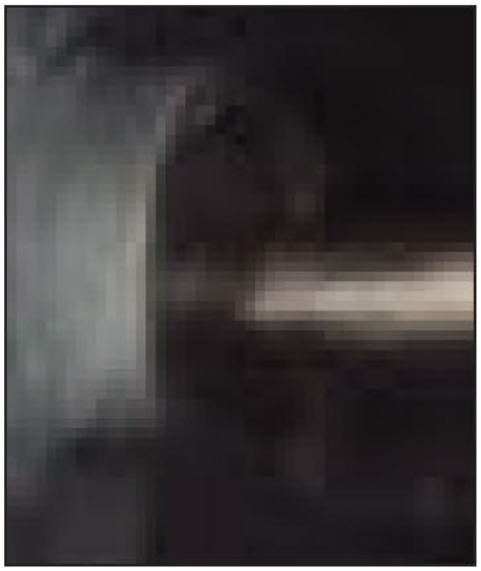
X760 corrosion test ok wthout SC

OK without short circuit

OK without short circuit

Colour comparison of KV sinter bearing

[redacted]



Brose corrosion test (360h)

OK without short circuit

OK without short circuit

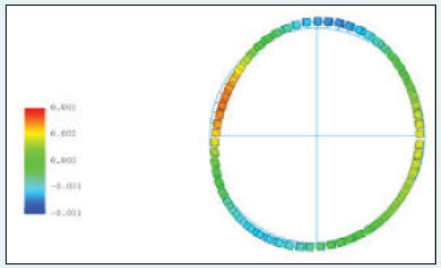
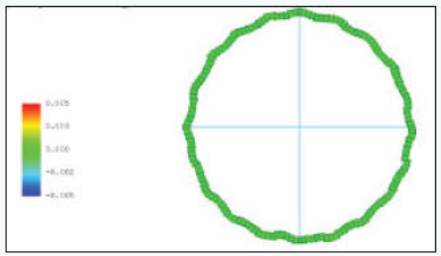
Conclusion: grey colour of sinter bearing known and no indication of non working KV actuator

Dimension check of front bearing and shaft

Parts available from material lab, parts will be send to external lab to check the dimensions
Results available:

Material analysis after dimension check

Dimensional Check:

Part	[redacted]	[redacted]	Grafik
Sinter Bearing	Diameter: **2,061 mm** Roundness: **0,004 mm**	Diameter: **2,037 mm** Roundness: **0,001 mm**	
Shaft	Area Interface to sinter bearing: Diameter: **1,985 mm** Roundness: **0,006 mm** Area out of sinter bearing: Diameter: **1,975 mm** Roundness: **0,001 mm**	Area Interface to sinter bearing: Diameter: **1,988 mm** Roundness: **0,013 mm** Area out of sinter bearing: Diameter: **1,975 mm** Roundness: **0,001 mm**	
Freeplay	0,076 mm	0,049 mm	

Conclusion: Freeplay between inner diameter sinter bearing and outer diameter shaft.
Slightly higher diameter on shaft of area interface to sinter bearing due to corrosion residues.

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Mechanical Function check of KV actuator after software flash P068

1. Close all doors to fully latched position
2. Lock (or double lock) the vehicle
3. Open the driver door by KV actuator (touching and pulling the o/s handle fast before system switches to unlock)
4. Close the door to fully latched position
5. Check if latch is engaged (pull door through open window from outside)
6. If door stays in engaged position → ok, if door opens → nok
7. Repeat step 1 to 6 with front passenger, LH rear passenger and RH rear passenger door

→ Replace nok latch and send it for investigation to Brose

Methodology Step:- D M A I C R

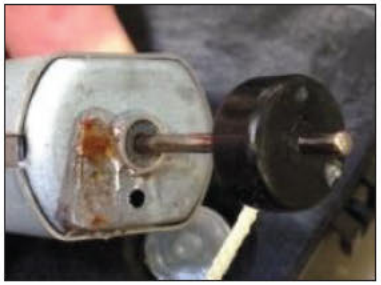
Scope and Prioritise Potential Causes

Latch from Critical Concern List / [redacted] UNITED STATES(USA)
"Inadvertent Door Open Post P068 27/07/2015 dbromage"

Latch received with 3 windings left on motor shaft

After KV operation at test box with open circuit cord fully unwound

→ OK



Corrosion visible at motor housing, sinter bearing grey

Video first KV operation

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Latch from Critical Concern List / unknown VIN number

Latch received with 3 windings left on motor shaft

After 3 KV operation at test box with open circuit cord fully unwound

→ **OK**

Video of KV actuations

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

Latch from Critical Concern List / [redacted] UNITED STATES (USA)
"Inadvertent Door Open Post P068 26/08/2015 dbromage"

FT RH CL PC KV
18.08.2014

Latch received with 6 windings left on motor shaft

Sinter bearing grey, corrosion at the motor housing
Failure prior to P068 update, P068 didn't resolve issue, latch replaced

KV motor operation

→ nok KV function

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] // USA

passenger door swung open while vehicle was in motion

Software flash 26.08.2015 → repair date 30.09.2015

FT RH CL PC KV
07.02.2015

Latch received completely unwound

Grease on the sinter bearing

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **ok KV function**

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] // USA

Door opened whilst vehicle in motion & struck pole. 09/10/2015 kcrutchl

Software flash 03.09.2015 → repair date - no latch change according AWS data

received four handles back, but no latch

As agreed parts forwarded to Matt Newman
UPS Tracking No: [redacted]

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] / USA

Inadvertent Door Open 13/11/2015 dbromage

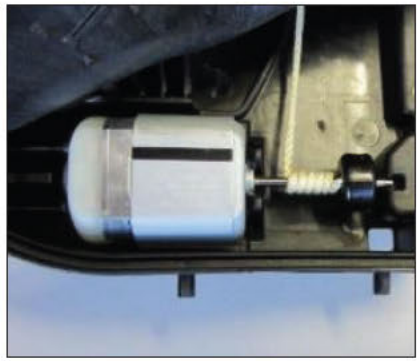
Software flash 26.08.2015 → repair date 12.11.2015

FT RH CL KV
23.08.2013

Latch received with 6 windings left on motor shaft

Sinter bearing grey, corrosion on motor housing visible

KV motor operation open circuit	**→ ok KV function - cord fully unwound after first operation**
KV motor operation short circuit	**→ nok KV function**
KV operation first short then open	**→ ok KV function**



Latch from Critical Concern List [redacted] // USA

Shake-Test under seal load

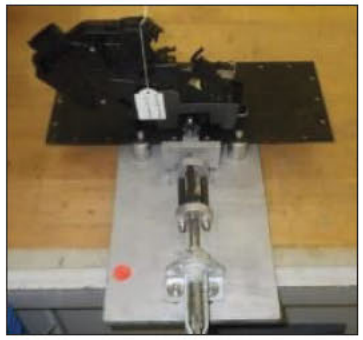
Test procedure:

1. **Start condition: Latch in primary position, seal load 311N, locked**
2. **KV operation with pulled o/s lever, (with short circuit condition)**
3. **Latch releases, self return of o/s lever, → KV motor stops with ~4 windings left on motor shaft**
4. **Close latch to primary position again, applied seal load 311N**
5. **Shake fixture (also with shocks to simulate pot-holes)**

Result:

No self release can be provoked, cord rotates in unwinding direction and ends with ~1,5 windings left

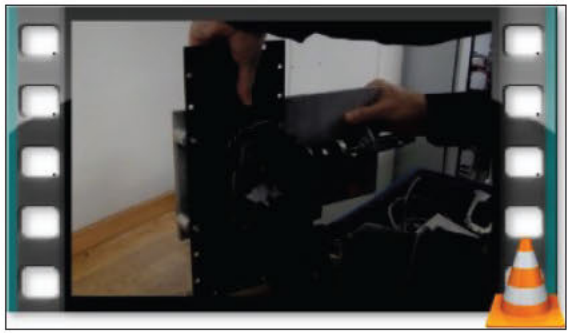
Fixture:



before shaking:

after shaking:

Video:



Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

Latch not from Critical Concern List [redacted] // USA

CUSTOMER STATES SINCE RECALLS PREFORMED VEHICLE HAS HAD CONSTANT ISSUES DOOR WILL NOT LATCH OR LOCK MUST BE HELD CLOSED WHEN DRIVING ADVISE

Software flash 22.10.2015 → repair date 17.11.2015

FT RH CL PC KV
27.10.2014

Latch received with 6 windings left on motor shaft

Sinter bearing grey, corrosion on motor housing visible

KV motor operation open circuit	**→ ok KV function - cord fully unwound after first operation**
KV motor operation short circuit	**→ nok KV function**
KV operation first short then open	**→ ok KV function**

Latch not from Critical Concern List [redacted] // USA

Shake-Test under seal load

Test procedure:

1. **Start condition: Latch in primary position, seal load 311N, locked**
2. **KV operation with pulled o/s lever, (with short circuit condition)**
3. **Latch releases, self return of o/s lever, → KV motor stops with ~4 windings left on motor shaft**
4. **Close latch to primary position again, applied seal load 311N**
5. **Shake fixture (also with shocks to simulate pot-holes)**

Result:

No self release can be provoked, cord rotates in unwinding direction and ends with ~2 windings left

Fixture:

before shaking:

after shaking:

Video:

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] // USA

Inadvertent Door Open (B-Post Harness Short) 04/01/2016 dbromage

Software flash 28.09.2015 → repair date 23.12.2015

AWS Customer: CUSTOMER STATES; R/R DOOR WILL OPEN ON ITS OWN WHILE DRIVING SEE ATTACHED

AWS Tech: UNABLE TO VERIFY CUSTOMER CONCERN. RAN VEHICLE FOR FAULTS FOUND CODE B10CF 23 RIGHT REAR LATCH CLUTCH SWITCH SIGNAL STUCK LOW. PERFORMED PIN POINT DIAGNOSIS FOUND WIRING FROM C38 A1 14 AND 10 TO C4PK28C 24 AND 10 SHORTED TO BODY. CONTACTED TECHLINE WITH FINDINGS AND WAS ADVISED TO REPLACE R/R DOOR LATCH AND PERFORMED WIRING REPAIR. REPAIRED SHORTED WIRING INSIDE PASSENGER SIDE B PILLAR AND REPLACE

RR RH CL KV ECS
05.11.2014

Latch received completely unwound

Sinter bearing shiny, no corrosion on motor housing visible

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **ok KV function**

KV operation first short then open → **ok KV function**

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] // USA

Software flash 08.09.2015 → repair date 12.01.2016

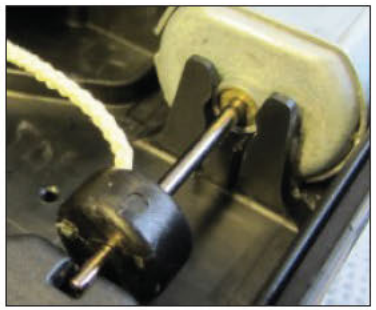
AWS data from 12.01.2016: CUSTOMER STATES THE DRIVERS DOOR COMES OPEN WHILE DRIVING. SEE HISTORY

CAUSE: LEFT FRONT LATCH HAS INTERMITTENT INTERNAL FAILURE CORRECTION: RUN SDD, NO CODES PERTAINING TO OWNER'S COMPLAINT, OPEN TA# 2092570, SAID TO REPLACE L/F DOOR LATCH. REPLACE LATCH, CLEAR ALL CODES RETEST SYSTEM. OPERATES AS PER MANUFACTURES SPECIFICATIONS. CLOSE CASE.

AWS history from 21.10.2014: CUSTOMER STATES LEFT FRONT DOOR WONT LATCH.

CAUSE: LATCH MECH. BINDING CORRECTION: R&R LEFT FRONT DOOR LATCH, WHEN LATCH WAS LOOSEN BEGAN TO WORK CORRECTLY. REPLACE DOOR LATCH SO PROBLEM WON'T REOCCUR, RETEST, OPERATES PER MANUFACTURES SPECIFICATIONS. NOTE NO BULLETINS OR SSM'S AT THIS TIME.

FT LH CL PC KV LB
12.05.2014



Latch received completely unwound

Sinter bearing shiny, no corrosion on motor housing visible

KV motor operation open circuit	→ ok KV function - cord fully unwound after first operation
KV motor operation short circuit	→ nok KV function
KV operation first short then open	→ ok KV function

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] **// USA**

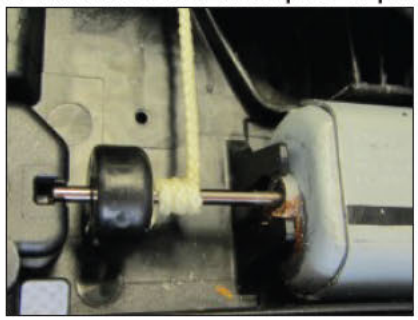
FT LH CL PC KV LB
21.09.2013

-

Software flash 24.09.2015→ repair date 24.02.2016

Cust Comments: CUST. STATES THE DRIVERS DOOR WOULD NOT CLOSE (CUST. NEEDED TO HOLD DOOR CLOSED WHILE DRIVING SO IT WOULD NOT OPEN)

Tech Comments: intermittent door latch failure as per techline. our driver went to retrieve truck and was necc to hold door closed, during drive back deemed not safe and towed truck. truck was moved numerous timesbefore brought into shop and door was working. tile t/a case withseesion file and advised to attempt to duplicate and replace lathc. unable to duplicate. replaced latch as per techline t/a and clos



Latch received with 3 windings left on the motor shaft

Sinter bearing and motor housing corroded

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **nok KV function - 6 windings on motor shaft**

KV operation first short then open → **ok KV function**

Methodology Step:- D M A I C R

Separation of 6-panel document on the 15th of September 2017 in two parts for better handling:

Slide 1-130 see file: *20170915_6Panel_Will_not_latch_excerpt slide 1-130*

6-panel in progress: *20170915_6Panel_Will_not_latch*

Both documents were sent out on the 15th of September 2017

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] // USA

Ft RH CL KV
11.11.2014

CRC ICR. Inadvertent door opening whilst vehicle in motion (Car Door Swung Open). 35 mph. P068B carried out Dec 2015. CRC doc states latch was seized? No recent claims in DDW?

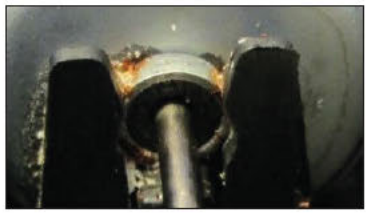
Software flash: 16.12.2015 → repair date: 28.03.2017

Cust: CLIENT STATES THE FRONT PASSENGER DOOR OPENED WHEN DRIVING AND WILL NOT STAY CLOSED.

Tech: VERIFIED RF DOOR WILL NOT LATCH DUE TO AN INTERNAL MECHANICAL FAULT WITH DOOR LATCH. REPLACED RF DOOR LATCH TO CORRECT.

[redacted]	T/LX	R	T/ES	T/D6	T/F
AWS Claim Key:	[redacted]	Trx Code:		P068	Labor Hrs:
Dlr Cd-Sub Cd:	R0355-LR	Name:	LAND ROVER NORTH HILLS		
Cust Comments:	P068B:DDW SHOWS CAMPAIGN P068 IS INCOMPLETE				
Tech Comments:	PERFORMED Q068, RECONFIGURED LOCK SOFTWARE. OPTION B.				

Latch received completely unwound



Sinter bearing grey, corrosion on motor housing visible

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **nok KV function - cord stays with 3 winding left on motor shaft**

KV operation first short then open → **ok KV function**

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

Rr LH CL KV ECS
22.09.2014

Latch from Critical Concern List [redacted] // USA

Inadvertent door opening whilst vehicle in motion. P068C carried out 18-Jul-2015.

02/05/2017 kcrutchl

Software flash: 18.06.2015 → repair date: 28.03.2017

Cust: CUSTOMER STATES THE DRIVERS REAR DOOR OPENED AGAIN BY IT SEL F. SEE HISTORY AND ADVISE.C/S:

Tech: VERIFIED DOOR WILL NOT STAY SHUT. REMOVED DOOR PANEL AND INSPECTED LATCH. GOOD POWER AND GROUND. INTERNAL FAILURE OF LATCH. INSTALLED NEW AND TESTED MUTLIPLE TIMES AND IS WORKING FINE

→ Other door replaced on 26.10.2016 → Brose does not received the latch → Not part of the CC-List

Cust: CUSTOMER STATES THE PASS FRONT DOOR CAME OPEN WHILE DRIVING. C/S:

Tech: PF FRONT DOOR DOES NOT LATCH. TOOK DOOR PANEL OFF TO CHECK ELECTRONIC LOCKING AND UNLOCKING SOLENIOD WORKING, ORDERED NEW ACTUATOR. NEW INSTALLED NEW PF DOOR LOOK ASSEMBLY AND NOW WORKS PER DESIGN.

Latch received completely unwound

Sinter bearing grey, corrosion on motor housing visible

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **nok KV function - cord stays with 4 winding left on motor shaft**

KV operation first short then open → **ok KV function**

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

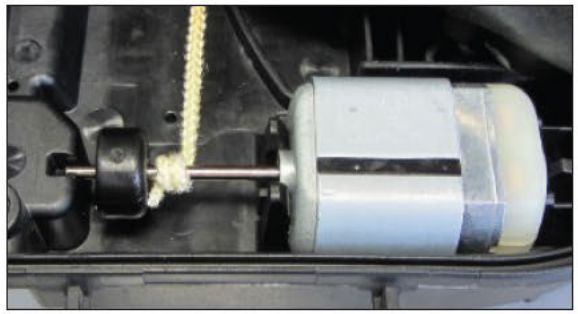
Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] **// USA**

Rr RH DL PC KV ECS
04.11.2013

Inadvertent door opening. Customer states that the front driver and rear driver side doors will randomly come open while driving. P068 carried out Oct 2015. Open TA USA.

Software flash: 08.10.2015→ repair date: 19.07.2017



Latch received with two windings left on the motor shaft

Sinter bearing grey, slight corrosion on motor housing visible

KV motor operation open circuit	→ ok KV function - cord fully unwound after first operation
KV motor operation short circuit	→ nok KV function - cord stays with 4 winding left on motor shaft
KV operation first short then open	→ ok KV function

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D M A I C R

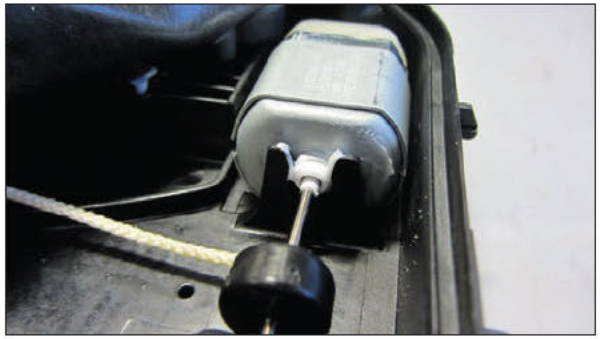
Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted]// USA

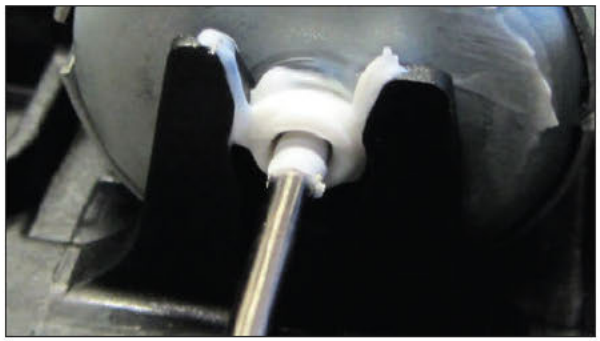
FT LH CL PC KV LB
24.09.2015

RHR door opened whist vehicle in motion. Confirmed as partial opening only (not fully open). P068B completed August 2015.Door latch replaced. 11/10/2017 smccull3

Software flash: 04.08.2015 → loaded date: unknown



Latch completely unwound



Sinter bearing greased, no corrosion on housing visible

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **ok KV function - cord fully unwound after first operation**

KV operation first short then open → **ok KV function**

Methodology Step:- D M A I C R

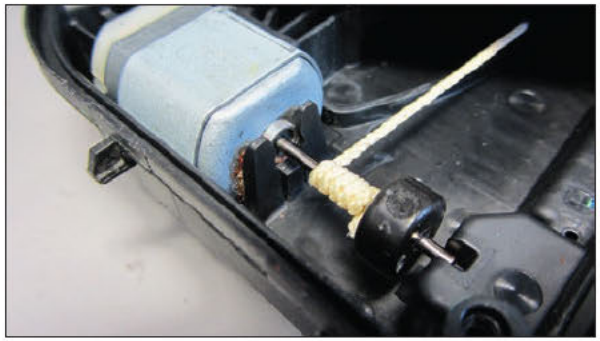
Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] // USA

FT RH CL KV
07.05.2014

Front RH door will not latch/close - TA case closed - per related QR "CRC ICR ... Customer states while travelling at 60 MPH the right front door opened. He was travelling around a corner. Customer states no lights illuminated, the door shuts but does not lock - SEE NEXT CASE FOR QR

Software flash: 25.01.2016 → loaded date: unknown



Latch received with 5 windings left on the motor shaft.

Sinter bearing grey, corrosion on housing visible

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **nok KV function - cord stays with 5 windings left**

KV operation first short then open → **ok KV function**

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

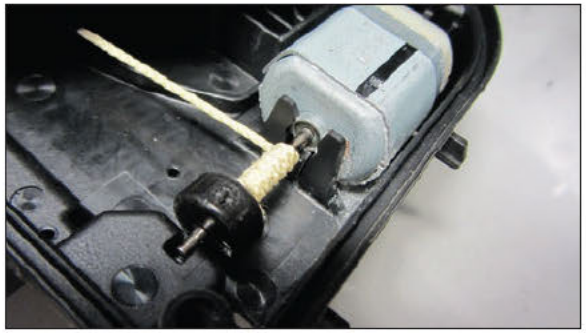
Latch not from Critical Concern List [redacted] // USA

Rr LH CL PC KV ECS
06.09.2013

Software flash: 27.01.2016 → loaded date: 10.08.2017

Cust: CUSTOMER STATES LEFT REAR DOOR FLEW OPEN WHILE TURNING. CUSTOMERS INCONVIENCED BY VEH DOORS COMING UP WHILE DRIVING,UNSAFE FOR PASSENGERS. VEHICLE JUST OUT BY MILEAGE.

Tech: 1 LEFT REAR DOOR LATCH INTERNAL FAILURE,R&R LATCH. THE L/F AND R/R LATCHES WERE REPLACED ON RO 84891, PER CALL FROM LRNA WAS TOLD TO REPLACE R/F LATCH AT THIS TIME. R&R R/F LATCH UNDER GOODWILL.CASE#8000461608. 2014 RR WITH 50,860 MILE.



Latch received with 6 windings left on the motor shaft.

Sinter bearing grey, corrosion on housing visible

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **nok KV function - cord stays with 1 windings left**

KV operation first short then open → **ok KV function**

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

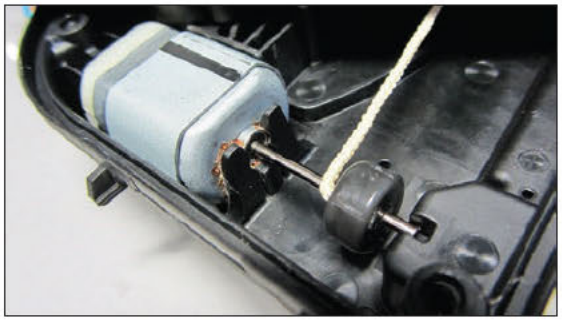
Latch not from Critical Concern List [redacted] // USA

FT RH CL PC KV
05.09.2013

Software flash: 27.01.2016 → loaded date: 10.08.2017

Cust: CUSTOMER STATES LEFT REAR DOOR FLEW OPEN WHILE TURNING. CUSTOMERS INCONVIENCED BY VEH DOORS COMING UP WHILE DRIVING,UNSAFE FOR PASSENGERS. VEHICLE JUST OUT BY MILEAGE.

Tech: 1 LEFT REAR DOOR LATCH INTERNAL FAILURE,R&R LATCH. THE L/F AND R/R LATCHES WERE REPLACED ON RO 84891, PER CALL FROM LRNA WAS TOLD TO REPLACE R/F LATCH AT THIS TIME. R&R R/F LATCH UNDER GOODWILL.CASE#8000461608. 2014 RR WITH 50,860 MILE.



Latch received completely unwound

Sinter bearing grey, corrosion on housing visible

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **nok KV function - cord stays with 5 windings left**

KV operation first short then open → **ok KV function**

Latch from Critical Concern List [redacted] **// USA**

Ft RH CL PC KV
02.04.2013

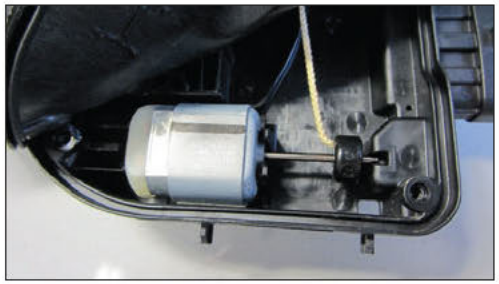
Front RH door opened whilst vehicle in motion and will not close - door latch mechanism not latching - Previously reported via USA CRC case, CC9181371 refers

07/03/2018 kcrutchl

Software flash: 04.09.2015 → repair date AWS: ??

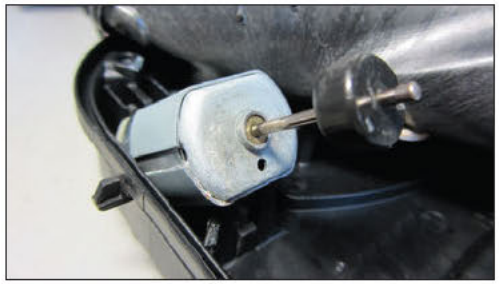
Cust: %

Tech: %



Latch received completely unwound

Sinter bearing shiny, slightly corrosion on motor housing visible



KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

KV motor operation short circuit → **ok KV function - cord fully unwound after first operation**

KV operation first short then open → **ok KV function**

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] **// USA**

Ft RH CL PC KV
02.04.2013

O/S transmission lever	I/S transmission Lever	KV transmission lever	Bushing	Subassy retention plate
				
				

→ **No mark of traces or other damages could detected**

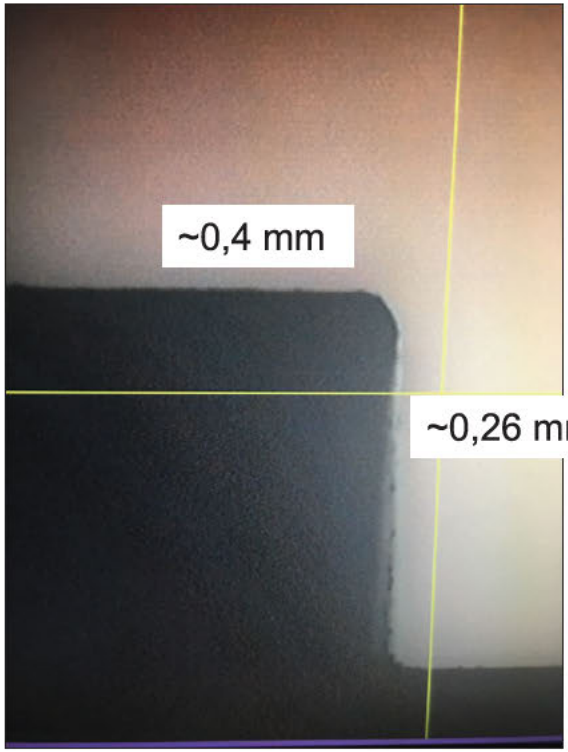
→ **Subassy retention plate easily to rotate**

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] **// USA**

Ft RH CL PC KV
02.04.2013



→ **Chamfer from bushing and height of KV transmission lever ok**

Investigation completed. Root cause for failure mode can not be detected. Latch passed all tests.

Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D – M ✓ – A – I – C – R

Scope and Prioritise Potential Causes

Latch from Critical Concern List [redacted] // USA

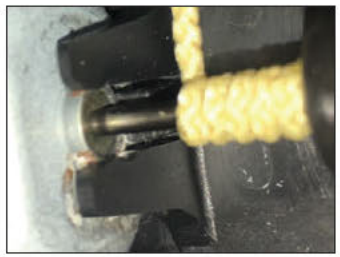
Ft RH CL KV
29.05.2013

CRC ICR ... Customer states the passenger side door flew open. Customer was driving 15-20 miles per hour. Not able to close the door, no warning lights displayed. No additional details available, requested CRC rep to provide appointment date and have retailer submit an EPQR or TA if needed. No assistance needed. 07/03/2018 Igorman

Software flash: 27.08.2015 → repair date AWS: 01.03.2018

Cust: CUSTOMER STATES PASSENGER SIDE FRONT DOOR CAME OPEN WHILE DRIVING.CUSTOMER OPENING A CASE WITH LAND ROVER.

Tech: LATCH FAILURE. T/A CASE FILE 2520408. FRONT PASSENGER DOOR NOT LATCHING. FOUND INTERNAL FAILURE OF DOOR LATCH. REPLACED RIGHT FRONTDOOR LATCH ASSEMBLY AND TEST. DOOR LATCHES. CUSTOMER CARE WANTED TA CASE OPENED. TA # 2520408



Latch received with 5 windings left on the motor shaft

Sinter bearing grey, corrosion on housing visible

KV motor operation open circuit → **ok KV function - cord fully unwound after first operation**

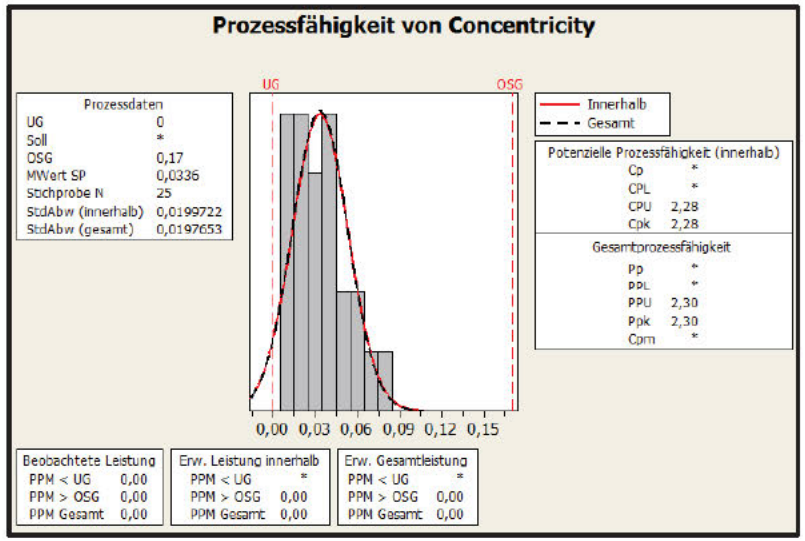
KV motor operation short circuit → **nok KV function - cord stays with 5 windings left**

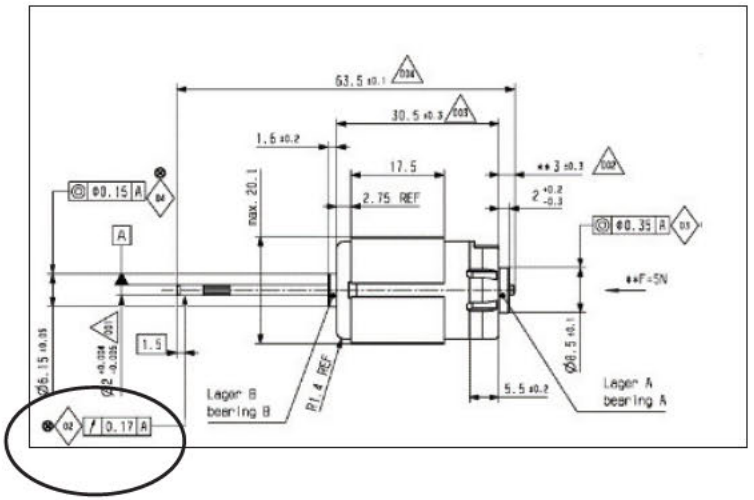
KV operation first short then open → **ok KV function**

Methodology Step:- D M A I C R

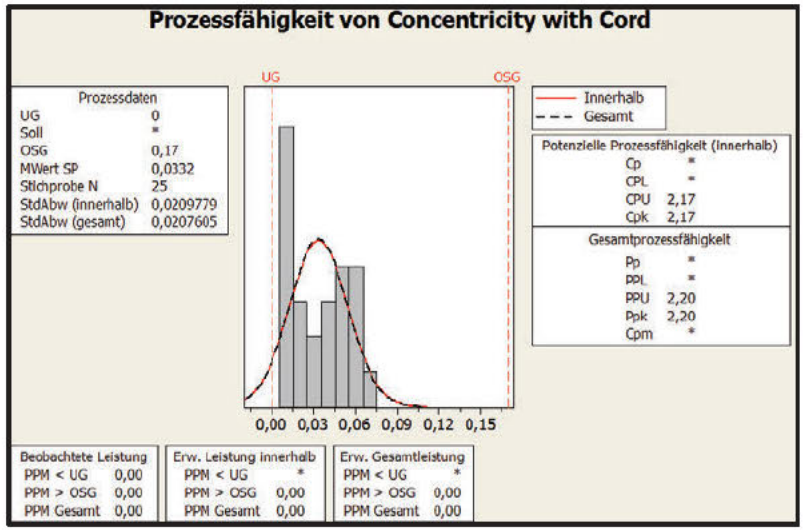
Concentricity Measuring

Capability Study Concentricity Single-Part Motor

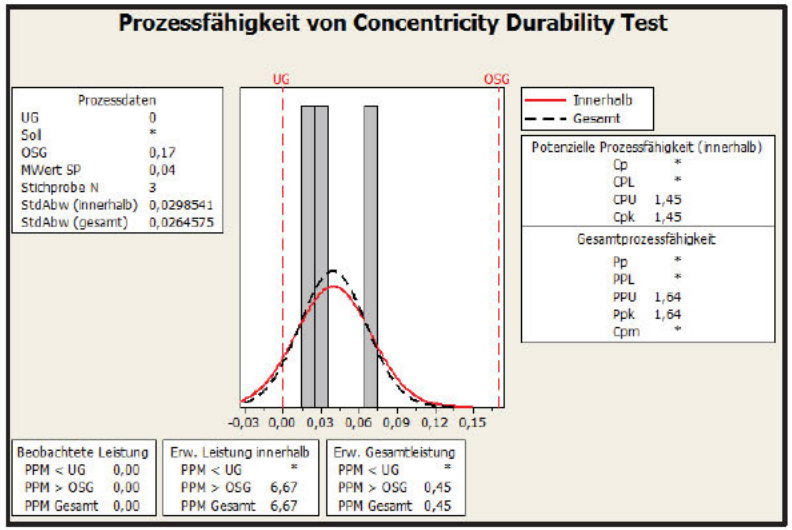




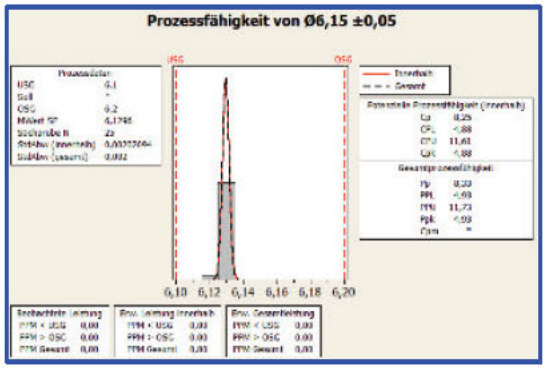
Capability Study Concentricity Subassy Motor with Cord

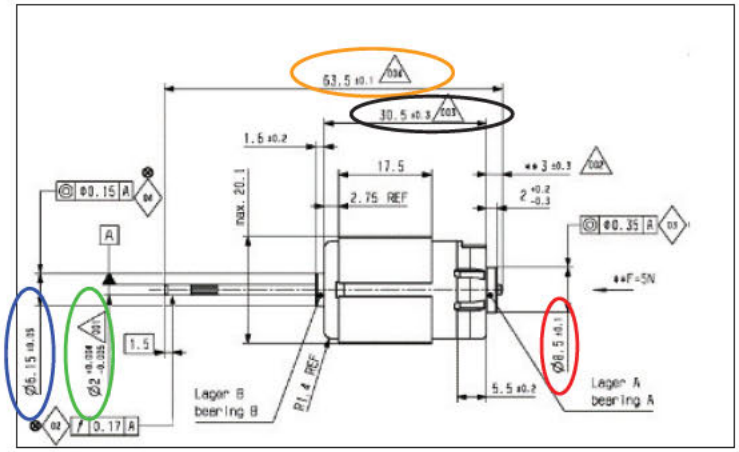


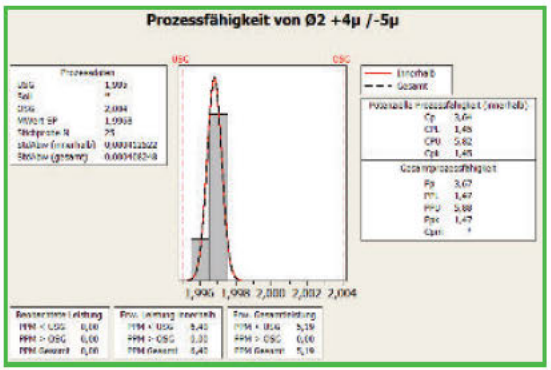
Capability Study Concentricity Durability Test Part

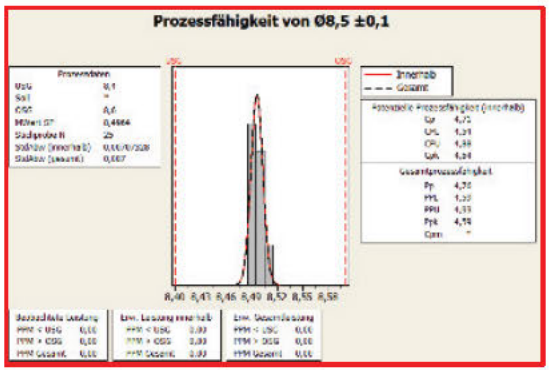


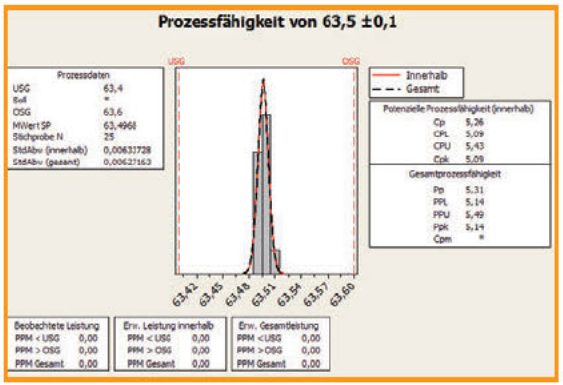
Capability Study dimensional characteristic

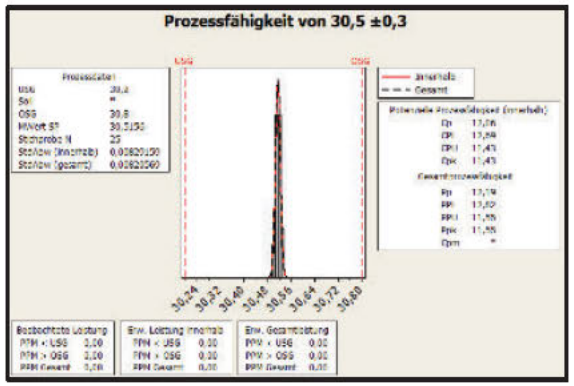




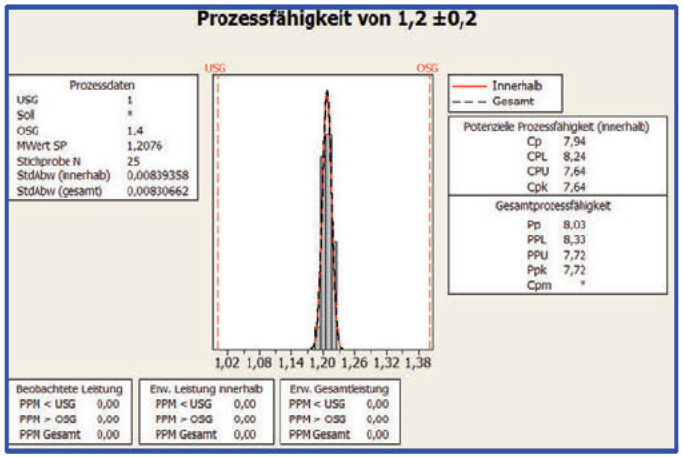


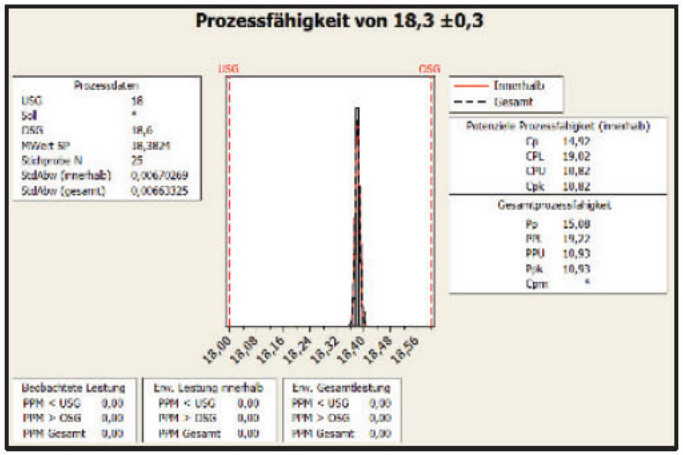


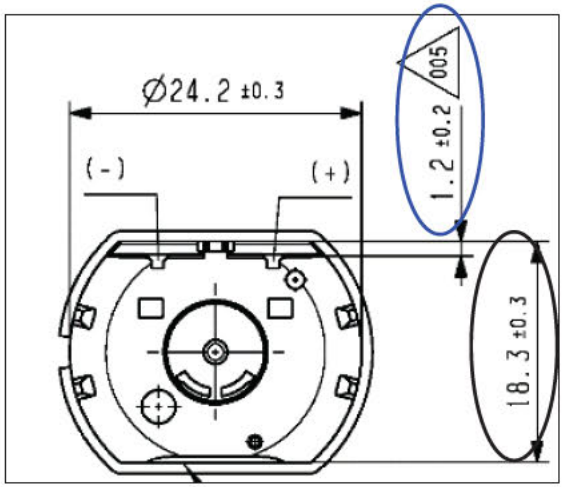




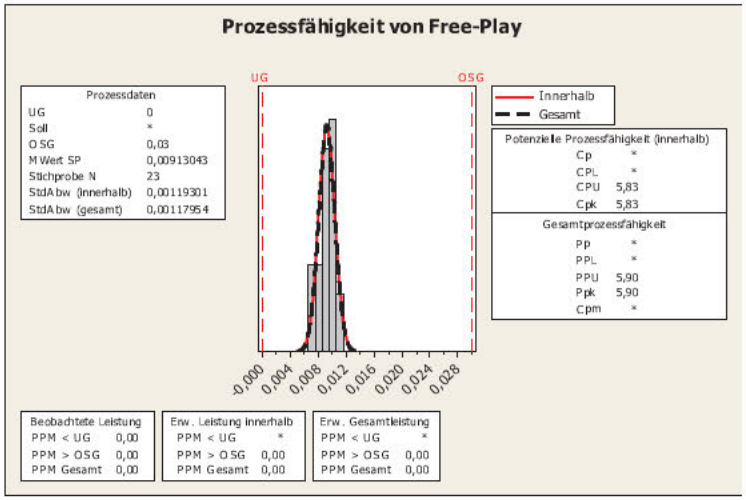
Capability Study dimensional characteristic



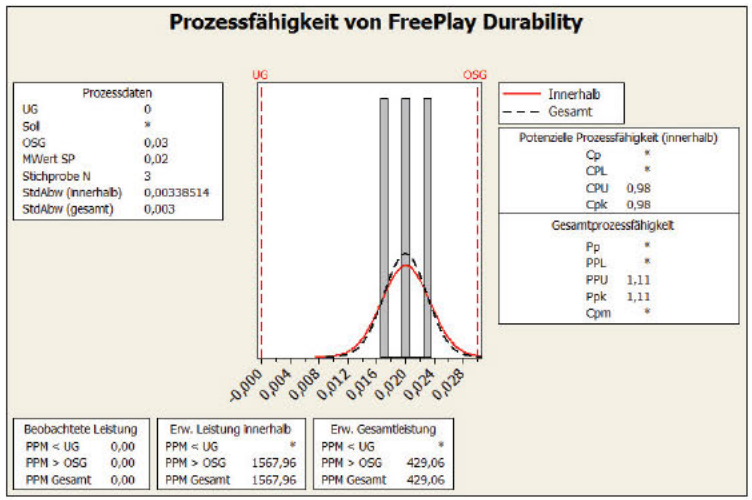




- Capability Study 23 new KV Actuator



- Capability Study 3 KV Actuator after Durability Test



→ Tolerances assumed by Brose.

Methodology Step:- D M A I C R — Testing

Test with latch from vehicle [redacted] **to provoke failure**

03.09.2015

Status after one week storage:

1st rewinding with short circuit 3 windings left on motor shaft

(no unwinding by hand)

2nd rewinding with open circuit ok

3rd application of 25 µl water on the sinter bearing

4th rewinding with short circuit 5 windings left on motor shaft

Storage for one week with 5 windings left on motor shaft until 10th of September 2015.
Again function check with short circuit and open circuit.

10.09.2015

Status second week storage:

Start with 3 windings left on motor shaft (two winding unwound during the storage time)

1st rewinding with open circuit ok

2nd application of 25 µl water on the sinter bearing

3rd rewinding with short circuit 3 windings left on motor shaft

Storage of the latch for 4 weeks to replicate failure

Methodology Step:- D M A I C R — Testing

Test with latch from vehicle [redacted] to provoke failure

07.10.2015

Status after six weeks storage: **Start with 2 windings left on motor shaft (one winding unwound during the storage time)**

1st rewinding with short circuit 4 windings left on motor shaft

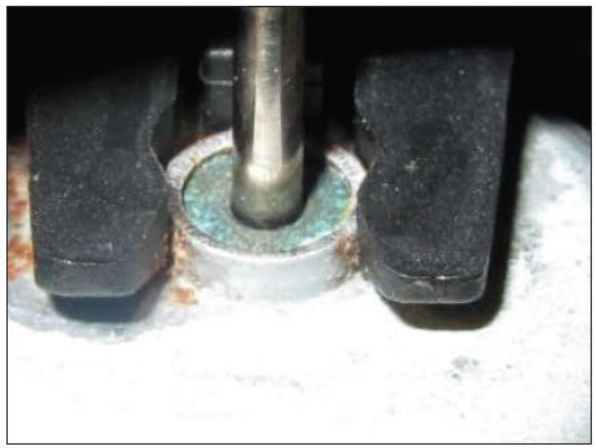
2nd rewinding with open circuit ok

3rd application of 25 µl water on the sinter bearing

4th rewinding with short circuit 4 windings left on motor shaft

Next Steps: Additional storage for another 4 weeks and function check

Bearing



After Short Circuit

After Open Circuit

Methodology Step:- D M A I C R — Testing

Test with latch from vehicle [redacted] to provoke failure

04.11.2015

Status after ten weeks storage: **Start with 3 windings left on motor shaft (one winding unwound during the storage time)**

1st rewinding with short circuit 3 windings left on motor shaft

2nd rewinding with open circuit ok

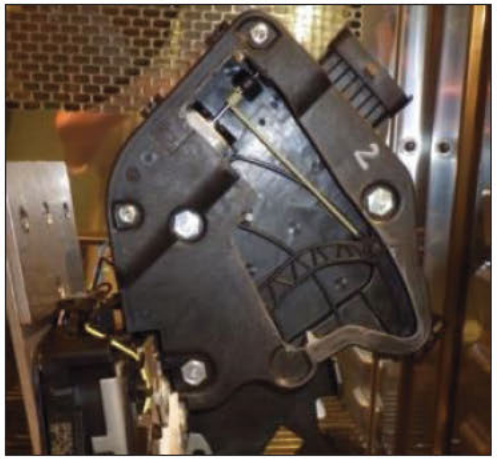
3rd application of 25 µl water on the sinter bearing

4th rewinding with short circuit 3 windings left on motor shaft

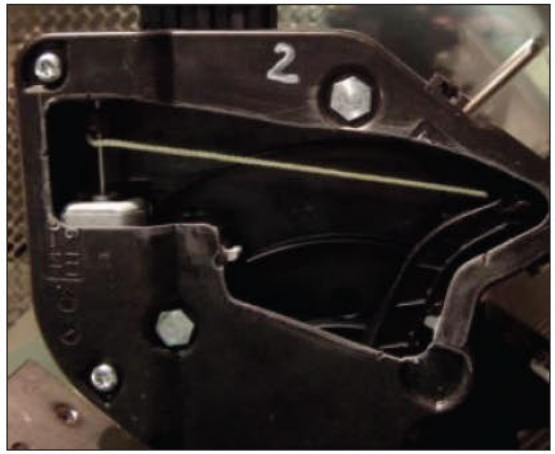
Next Steps: Application of 1 water drop onto bearing and additional storage for another 4 weeks and function check (01.12.2015 after 14 weeks in total)

Bearing

After Short Circuit



After Open Circuit



Methodology Step:- D M A I C R — Testing

Test with latch from vehicle [redacted] to provoke failure

01.12.2015 **Status after fourteen weeks storage:**

Conclusion:
No failure reproducable with open circuit condition during more than 3 months storage time.

Start with 1 winding left on motor shaft (two windings unwound during the storage time)

1. **rewinding with short circuit: 1 winding left on motor shaft**
2. **rewinding with open circuit ok**
3. **application of 25 µl water on the sinter bearing**
4. **rewinding with short circuit 3 windings left on motor shaft**

Next Step : 2 Proposals:

A) Test finished; disassembly of motor can be started → agreed

~~**B) Carry on storage test with uncontrolled temp./humidity for 3 months (?) and perform function check afterwards**~~

Bearing after 1. short circuit operation: 1 winding left

After second Short Circuit operation: 3 windings left

Remark:
Visual check after 1 h:
Only one winding unwound again!

After Open Circuit operation: ok

Methodology Step:- D M A I C R

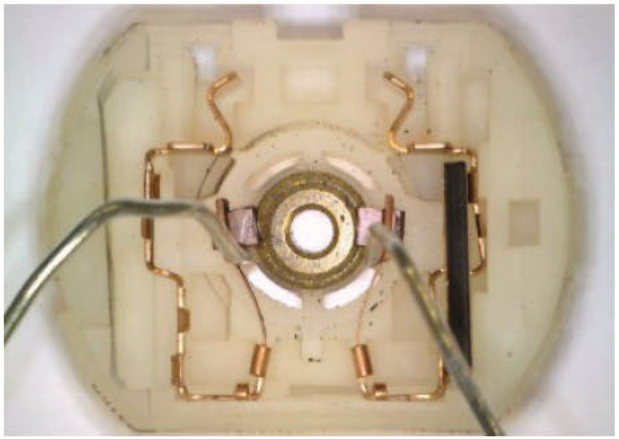
Testing

Test with latch from vehicle [redacted] to provoke failure

08.12.2015 visual inspection of motor:

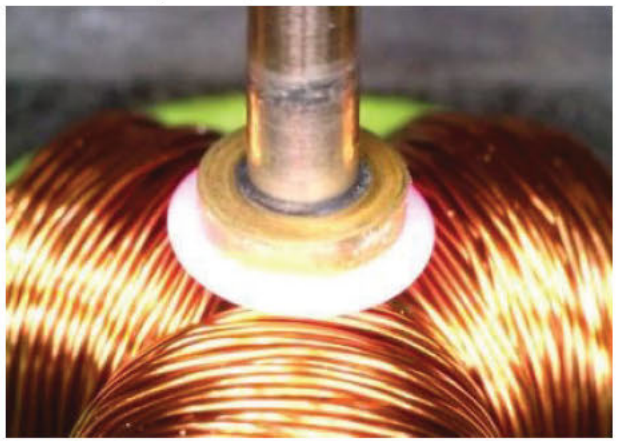
Corroded bearing and housing

Bearing Commutator side ok

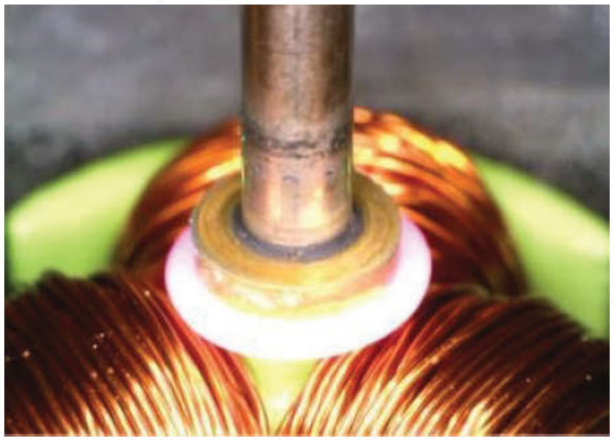


Washer Commutator side ok

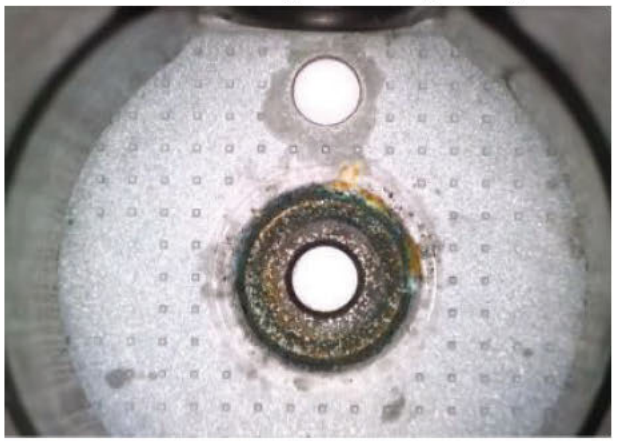
Corroded axis and residues at washer (360°),



Corroded axis and residues at washer (360°)



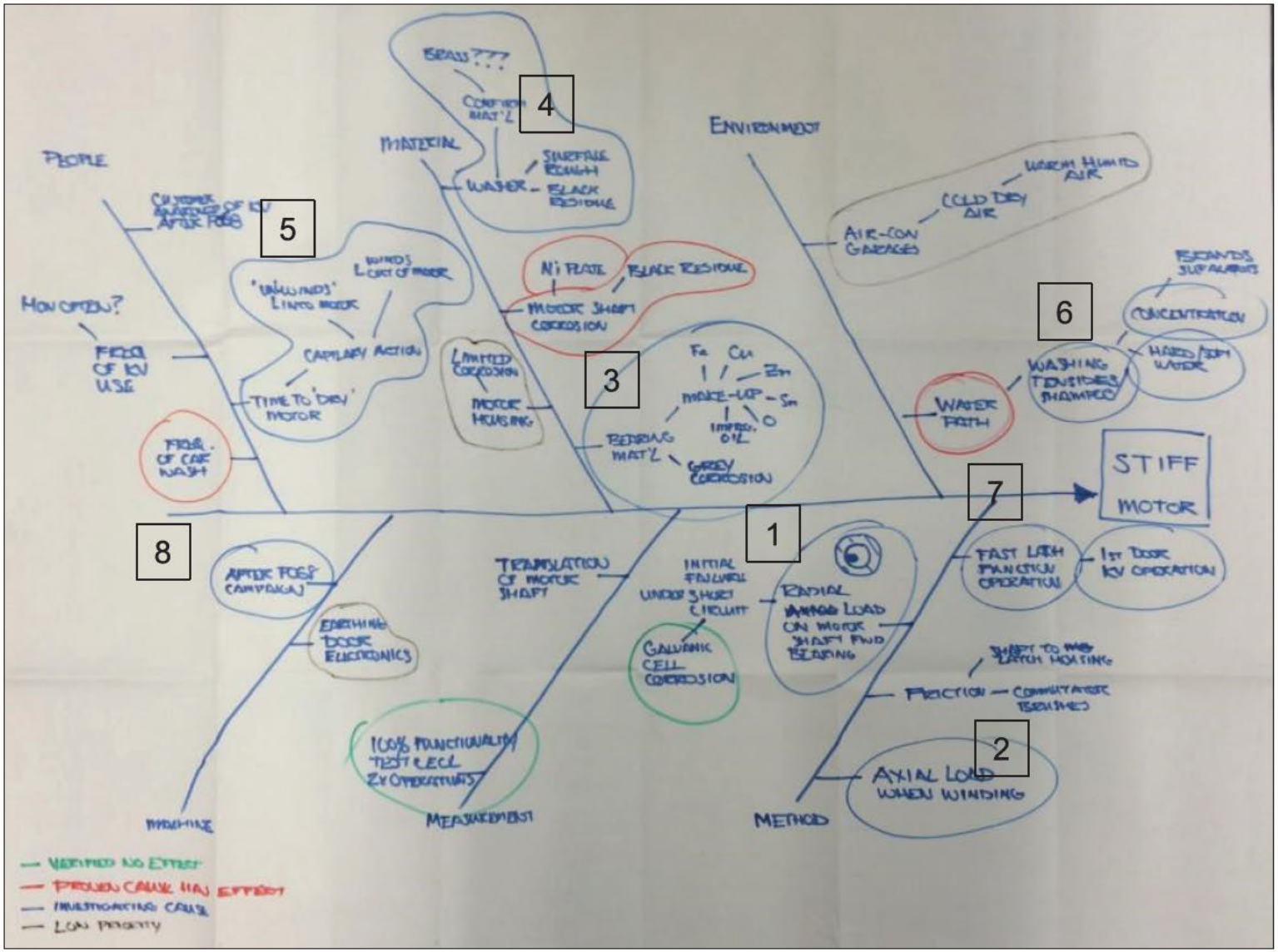
Corroded bearing inside (360°)



Methodology Step:- D M A I C R

Ishikawa

Ishikawa Stiff Motor – KV Workshop 08.10.2015



Investigating cause

1. Radial load on motor shaft (front bearing) → ongoing
2. Axial load when winding → ongoing
3. Bearing material
   a. EDX Analysis of bearing material ✓
   b. ICP Analysis of bearing material ✓
   c. Grey Corrosion: What is the reason for the colour? ✓
   d. Bearing oil, material and amount ✓
4. Washer material, Brass?
   a. EDX Analysis of bearing material ✓
   b. Black residues ✓
   c. Roughness washer in new condition ✓
5. Time to dry motor
   a. Time to dry motor
   b. Capillary action due to axial movement of shaft ✓
6. Washing tensides shampoo
   a. Can different tensides be identified in residues of corrosion?
   b. Are different tensides used in different markets, different countries, different carwashes, different concentrations, different water conditioning? → JLR
   c. Testing to be defined after clarification of a. and b.
7. Fast latch function
   a. Use of KV function on doors. Correlation existing to KV-issue? → JLR ✓
8. After P068 campaign
   a. Function ok after flash on every door? →JLR
   b. Is data base of AWS reliable (conflict between load date and repair date)? →JLR

1

Testing if transverse force on the motor shaft can abet Corrosion

Theory:

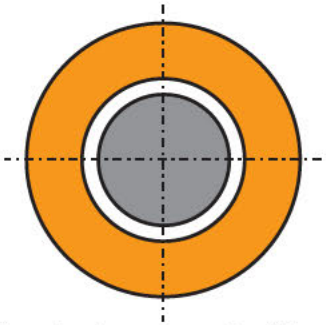
When having transverse force on the motor shaft, there is a forced metal to metal contact between the bearing and the shaft. By this the oil in the bearing will be taken to the contact area (capillary effect). Water with washing tenside can wash out and suppress the oil and makes corrosion start.

Without a transverse force in the bearing the shaft is positioned more or less centrical in the bearing, with less metal to metal contact (only gravity force).

Samples:

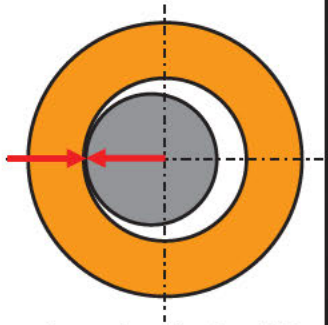
10 pc. (5 LH / 5 RH) KV-actuator with load in the bearing (simulated by cord wound on KV-lever)
10 pc. (5 LH / 5 RH) KV-actuator without load in the bearing

Without transverse force



Play between shaft and bearing

With transverse force

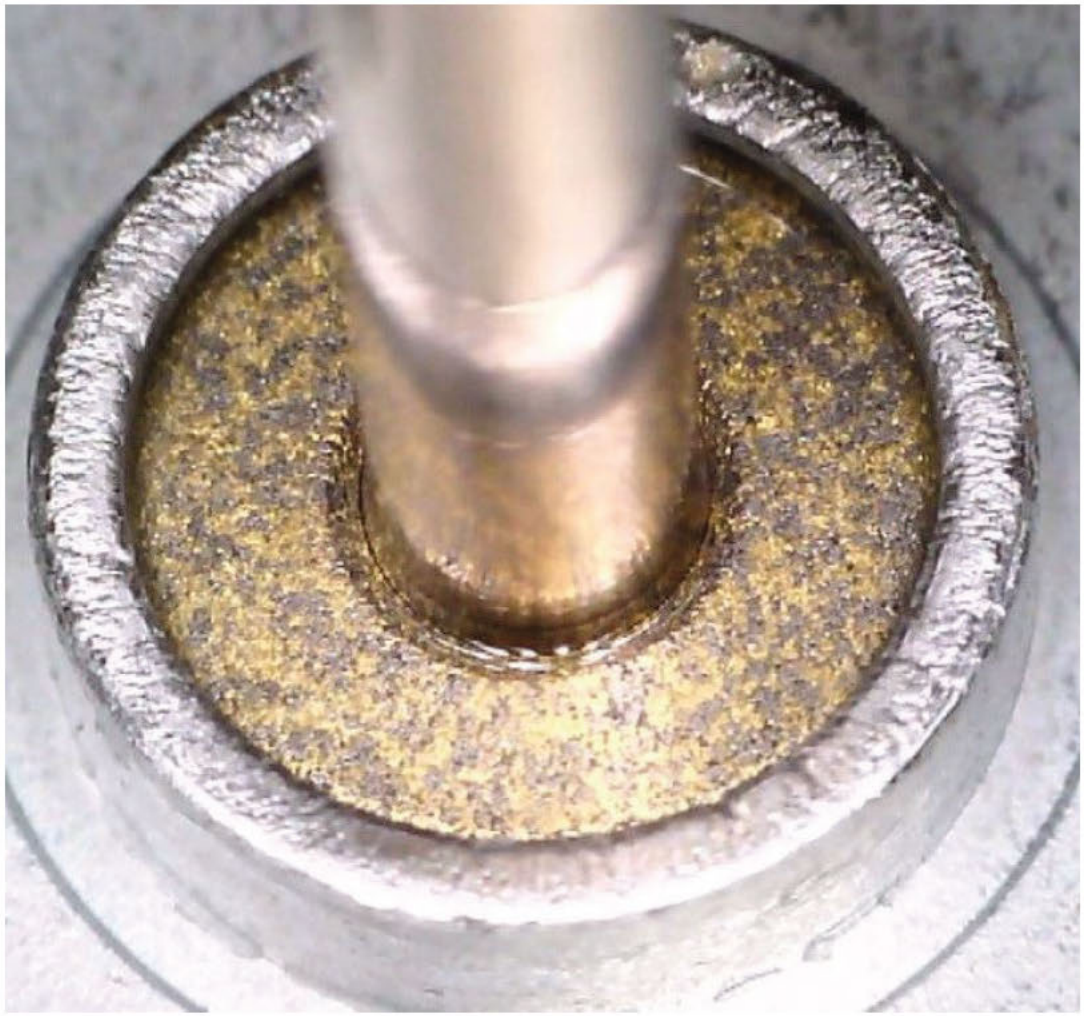


Forced contact shaft is pulled against bearing

1

Testing if transverse force on the motor shaft can abet Corrosion

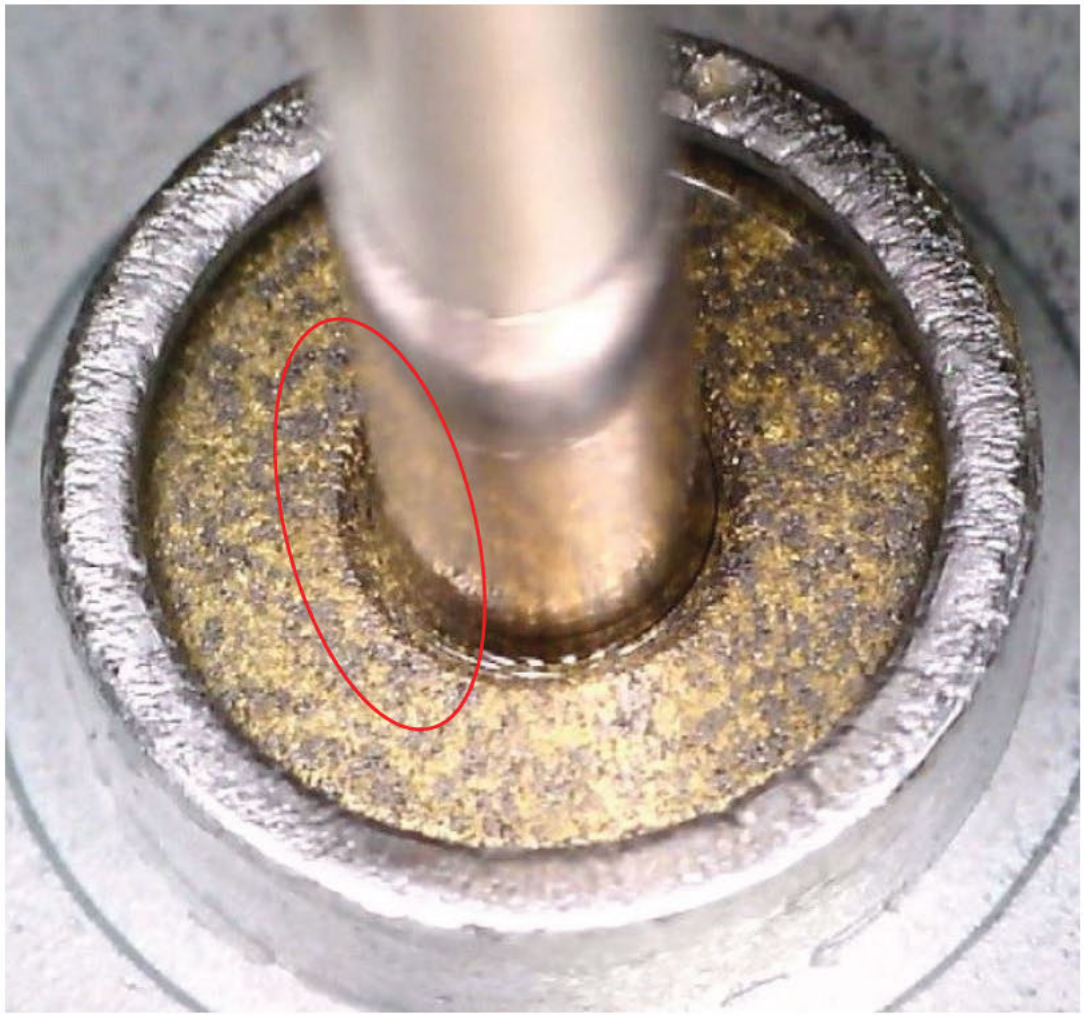
Without transverse force



1

Testing if transverse force on the motor shaft can abet Corrosion

With transverse force



1

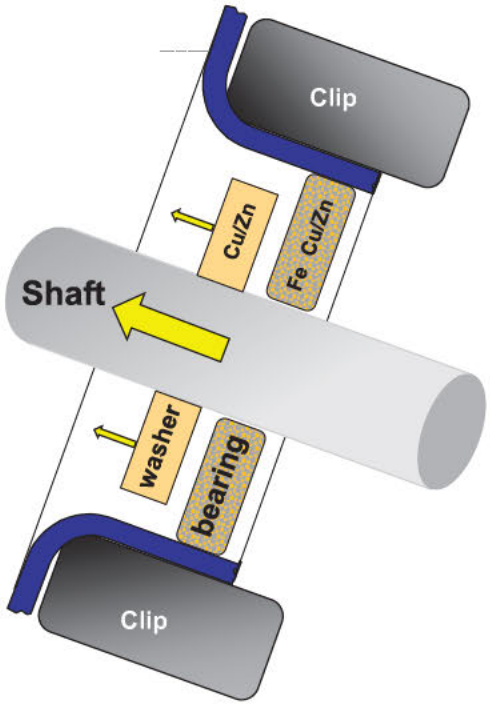
Testing if axial force on the motor shaft can abet Corrosion

Theory:

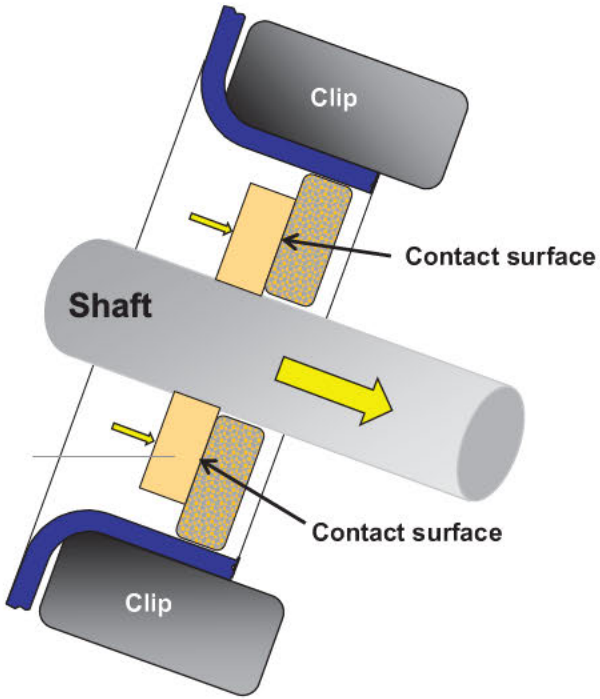
When having axial force on the motor shaft, there is a forced metal to metal contact between the bearing and the washer. Water with washing tenside can wash out and suppress the oil and makes corrosion start.

Without a axial force in the washer on the shaft is not in contact with the bearing. Contact between washer and bearing simulates a wound cord.

Without axial force (schematically)



With axial force (wound condition) (schematically)



1. Testing if radial / axial Load in the Bearing can abet Corrosion

Testing condition:
Cyclic temperature for the complete time (10°C-30° with uncontrolled humidity).

Test procedure:
Activation of corrosion by water with

Car washing shampoo ("Shell Wax Shampoo"). Mixture according to instruction → 50ml Shampoo in 10l water:

a. → 5 pc. LH / 5 pc. RH with radial force
b. → 5 pc. LH / 5 pc. RH without radial force

c. → 5 pc. LH / 5 pc. RH with axial force
d. → 5 pc. LH / 5 pc. RH without axial force

Salt spray solution (5%):

e. → 5 pc. LH / 5 pc. RH with radial force
f. → 5 pc. LH / 5 pc. RH without radial force

g. → 5 pc. LH / 5 pc. RH with axial force
h. → 5 pc. LH / 5 pc. RH without axial force

1. Testing if radial Load in the bearing can abet corrosion

Test procedure:

Day 1-5 → Application of 1 drop on sinter bearing + electrical actuation with test box (open circuit)
Day 6-7 → Storage
Day 8-12 → Application of 1 drop on sinter bearing + electrical actuation with test box (open circuit)
Day 13-14 → Storage
Day 15 → Application of 1 drop on sinter bearing
Day 16-21 → Storage
Day 22 → Visual inspection and function check with test box:
1st with Short Circuit 2nd with Open Circuit

Afterwards internal agreement about next steps, based on first results (bearing corroded?).

Results after 4rd loop: washing shampoo test ongoing: still ok and slightly corrosion visible

Test-No	Description	Load	Samples	Start	Result loop 1	short circuit 10 samples	open circuit 10 samples	corrosion	Result loop 2	short circuit 10 samples	open circuit 10 samples	corrosion	Result loop 3	short circuit 10 samples	open circuit 10 samples	corrosion	Result loop 4	short circuit 10 samples	open circuit 10 samples	corrosion
V10.538	Washing Shampoo	radial load	5LH/5RH	12.10.2015	04.11.2015	all ok	all ok	no corrosion	02.12.2015	all ok	all ok	no corrosion	22.12.2015	all ok	all ok	no corrosion	26.01.2016	all ok	all ok	slightly corrosion trace
		without load	5LH/5RH	12.10.2015	04.11.2015	all ok	all ok	no corrosion	02.12.2015	all ok	all ok	no corrosion	22.12.2015	all ok	all ok	no corrosion	26.01.2016	all ok	all ok	slightly corrosion trace
V10.568	5% Saltwater	radial load	5LH/5RH	26.10.2015	17.11.2015	1 nok 8 windings left	all ok	corrosion visible	08.12.2015	5 nok with 6 windings left, 4 nok with no actuation at all	4 nok with no actuation at all	corrosion visible	test stopped	-	-	-	test stopped	-	-	-
		without load	5LH/5RH	26.10.2015	17.11.2015	all ok	all ok	corrosion visible	08.12.2015	3 nok with 5 windings left, 6 nok with no actuation at all	6 nok with no actuation at all	corrosion visible	test stopped	-	-	-	test stopped	-	-	-
V10.569	Washing Shampoo	axial load	5LH/5RH	26.10.2015	17.11.2015	all ok	all ok	no corrosion	08.12.2015	all ok	all ok	no corrosion	05.01.2016	all ok	all ok	no corrosion	26.01.2016	all ok	all ok	slightly corrosion trace
		without load	5LH/5RH	26.10.2015	17.11.2015	see V10538	see V10538	no corrosion	08.12.2015	see V10538	see V10538	no corrosion	22.12.2015	see V10538	see V10538	no corrosion	26.01.2016	see V10538	see V10538	slightly corrosion trace
V10.570	5% Saltwater	axial load	5LH/5RH	26.10.2015	17.11.2015	all ok	all ok	corrosion visible	08.12.2015	2 nok with 8 windings left, 4 nok with no actuation at all	4 nok with no actuation at all	corrosion visible	test stopped	-	-	-	test stopped	-	-	-
		without load	5LH/5RH	26.10.2015	17.11.2015	see V10568	see V10568	corrosion visible	08.12.2015	see V10568	see V10568	corrosion visible	test stopped	-	-	-	test stopped	-	-	-

1. Testing if radial Load in the bearing can abet corrosion

After having two test loops (22 days each) performed, this test is stopped for salt water drop samples for all load szenarios. During telco from 11.12.2015 follwing steps as final examination were agreed:

1. Take samples, which still fail in short circuit condition (e.g. 6 windings unwound).
2. Apply 1 drop of saltwater, perform **short** circuit actuation and than store the samples with the thereby obtained unwound condition without any further open circuit operation. One salt water drop is still applied each working day during storage.
3. Question: Do the samples fully unwind when operated with **open** circuit after 4 days/7days?

Results after 4 days/7 days/12 days (2/5/8 saltwaterdrop applications):

As entrance for this examiantion following samples were available:

- radial load : 3 samples
- without any load: 2 samples
- axial load: 0 samples

(All other parts were either fully functional or not functional at all and therefore not suitable for this examination.)

sample 13 (radial, 6 windings left)

4 days: Fully unwinding at 1st open circuit operation
7 days: motor blocked

sample 14 (radial, 6 windings left)

4 days: Fully unwinding at 1st open circuit operation
7 days: motor blocked

sample 16 (radial, 3/6 windings left)

4 days: Fully unwinding at 1st open circuit operation (start condition 3 windings left)
7 days: motor blocked (start condition 6 windings left)

sample 1 (without load, 5 windings left)

4 days: Fully unwinding at 1st open circuit operation
7 days: Fully unwinding at 1st open circuit operation
12 days: motor blocked

sample 5 (without load, 5 windings left)

4 days: Fully unwinding at 1st open circuit operation
7 days: Fully unwinding at 1st open circuit operation
12 days: motor blocked

2. Testing if radial / axial Load in the Bearing can abet Corrosion

Samples:

6 pc. LH / 6 pc. RH latches (with covers, without grease at bearing, without pad at pin)

Testing condition:
360h Salt Spray Testing + 168h drying at RT without any actuation

Test procedure:
a. 2 pc. LH / 2 pc. RH latches with radial force
b. 2 pc. LH / 2 pc. RH latches without radial / axial force
c. 2 pc. LH / 2 pc. RH latches with axial force

Visual inspection and function check with test box: 1st with Short Circuit / 2nd with Open Circuit

Afterwards internal agreement about next steps, based on first results (bearing corroded?).

Testing if Load in the Bearing can abet Corrosion

Testing condition:

Cyclic temperature for the complete time (10°C-30° with uncontrolled humidity).

Test procedure:

Activation of corrosion by water with car washing shampoo ("Shell Wax Shampoo").
Mixture according to instruction → 50ml Shampoo in 10l water

Day 1-5	→ Application of 1 drop on sinter bearing + electrical actuation with test box
Day 6-7	→ Storage
Day 8-12	→ Application of 1 drop on sinter bearing + electrical actuation with test box
Day 13-14	→ Storage
Day 15	→ Application of 1 drop on sinter bearing
Day 16-21	→ Storage
Day 22	→ Visual inspection and function check with test box: 1st with Short Circuit 2nd with Open Circuit

Afterwards internal agreement about next steps, based on first results.

1 2

Testing Tenside Droplet samples with additional 1% salt solution

Overview:

Test-No	Description	Load	Samples	Start	Result loop 4	short circuit 10 samples	open circuit 10 samples	corrosion	Start	Description
V10.538	Washing Shampoo	radial load	5LH/5RH	12.10.2015	26.01.2016	all ok	all ok	slightly corrosion traces	01.02.2016	Washing Shampoo + 1% Salt solution
V10.538	Washing Shampoo	without load	5LH/5RH	12.10.2015	26.01.2016	all ok	all ok	slightly corrosion traces	01.02.2016	Washing Shampoo + 1% Salt solution
V10.569	Washing Shampoo	axial load	5LH/5RH	26.10.2015	26.01.2016	all ok	all ok	slightly corrosion traces	01.02.2016	Washing Shampoo + 1% Salt solution

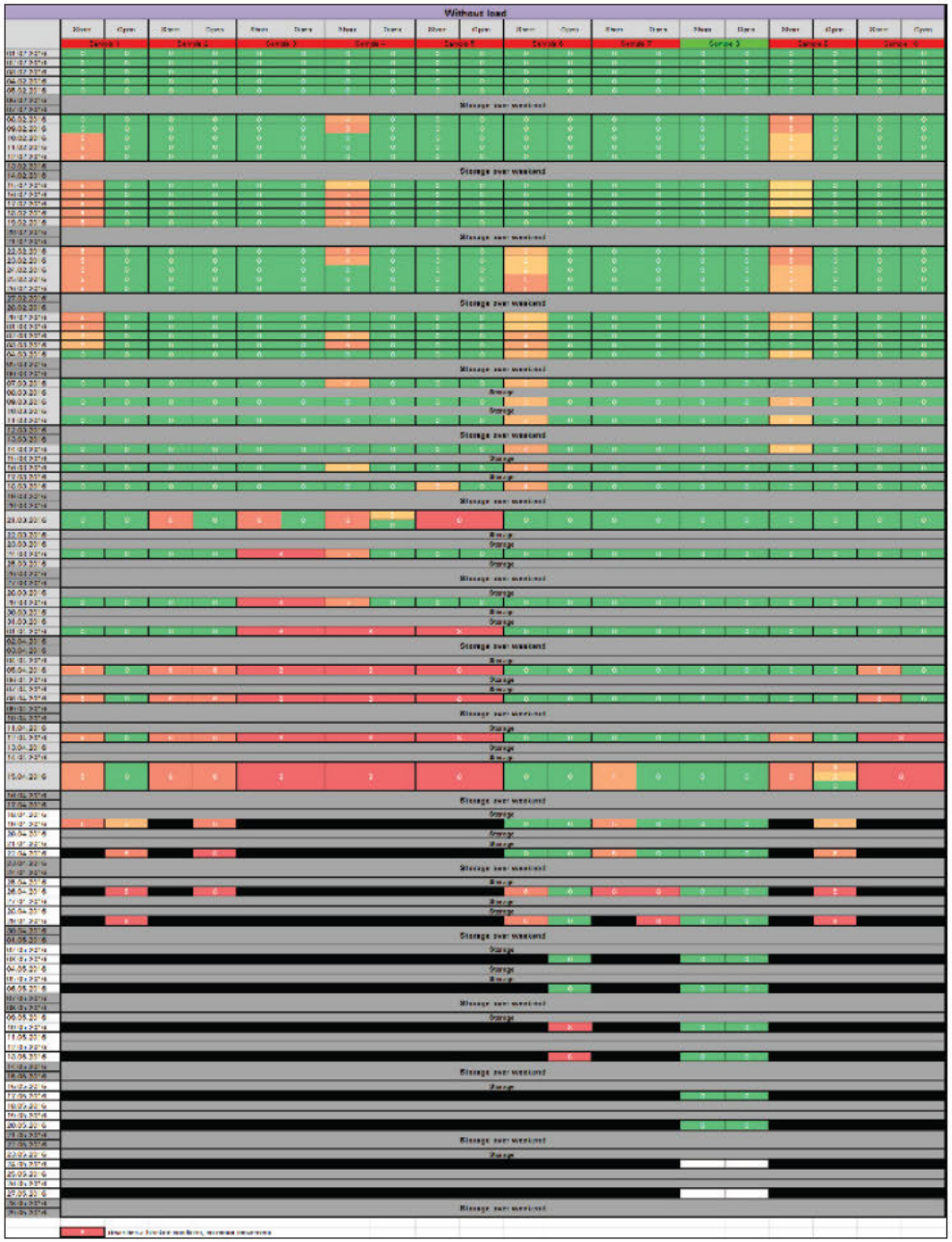
New agreed test procedure:

Daily apply of washing shampoo and 1% salt solution water drop on sinter bearing

First operation with short circuit

Then open circuit operation

Overview without load test samples



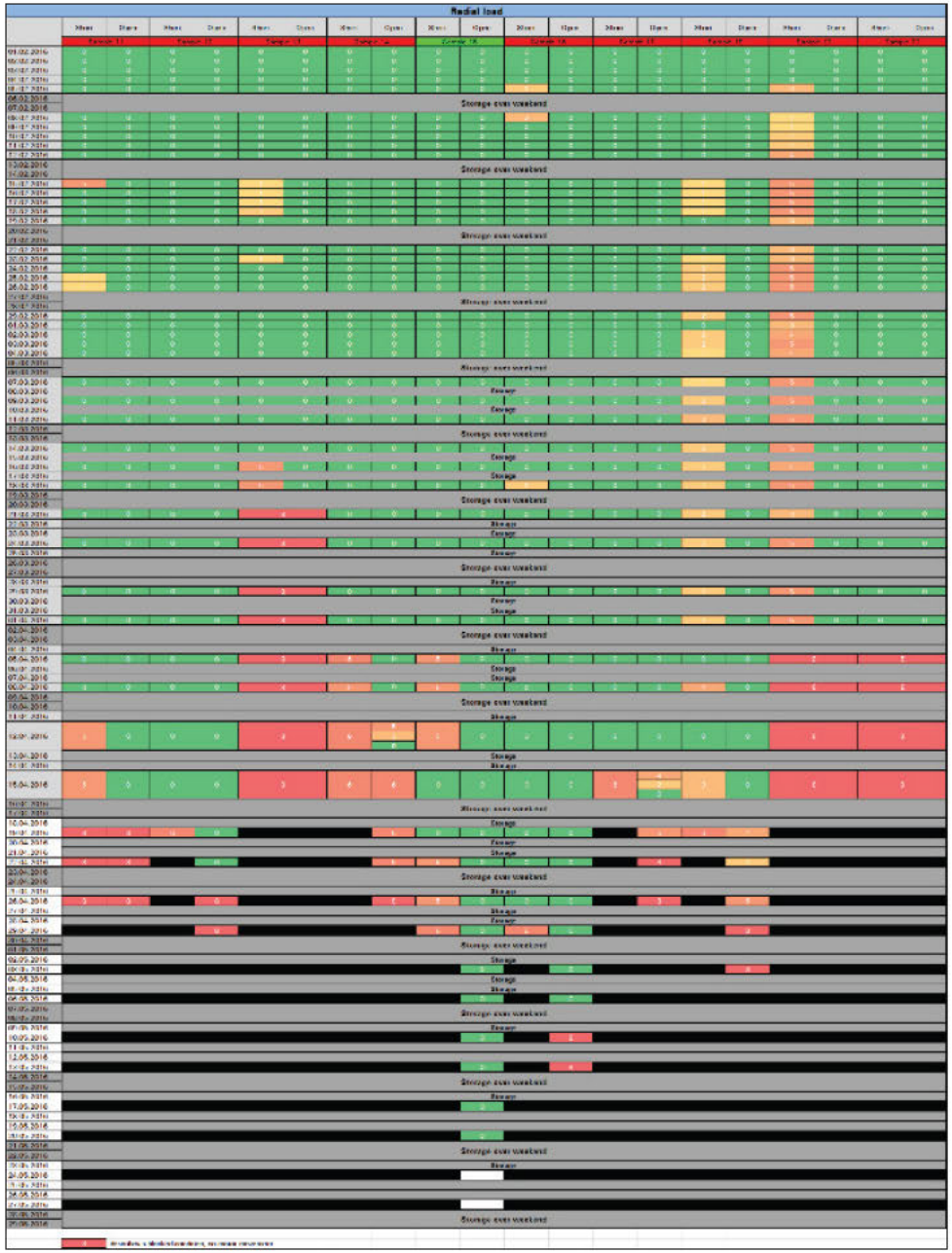
1 2

summary 20.05.2016 (after 31 weeks of testing):

- **9 out of 10 parts failed by now**
- **1 part still working with short & open circuit**
- **more parts started to fail completely after 24 weeks**

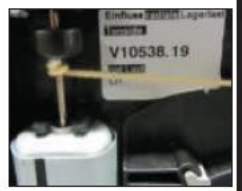
Overview radial load test samples

1 2

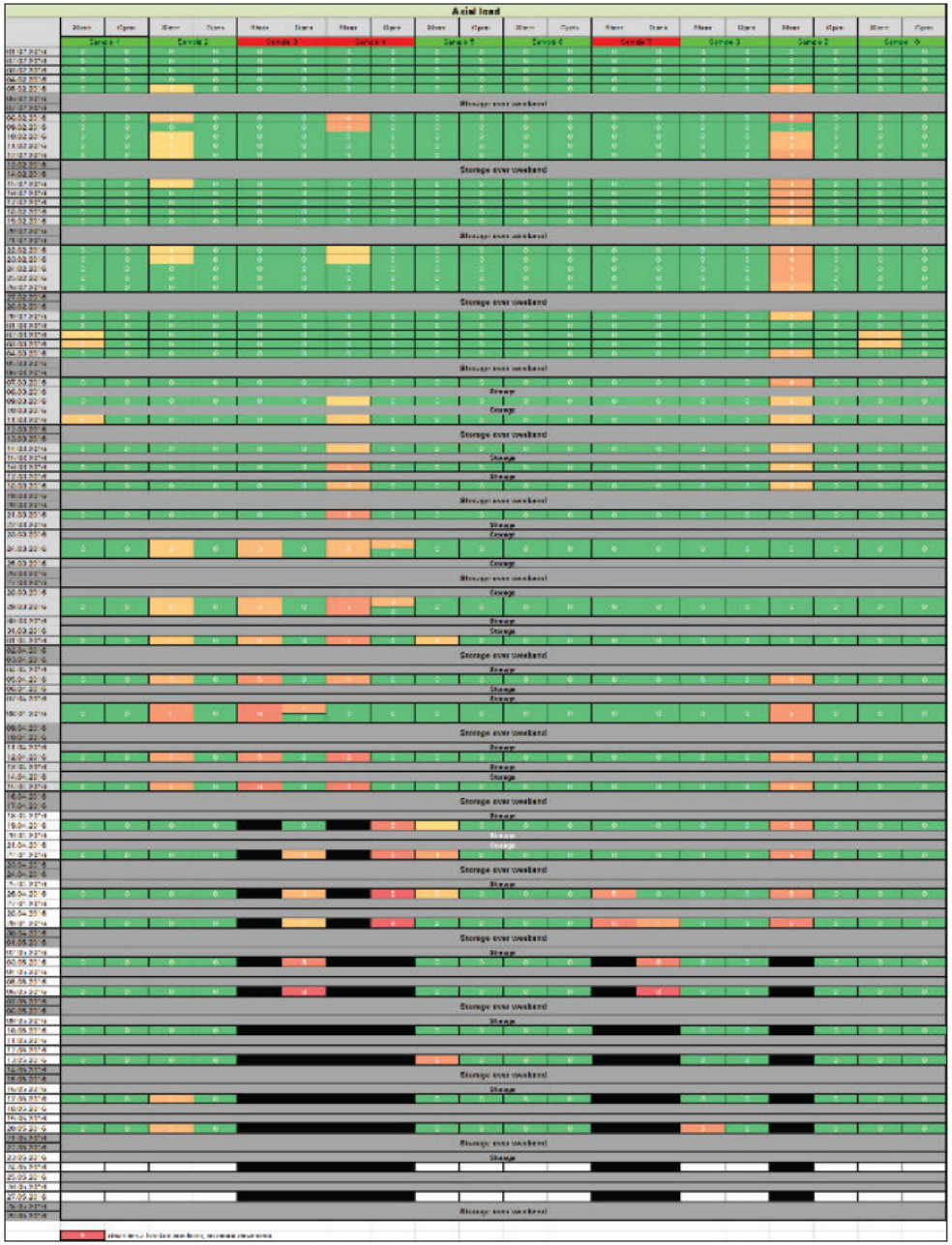


summary 20.05.2016 (after 31 weeks of testing):

- **9 out of 10 parts failed by now**
- **1 part still working with open circuit**
- **more parts started to fail completely after 25 weeks**



Overview axial load test samples



1 2

summary 20.05.2016 (after 31 weeks of testing):

- **3 out of 10 parts failed by now**
- **4 parts still working with short & open circuit**
- **3 parts still working with open circuit**
- **more parts started to fail completely after 27 weeks**

- **different test procedure must be kept in mind**
  - **axial condition created by metal spacer**
  - **spacer will be removed before testing**
  - **due to this procedure the shaft get axial movement and resolves blocked situation**

Conclusion

1 2

Purpose of this performed test: Testing if axial / radial force on the motor shaft can abet Corrosion

Influence of axial / radial load on motor shaft should be evaluated by time until failure occurrence.

- with the tensides used in this performed test no malfunction of motor could be provoked – results after test duration of 15 weeks:
  - axial load - all parts okay with short and open circuit
  - radial load - all parts okay with short and open circuit
  - without load - all parts okay with short and open circuit
- agreed change of test procedure after 15 weeks to accelerate failure occurence - adding 1% salt to tenside solution, first parts started to fail with short circuit:
  - radial load - first failure after 16 weeks
  - axial load - first failure after 16 weeks
  - without load - first failure after 17 weeks
- after adding 1% salt to tenside solution, first parts started to fail with open circuit after previous short circuit operation:
  - radial load - first failure after 23 weeks
  - axial load - first failure after 23 weeks
  - without load - first failure after 23 weeks

Conclusion

1 2

Purpose of this performed test: Testing if axial / radial force on the motor shaft can abet Corrosion

- no difference in the test results between tests *without* radial load and *with* radial load on motor shaft could be identified (after 31 weeks in both tests showed 9 failed motors)
- test results with axial load can not be compared to radial load / without load test results due to different test procedure (positioning/removal of spacer causes additional movement of shaft at each test cycle – see overview axial load test samples)

- **After the conducted tests it could not be confirmed that an additional force to the motor shaft will abet corrosion**

Overview Validation testing for Ishikawa "stiff motor" and sealed leakage path

Teststatus from: 26.01.2016

Pos.	test-No.	test-description	testsamples	duration	start	finish	remark
1	V10.538	**Washing shampoo** (drop on bearing): Comparison **with and without radial** load on motorshaft	5LH/5RH 5LH/5RH	Per loop 22days	12.10.2015	~~03.11.2015~~ ~~01.12.2015~~ ~~22.12.2015~~ ~~26.01.2016~~ 16.02.2016	26.01.2016: 4th evaluation after 12 weeks application and storage time: → Slightly corrosion visible. Operation of all parts with short circuit and open circuit ok
2	V10.568	**5% saltwater** (drop on bearing): Comparison **with and without radial** load on motorshaft	5LH/5RH 5LH/5RH	Per loop 22days	26.10.2015	~~17.11.2015~~ 08.12.2015	2. evaluation after 6 weeks application and storage time: 08.12.2015: failures occur with and without load, see table on page 56; test finished
3	V10.569	**Washing shampoo** (drop on bearing): Comparison **with** and without **axial** load on motorshaft	5LH/5RH	Per loop 22days	26.10.2015	~~17.11.2015~~ ~~08.12.2015~~ ~~05.01.2016~~ ~~26.01.2016~~ 16.02.2016	26.01.2016: 4th evaluation after 12 weeks application and storage time: → Slightly corrosion visible. Operation of all parts with short circuit and open circuit ok
4	V10.570	**5% saltwater** (drop on bearing): Comparison **with** and without **axial** load on motorshaft	5LH/5RH	Per loop 22days	26.10.2015	~~17.11.2015~~ 08.12.2015	2. evaluation after 6 weeks application and storage time: 08.12.2015: failures occur with and without load, see table on page 56 test finished
5	V10.571	**360h saltspray** test + 168h storage at RT (samples without greaseand sticker With **radial** load on motorshaft	2LH/2RH	360h + 168h	28.10.2015	~~17.11.2015~~ 27.11.2015	17.11.2015: Salt Spray test finished. Storage started 27.11.2015: Test finished, test KV function with first short then open circuit passed ok. → Failure mode in standard salt spray test not reproduceable.
6	V10.572	**360h saltspray** test + 168h storage at RT (samples without greaseand sticker) **without** load on motorshaft	2LH/2RH	360h + 168h	28.10.2015	~~17.11.2015~~ 27.11.2015	17.11.2015: Salt Spray test finished. Storage started 27.11.2015: Test finished, test KV function with first short then open circuit passed ok. → Failure mode in standard salt spray test not reproduceable.
7	V10.573	**360h saltspray** test + 168h storage at RT (samples without greaseand sticker) With **axial** load on motorshaft	2LH/2RH	360h + 168h	28.10.2015	~~17.11.2015~~ 27.11.2015	17.11.2015: Salt Spray test finished. Storage started 27.11.2015: Test finished, test KV function with first short then open circuit passed ok. → Failure mode in standard salt spray test not reproduceable.

leakage path elimination with elimination of edge at KV housing and additional sealing contour

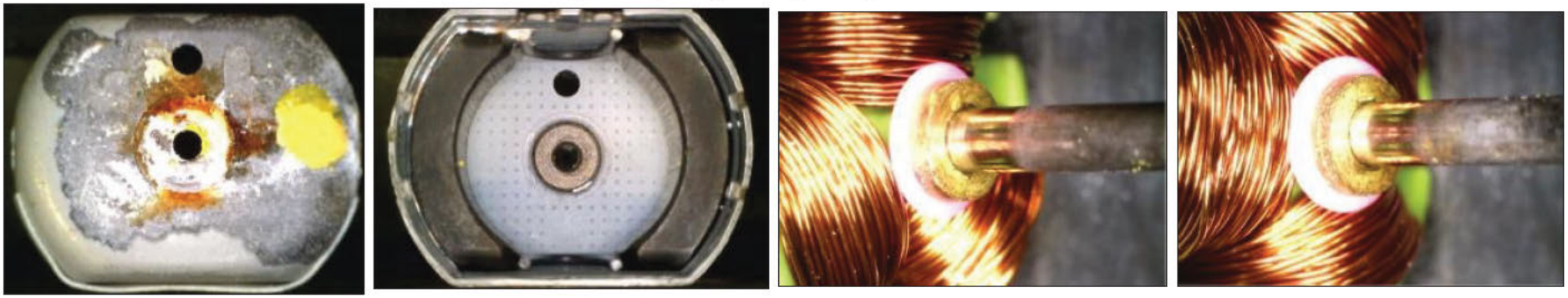
Pos.	test-No.	test-description	testsamples	duration	start	finish	Remark
1	V10.565	**leakage** test with **nominal** pinch and pre thermal shock test	2 FT LH 2 RR LH	9 days	~~12.11.2015~~ 21.12.2015	~~26.11.2015~~ 22.01.2016	27.11.2015: Test stopped due to single part deviation. New samples ordered.
2	V10.567	**leakage** test with **min/max** pinch and pre thermal shock test	each 4 FT LH 4 FT LH	9 days	~~12.11.2015~~ 21.12.2015	~~26.11.2015~~ 22.01.2016	27.11.2015: Test stopped due to single part deviation. New samples ordered.

Methodology Step:- D M A I C R

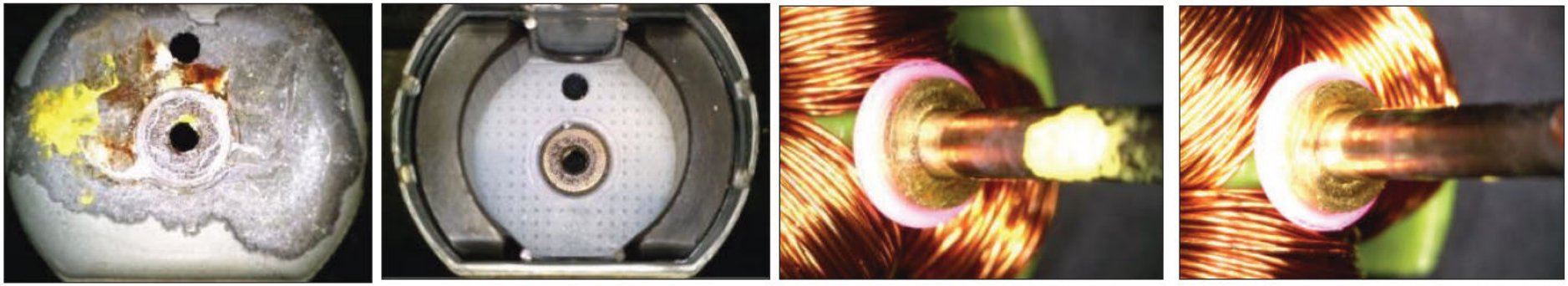
Salt Spray Test Samples

Foto documentation of salt spray test samples (360h):

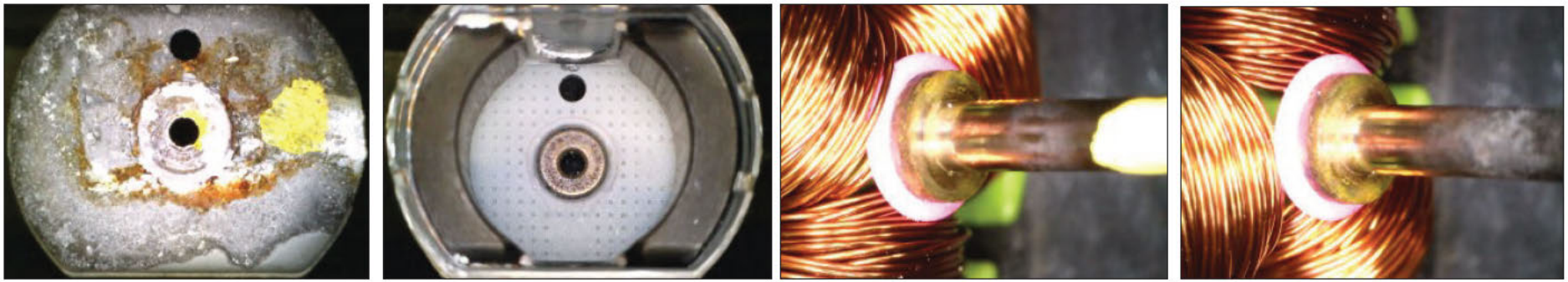
V10571: with **radial load** on motorshaft (exemplary sample 2):



V10572: **without load** on motorshaft (exemplary sample 4):



V10573: with **axial load** on motorshaft (exemplary sample 1):



Conclusion: No different corrosion behaviour due to load detected in this test with 3 different load szenarios.

3

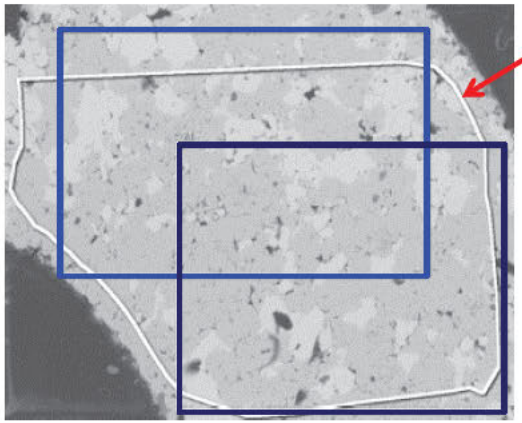
3. Bearing material

a. EDX surface analysis

SALWR2WF2EA399155

Bearing no. 48

Fe	Cu	Zn	Sn	O
66	27	7		

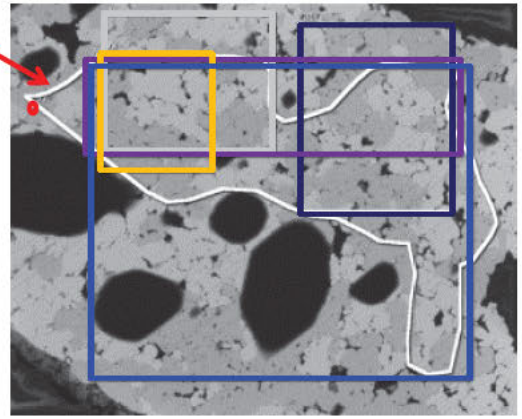


Measured area white frame

SALWV2EF2EA312738

Bearing no. 50

Fe	Cu	Zn	Sn	O
52	31	11	0,9	5,4



- Measured area <1mm²

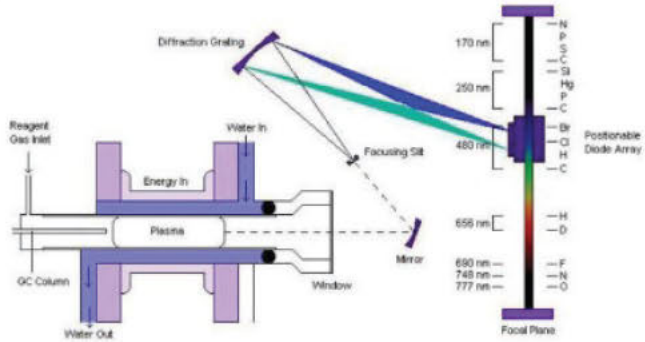
IMDS Motor Sinter Bearing	0,235 g
Copper	46,69 %
Zinc	16,11 %
Iron	35,0 %
Carbon	1 %

Material mix of analysed parts is different to IMDS data.
→ Deeper analysis is necessary, to check complete volume of bearing.

3

ICP Inductively Coupled Plasma investigation of sinter bearing

Inductively coupled plasma atomic emission spectroscopy (ICP-AES),… is an analytical technique used for the detection of trace metals. It is a type of emission spectroscopy that uses the inductively coupled plasma to produce excited atoms and ions that emit electromagnetic radiation at wavelengths characteristic of a particular element. It is a flame technique with a flame temperature in a range from 6000°K to 10000° K. It is also a solution technique & standard silicate dissolution methods are employed. The intensity of this emission is indicative of the concentration of the element within the sample (wikipedia.org)



Analyze of:

2 bearings from US vehicle August 2015

4 bearings from investigated latches Jan/Feb 2015

- L494 Dubai vehicle, KV motor with corrosion on bearing (picked up in Dubai)
- X351 UK vehicle, KV motor with corrosion on bearing
- L494 Dubai vehicle, NTF latch from Dubai, no corrosion on KV motor bearing, latch from vehicle set
- L494 UK vehicle, NTF latch from quality return process, no corrosion on KV motor bearing

1 bearing from new KV motor (current production)

3

3. Bearing material

b. ICP Analysis of bearing material → ongoing

Sample	VIN	Comment	Picture of bearing	Fe [%]	Zn [%]	Sn [%]	Cu [%]
I	[redacted]	US vehicle, page 1		47,8	9,8	<0,01	40,3
II		X351 vehicle, confirmed corrosion		37,2	16,1	0,98	44,6
III		US vehicle, page 2		36,3	15,5	0,81	42,7
IV		Dubai vehicle, confirmed corrosion		34,2	16,5	0,81	46,2
V		New part from Coburg	-	49,1	9,7	<0,01	40,8
VI		L494 NTF latch from warranty return process, no corrosion		47,8	9,5	<0,00	40,2
VII		NTF Latch from vehicle set		34,6	16,7	0,9	45,9
VIII		Russia car with confirmed nok KV funciton		30,2	18,4	0,95	49,5
IX		USA car with confirmed nok KV function		48,4	9,8	<0,05	40,4

→ **Unwinding behaviour of KV motor independent from iron percentage in sinter bearing**

→ **No other significant influences recognizable**

3

3. Bearing material

c. Grey Corrosion: What is the reason for the colour?

- The bearing basically consists of Iron and brass Cu/Zn and in some cases traces from tin. Based on the EDX analysis we found the oxygen close to the brass structure/grain (Cu/Zn). But oxygen is missing in the area of the Iron (Fe) grain. Based on this we conclude the main corrosion is happening at the brass and not at the iron. The grey colour is a corrosion result of the brass surface.
- **Green corrosion**
  Green coloured oxides are mainly a product of alkaline copper sulfite. They occur when copper is exposed to an atmosphere containing water vapor of carbon dioxide, sulfur dioxide and chlorides. Green corrosion products are commonly known as verdigris, which is factually not correct.
- Due to the more or less rough-grained sintered (powder) metal the structure is heterogenously and in some cases also the corrosion residues of the single chemical element can be visible in a different colour then the alloy of the single elements.
  The colour of corrosion products of one element / alloy can be different depending on additional media and environmental conditions.
- **Water composition**
  The composition of the water (acidic, alkaline, contamination with foreign elements Na, Cl, P, S) has also an affect on the corrosion behaviour.

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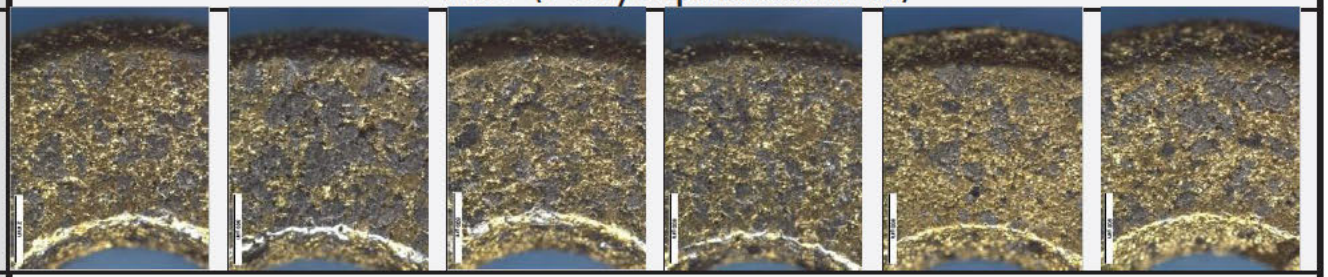
3. Bearing material

d. Bearing oil, material and amount?

Same oil in all analysed motor bearings with comparable amount in different charges.

		Motor tailgate latch BMW	Motor tailgate latch BMW	KV serial motors JLR High End			
		No. 1	No. 2	08/2012	02/2013	09/2013	06/2014
Rest of oil	[mg]	**6,0**	**6,1**	**6,2**	**5,9**	**6,0**	**5,5**
Kind of oil		PAO (Polyalphaolefine)					
Picture of bearing							
Material composition		Sinter Iron (Fe, Cu, Zn)					

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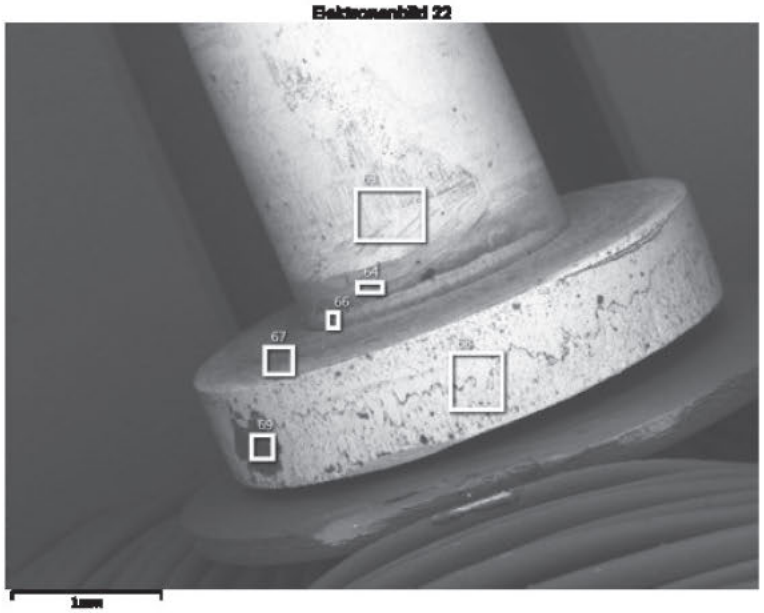
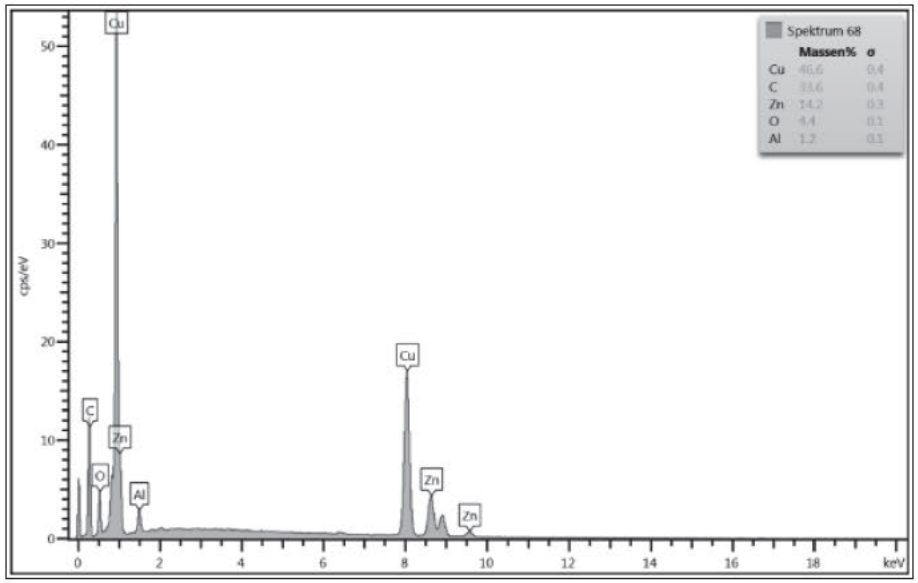
4. Washer

a. EDX Analysis of washer material





Elements of washer
Copper
Zinc
Aluminiun

Measured area <1mm²

Material mix of analysed part as expected.

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4. Washer

b. Black residues

→ Result of analysis (Answer from Lab)
Black paste is consisting of oil and abrasion and also corrosion products.

→ Results to be clarified and detailed with laboratory (Würzburg) again.

Black paste: consisting of oil and abrasion and also corrosion products. As well residues of penetrated water solution (component of salt, tenside or washing-active substances)

Due to the fact, that EDX can only identify chemical elements, it is not possible to assign clearly/unequivocally the origin of the medium. It is only possible to assign securely metallic elements of the sliding-partner.

We detected in black residues Na and P, which can be from washing substances. On corrosion residues was Cl detected.