INFORMATION REDACTED PURSUANT TO THE FREEDOM OF INFORMATION ACT (FOIA), 5 U.S.C. 552(B)(6)

4

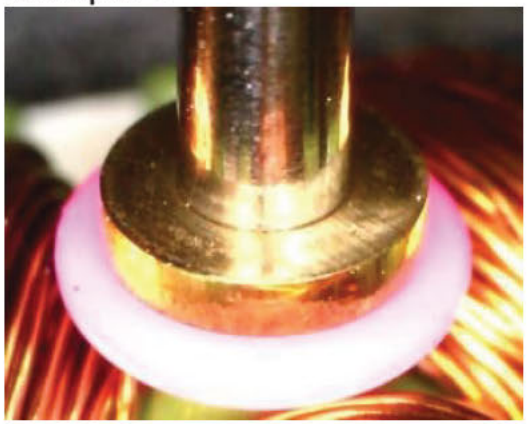
4. Washer

c. Roughness washer in new condition

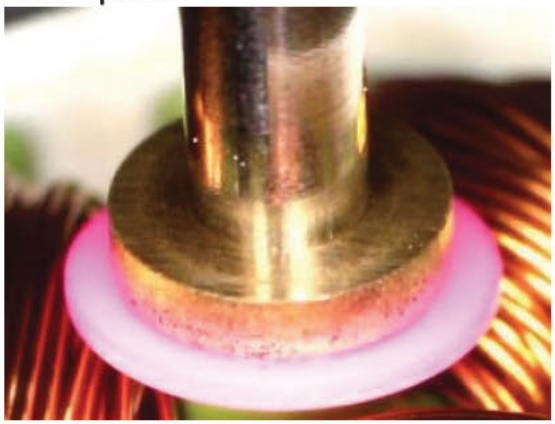
Comparison based on pictures of washers of 5 pc. Motors (V10561, new condition)

→ Due to not having seen rough surfaces on washers, agreed with JLR to point on low priority.

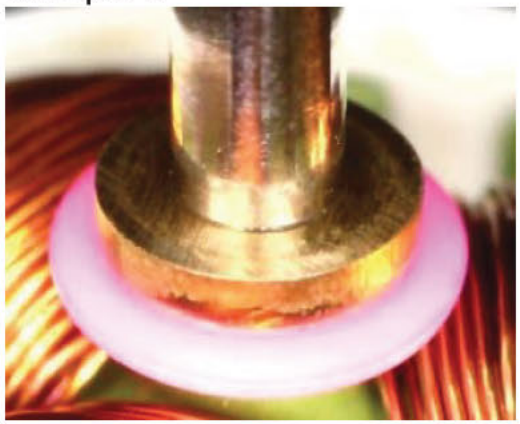
Sample 1



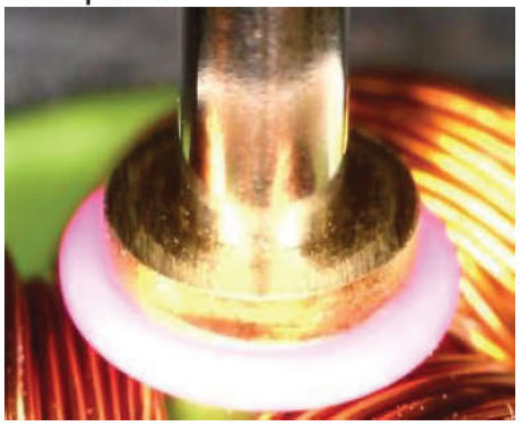
Sample 2



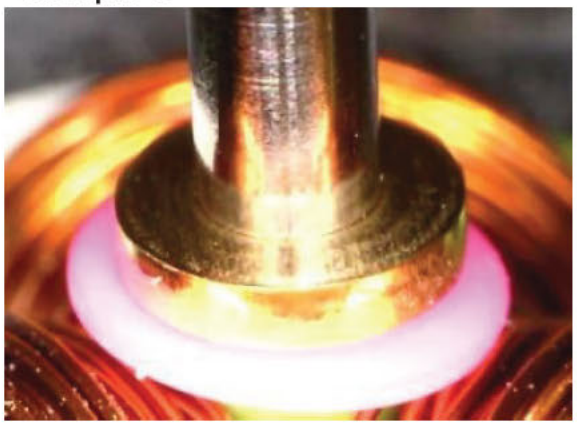
Sample 3



Sample 4



Sample 5



Conclusion:
No difference regarding roughness visually detectable on 5 washer surfaces in new condition.
Note:
Diameter washer: 3,75mm
Diameter shaft: 1,97mm

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5

5. Time to dry motor

a. Time to dry motor

- Take corroded latches from field
- 6 pc. (when available) apply tap water on bearing and pump it into motor by turning the shaft.
- 3 pc. storage for 1 week at high temperature and low humidity (80°C / ~10% rH)
  3 pc. storage for 1 week at room temperature and uncontrolled humidity
- 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.**

- **b. Capillary action due to axial movement of shaft**
  → Already confirmed, unwinding direction of motor moves shaft inwards the motor housing and generates pumping effect additionally to capillary effect

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6

6. Washing tensides shampoo

a. Can different tensides be identified in residues of corrosion? ✓

→ To be clarified and detailed with laboratory (Würzburg).

Tenside not possible to identify (see Ishikawa point 4). Only identification of elements possible. For example Na, S und P.

Therefore it is not possible to determine the used washing product and washing habit of the customer.

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6

6. Washing tensides shampoo

b. Are different tensides used in different markets, different countries, different carwashes, different concentrations, different water conditioning? → JLR ✓

Mail Sean Edwards:

JLR has no specification for world wide used washing tensides shampoos.

Test Procedure JLR: TPJLR.52.105

Exterior Trim Components: Resistance to Alkaline Car Wash Fluids

- 12,7g NaOH
- 2,31g Na3PO4
- 12H2O
- 0,165g NaCl
- 1000ml water

Brose Statement: Specific test which is critical for aluminium parts. This car wash fluid mixture do not represent world wide used washing products.

c. Testing to be defined after clarification of a. and b.

Point closed. Due to 6a und 6b ✓

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7

7. Fast latch function

a. Use of KV function on doors. Correlation existing to KV-issue? → JLR

→ Questionary prepared and provided to JLR, so far no feedback from dealer side.

→ Additional questionary will be prepared for JLR owned vehicle users.

→ Questionary JLR updated with KV specific points as agreed with Ash Dhir, Sean Edwards and Steve Hinsley

→ Wording will be updated, first proposal attached

Door latch investigation - Affects L405 / L494 / L462 / L550 / X152 / X260 / X351 (after 14MY) / X760

Dear Colleague

We are investigating the operation of door latches. If you ever have had an issue with your latch we would be grateful if you could complete the following questions.

Models we're reviewing are L405 / L494 / L462 / L550 / X152 / X260 / X351 (after 14MY) / X760.

*Required

Vehicle registration *

What door latch has an issue? Judged when sitting in the vehicle *

- [ ] RH Front
- [ ] LH Front
- [ ] RH Rear
- [ ] LH Rear

What failure have you seen? *

- ( ) Wont open - Unable to open the door when pulling the handle (inside or outside handle)
- ( ) Wont close / latch - when closing the door it will bounce back (latch will not grab striker)
- ( ) Wont lock - Although you have pushed the lock button (Central lock / Double lock) the door can still be opened
- ( ) Wont unlock -Lock status LED remains lit despite input from master switch / remote & door won't open
- ( ) Unable to activate / deactivate child lock - Although child lock has been switched off, it is not possible to open the rear door when pulling the inside handle
- ( ) Wont soft close (where fitted) - Door does latch but does not automatically pull shut. To close the door fully you have to slam it.

Wont open issues, was this found operating?

- ( ) Internal handle
- ( ) External handle

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For wont lock - Was the found operating....

- ( ) Remote
- ( ) Master lock switch (drivers door)
- ( ) Exterior handle (touch lock function / KV entry)
- ( ) All of the above

Is the fault all the time or intermittent? *

- ( ) All
- ( ) Intermittent

Other symptoms?

- [ ] Alarm sounding
- [ ] Door Ajar sign on dash

How often is the faulty door used?

- ( ) Regularly
- ( ) Once a day
- ( ) 3-4 times a week
- ( ) Rarely

How often do you open each door by handle (key-less) per week?

How often do you wash the car per month?

- ( ) 1 time
- ( ) 2-5 times
- ( ) 6-10 times
- ( ) 11-15 times
- ( ) 16 - 30 times

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8

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

→ 23.10.2015

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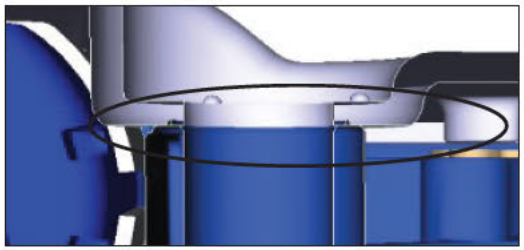
Methodology Step:- D M A I C R

Timing KV housing change

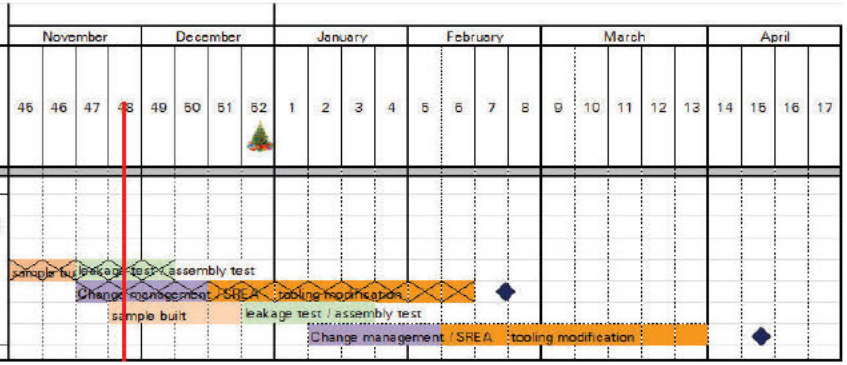
Design proposal to stop leakage path



1. **Elimination of edge in KV housing (contact area KV housing to lid), height will be increased**
2. **Add of sealing contour at KV housing, this will be pressed in KV lid to seal the contact surface**

Timing for testing and serial introduction of KV housing and lid

	latch upsuffix JLR needed	module upsuffix JLR needed	Alert required	latch upsuffix Brose needed	module upsuffix Brose needed	Next latch/module upsuffix	affected vehicle line	Issue	Action
Modification of KV housing / lid	yes	yes	yes	yes	yes	yes	all	modification of KV housing and lid for water protection of pin	height of contact geometry in housing will be increased by approx 0,3 mm and thickness of lid reduced to get a planar contact surface



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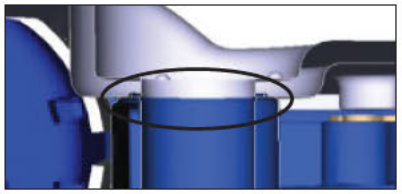
Methodology Step:- D M A I C R

Testing KV housing change



Testing / Validation of new design

- **Leakage Test with paint water**

- **Samples**
  - **Changed KV housing with sealing contour from tooling**
  - **Minimum / Nominal / Maximum compression between KV housing and lid**

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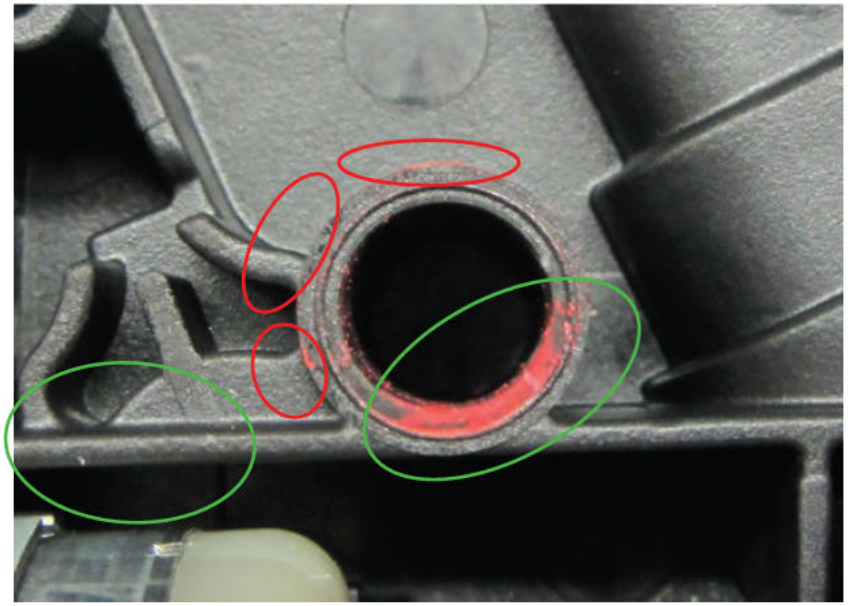
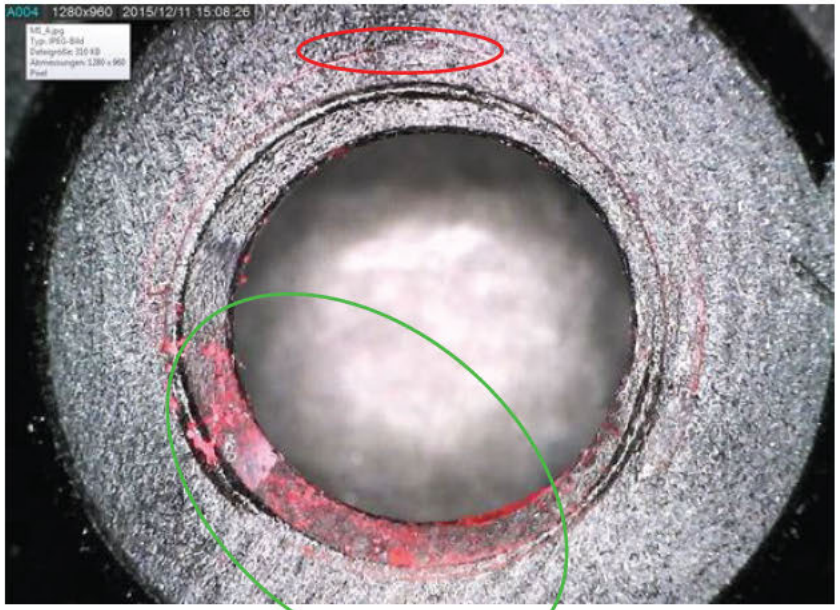
Test results leakage test

Samples with sealing contour (height 0,3 mm) in KV housing and 3 tolerance spots



KV housing after testing



KV lid after testing

Main content of water will be stopped by sealing contour ✓

No water is running to KV motor ✓

Slight water traces found inside of the sealing contour ✗

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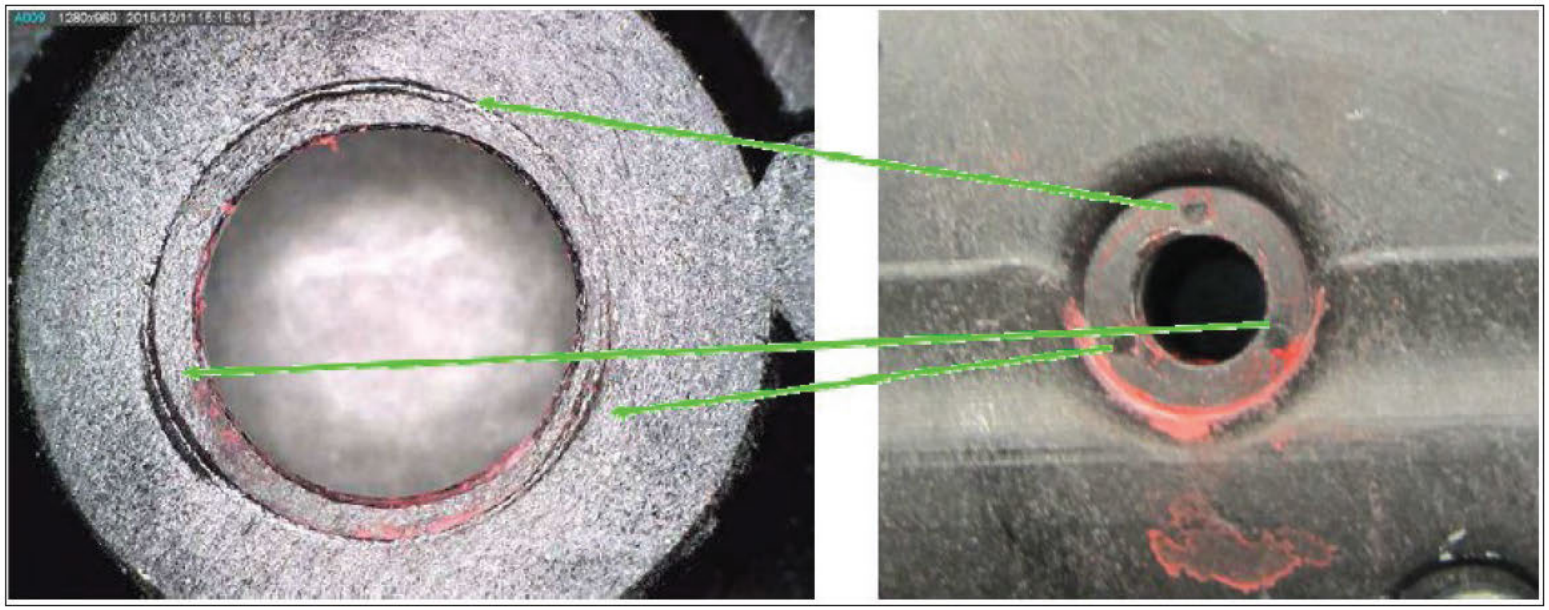
Test results leakage test

Investigation of test samples



KV housing after testing

KV lid after testing

Sealing rib of KV housing is pressed into KV lid sufficiently in the area of the tolerance spots

due to higher force during the riveting process. In the area between the tolerance spots the sealing contour is not pressed sufficiently into the KV lid.

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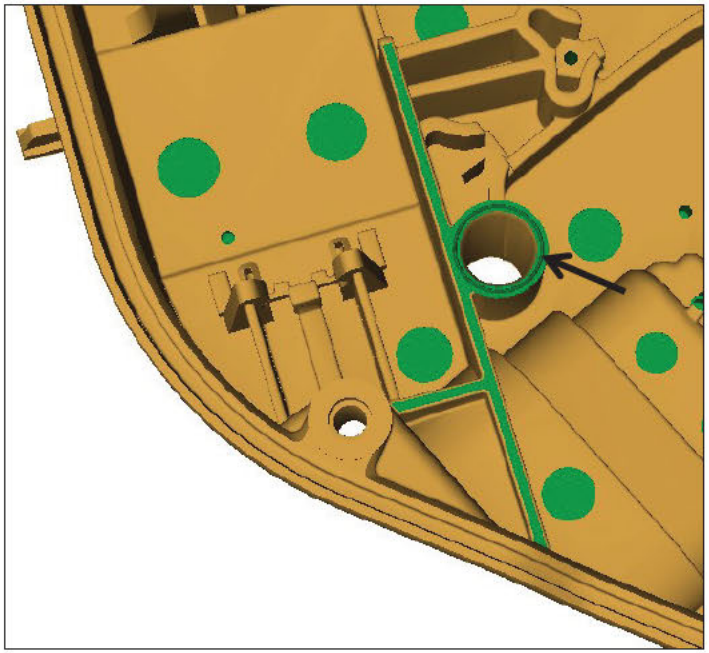
Methodology Step:- D M A I C R Testing KV housing change

Test results leakage test

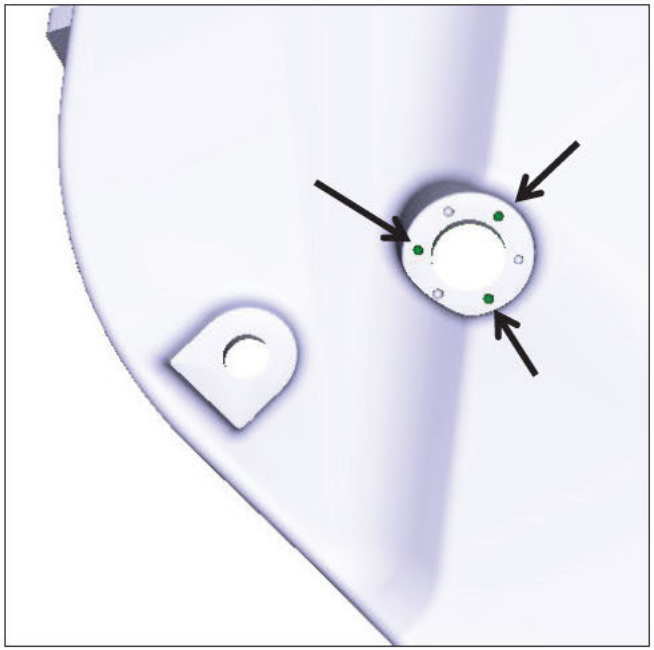
Investigation of test samples

Two actions needed for robust design solution

1. **Increase height of sealing contour at KV housing from 0,3mm to 0,5mm**



2. **Additional spots at lid to press sealing contour into lid**



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Methodology Step:- D M A I C R

Testing KV housing change

Test results leakage test

Samples with sealing contour (height 0,5 mm) in KV housing and 6 tolerance spots

Test procedure:
Fix a tube as water basin at the pin, storage of latches for 24h, check after 24h if water is visible behind the sealing contour

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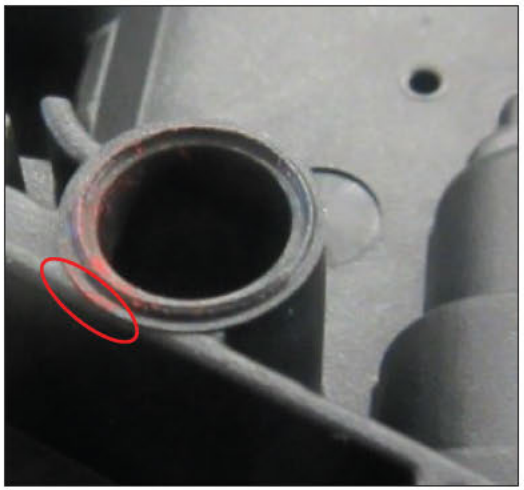
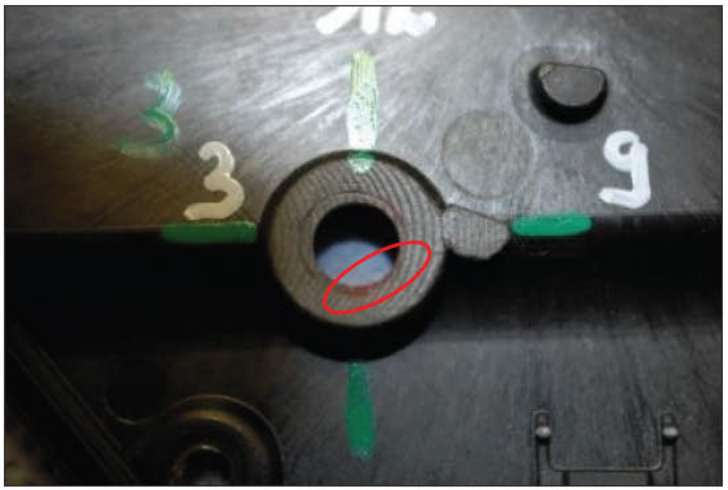
Methodology Step:- D M A I C R Testing KV housing change

Test results leakage test

Samples with sealing contour (height 0,5 mm) in KV housing and 6 tolerance spots



KV housing after testing



KV lid after testing

Main content of water will be stopped by sealing contour ✓

No water is running to KV motor ✓

Slight water traces found inside of the sealing contour ✗

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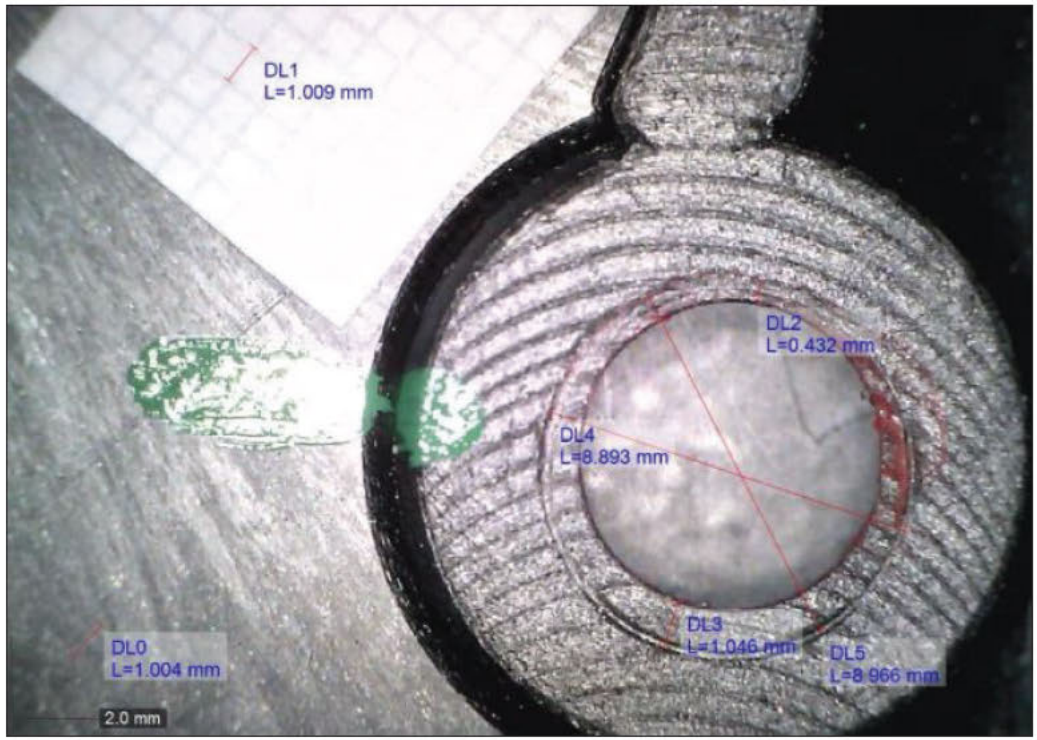
Test results leakage test

Investigation of test samples



Due to tolerances the sealing contour is not centrical. Depth of indentation not sufficient to seal complete area.

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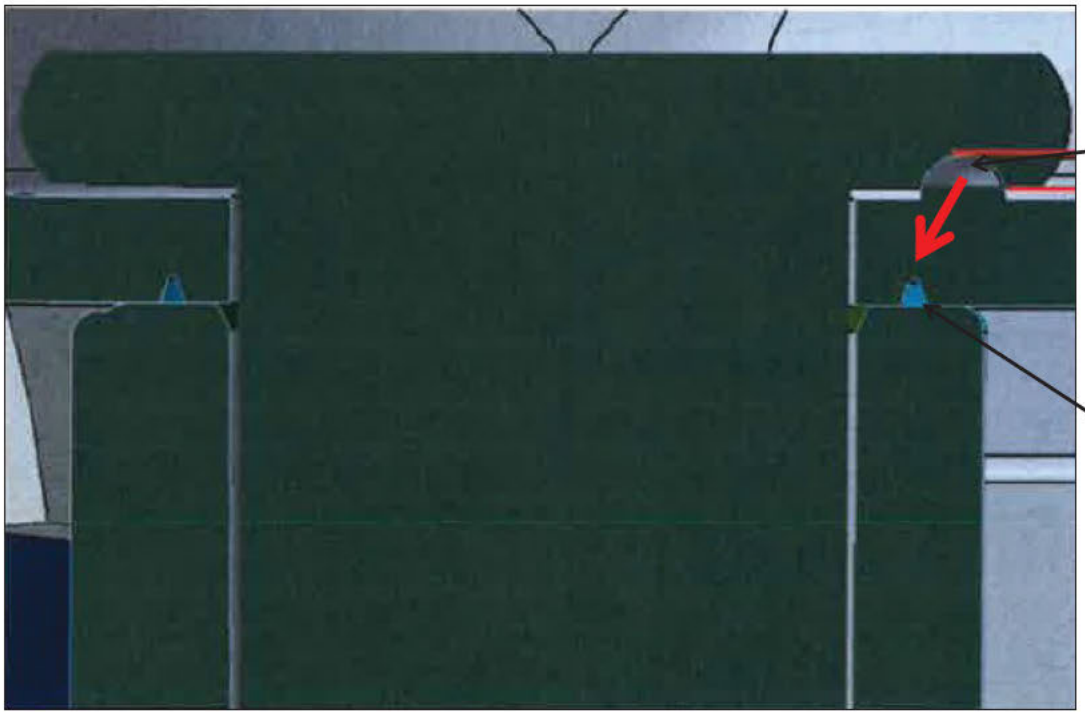
Test results leakage test

Investigation of test samples



Tolerance spots of the KV lid not perpendicular to the sealing contour at the KV housing. Force transmission during riveting process not optimal (transverse) to press the sealing contour into the lid

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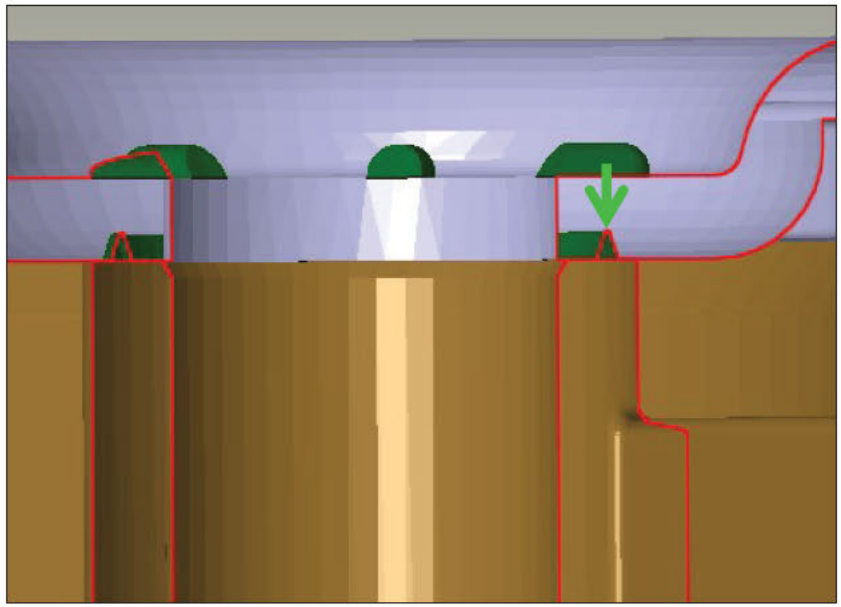
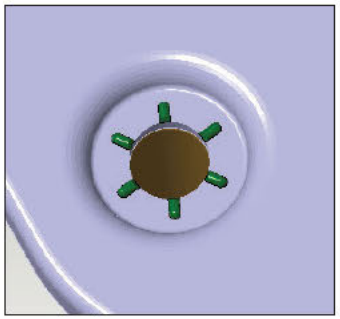
Methodology Step:- D M A I C R

Testing KV housing change

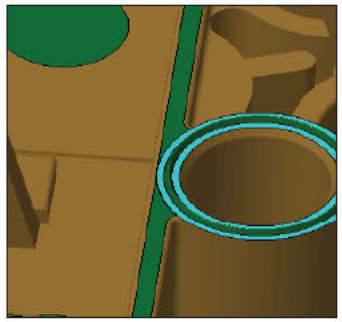
Test results leakage test

Design proposal





Optimized design of tolerance spots



Optimized design of sealing contour

Contour of tolerance spots modified

Diameter of sealing contour increased by 0,2mm

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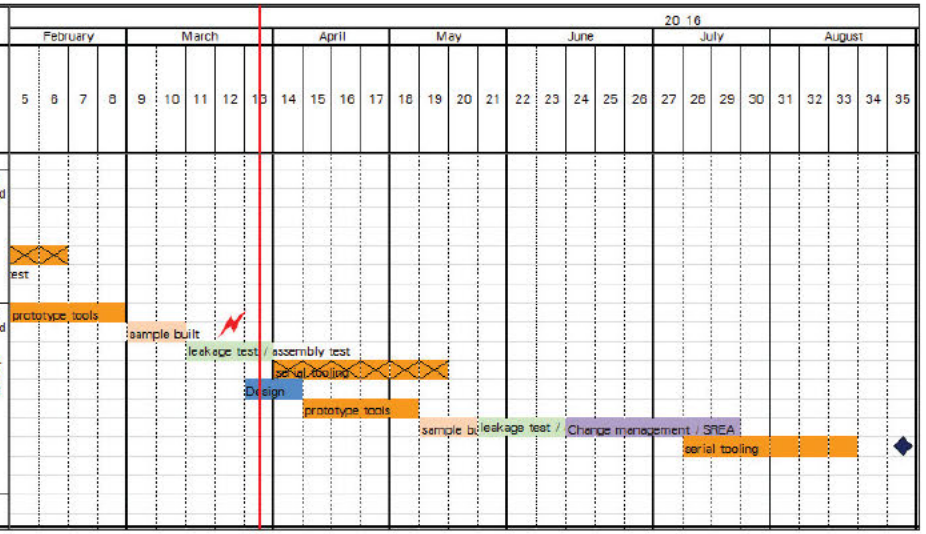
Methodology Step:- D M A I C R — Testing KV housing change

Test results leakage test

Updated timing for design/testing loop

	latch upsulfix JLR needed	module upsulfix JLR needed	Alert required	latch upsulfix Brose needed	module upsulfix Brose needed	Next latch/module upsulfix	affected vehicle line	issue	Action
Modification of KV housing / lid									
	yes	yes	yes	yes	yes	yes	all	modification of KV housing and lid for water protection of pin	height of contact geometry in housing will be increased by approx 0,3 mm and thickness of lid reduced to get a planar contact surface
	yes	yes	yes	yes	yes	yes	yes	modification of KV housing and lid for water protection of pin	height of contact geometry in housing will be increased by approx 0,5 mm and thickness of lid reduced to get a planar contact surface and additional contoure for tolerance compensation. 30.03.2016 Further optimisation of KV sealing contour (position) and tolerance spots in KV lid needed



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Methodology Step:- D M A I C R

Separation of 6-panel document on the 5th of October 2018 in three parts for better handling:

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

6-panel second extract: *20180906_6Panel_Will_not_latch_joint version_05102018*

6-panel in progress: *20170915_6Panel_Will_not_latch_ROZ*

Both documents were sent out on the 9th of October 2018

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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

L494 MY15 Open whilst driving

Software flash: 18-JAN-2016

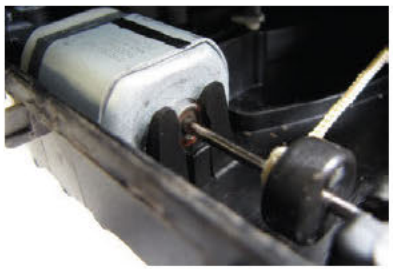
Repair date: 16-JUL-2018

FT RH CL PC KV
05.09.2013

Customer: VEHICLE DRIVERS DOOR WILL NOT STAY CLOSED WHILE DRIVING

Tech: Scanned the vehicle for related DTCs none present. Removed drivers door panel for access and inspected the door latch door latchnot latching, latch internal fault. Replaced the latch, re assembled the door panel, re tested door operation normal.

Latch received with 1 winding left on the motorshaft



Front sinter bearing red corrosion, corrosion on housing visible, w/o grey sticker.

KV motor operation open circuit	→ 0,5winding left on the motor shaft after the 1st actuation, 0 winding on second attempt.
KV motor operation short circuit	→ nok KV function, 5 windings left on the motor shaft
KV operation first short then open	→ 5 windings left on the shaft after short, cord fully unwound on open

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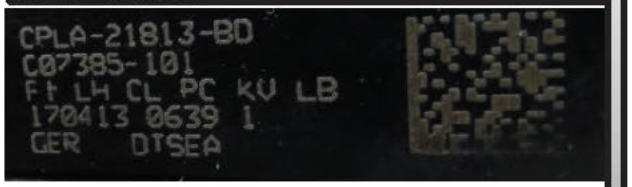
Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

FT LH CL PC KV LB
17.04.2013



Latch from Critical Concern List [redacted] // USA

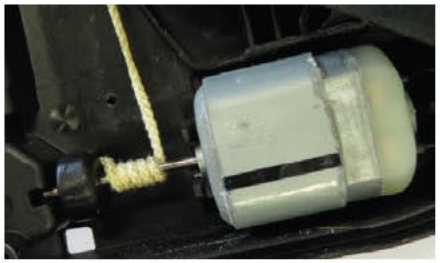
L405 MY 13, w/o grey sticker

Software flash: based on AWS P068 not performed

Repair date: 21-AUG-2018, 64MIS, Ft RH in 59MIS.

Customer: C/S DRIVER FRONT DOOR IS NOT LOCKING/LATCHING, ADVISE.

Tech: FOUND L/F DOOR LATCH FAILS TO LATCH. REPLACED LATCH. PERFORMED FUNCTION TEST. VEHICLE OPERATES AS DESIGNED.



Latch received with 5 windings left on the motor shaft.

Front sinter bearing red, corrosion on housing visible.

KV motor operation open circuit	→ **NOK KV function, shaft is rotating, 5 windings left**
KV motor operation short circuit	→ **NOK KV function, shaft is rotating, 5 windings left**
KV operation first short then open	→ **NOK KV function, 5 windings short, 4 windings open**

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Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

FT LH CL PV KV LB 18.02.2014

Latch from Critical Concern List [redacted] / USA

L494 MY 14, w/o grey sticker,

Inadvertent door opening whilst vehicle in motion & door will subsequently not latch.

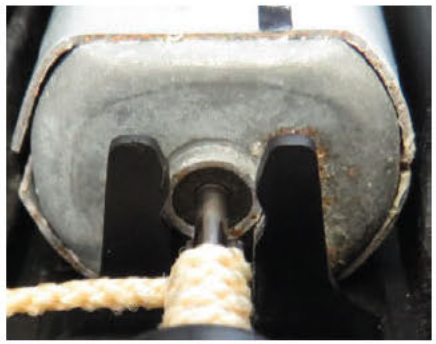
Software flash: 17-JUN-2016, 27MIS

Repair date: 17-SEP-2018 - 55MIS,

Customer: CUSTOMER STATES THE LEFT FRONT DOOR WILL NOT CLOSE

Tech: CODE 2 TO BUILD LOYALTY TO THE BRAND 90% GOODWILL PER SERVICEDIRECTOR. will need to replace left front door latch assy vor latch. replaced left front door latch assy. tested ok.

Latch received with 4 windings left on the motor shaft.



Front sinter bearing grey - corroded, red corrosion on the housing visible.

KV motor operation open circuit	→ **OK KV function, shaft is freely rotating, 0 windings left.**
KV motor operation short circuit	→ **NOK KV function, shaft is rotating, but 4 windings left.**
KV operation first short then open	→ **NOK KV function with short – 4 windings left,** → **OK KV function with open - 0 windings left.**

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Problem Solving Evidence Reporting (6-Panel)

Methodology Step:- D M A I C R

Scope and Prioritise Potential Causes

FT RH CL PC KV 08.09.2014

Latch from Critical Concern List [redacted]/USA

L405 MY 14, Inadvertent door opening in motion at 25 km/h

Software flash: 04-FEB-2016 – 13 MIS, W/O grey sticker

Repair date: 15-OCT-2018 – 17MIS

Customer: Claim not in AWS or IQM

Tech: Claim not in AWS or IQM

Latch received with 6 windings left on the motor shaft.

Front sinter bearing corroded and corrosion on the front side of motor found.

KV motor operation open circuit	→ **OK KV function, shaft re wound on the first attempt, 0 windings left.**
KV motor operation short circuit	→ **NOK KV function, shaft is rotating, but 5 windings left.**
KV operation first short then open	→ **NOK KV function on short, OK KV function on open.**

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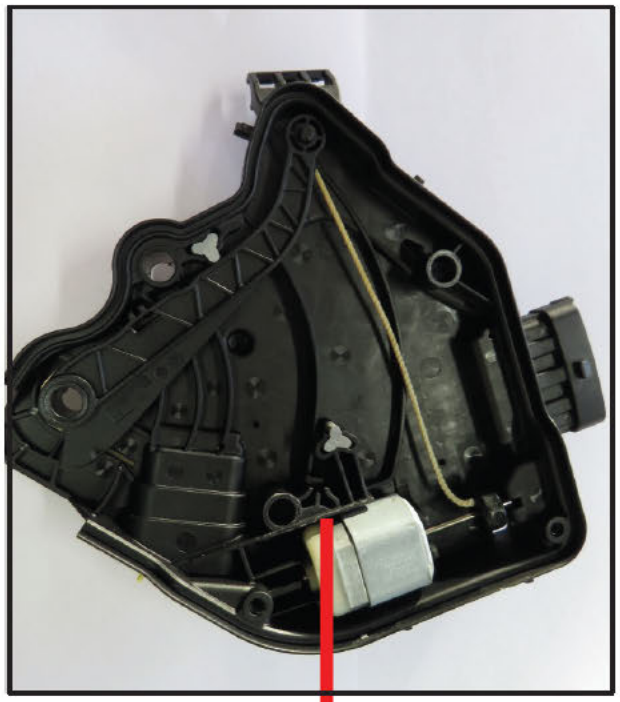
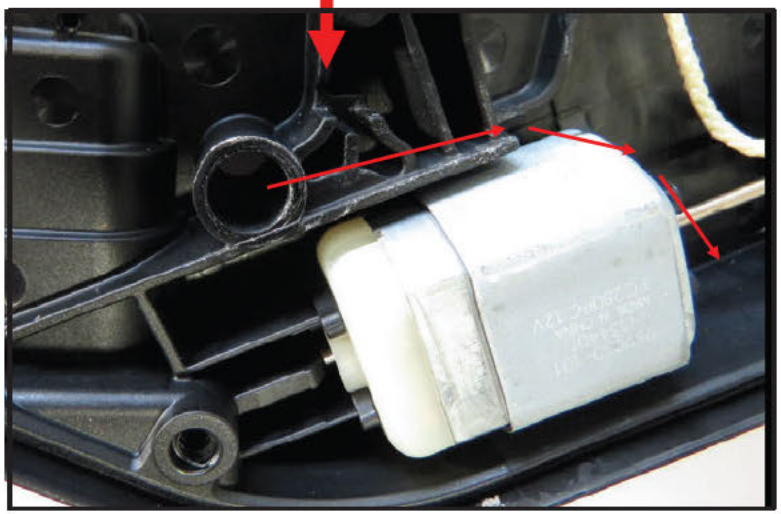
Documentation of latch from Critical Concern List [redacted]/USA





Conclusion: leak path via KV rivet hole found, part prior grey sticker introduction.

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

Scope and Prioritise Potential Causes

Problem Solving Evidence Reporting (6-Panel)

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

FT LH CL KV LB
18.9.2017

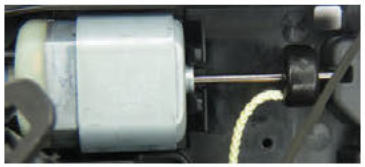
L462 MY 17

Software flash: N/A - since SOP

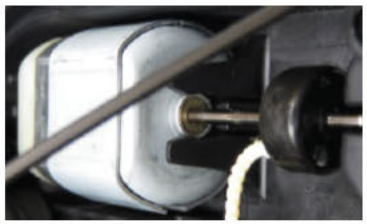
Repair date: 31-DEC-2018, 13 MIS, previous repair in AWS: **n/a**

Customer: GUEST STATES LEFT REAR AND FRONT PASSENGER DOOR LATCHS ARE NOT LATCHING PROPERLY. CHECK ALL LATCHES

Tech: Door latch and adjustments. Tested door latches. Found LF not latching on the secondary and the LR and RR doors intermittently latching. Ordered failed LF door latch and adjusted both rear door latch strikers to make a better connection. Installed LF door latch and holds great now. PN LR078731



Latch received with 0 windings left on the motor shaft.



No corrosion on the KV motor visible

KV motor operation open circuit → **OK KV function, 0 windings left, cord will fully unwound**

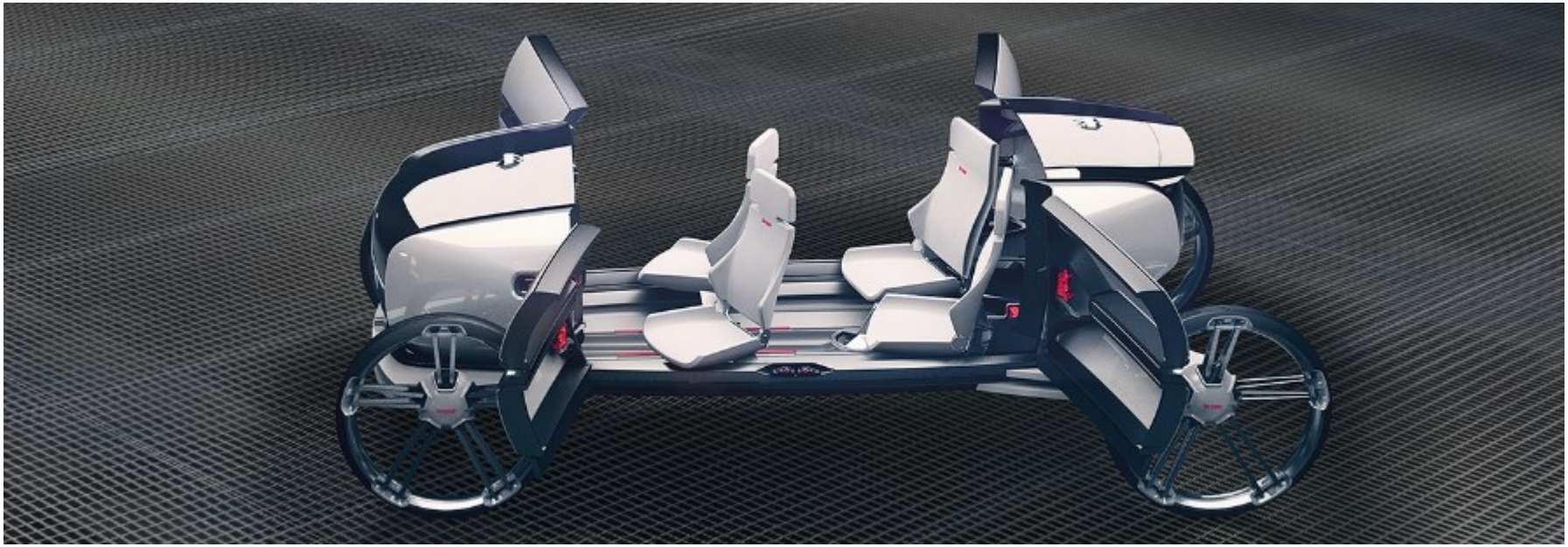
KV motor operation short circuit → **OK KV function, 0 windings left, cord will fully unwound**

KV operation first short then open → **OK KV function, 0 windings left, cord will fully unwound**

©Jaguar Land Rover Ltd. 2013.

[redacted] - China
- Kuwait

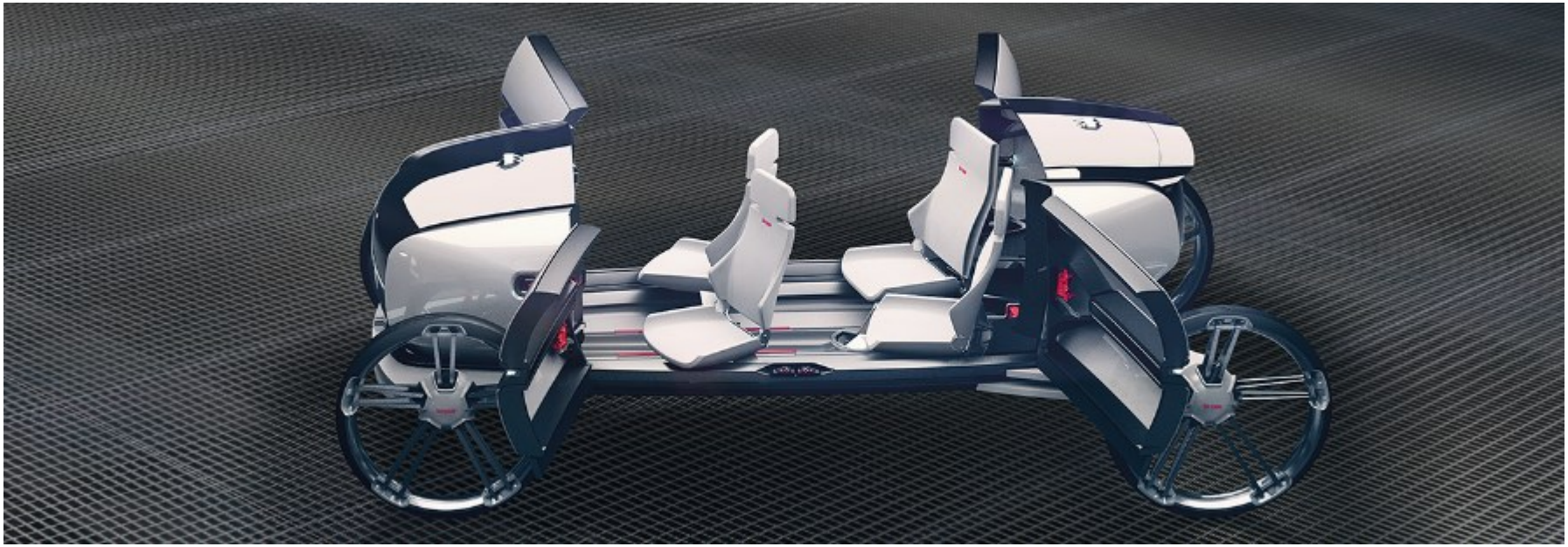
Tear down documentation



Wuppertal, 14.09.2017

[redacted] - Kuwait

Tear down documentation



Wuppertal, 14.09.2017

Voice of the customer - [redacted]

Email Matt Newman – 27.07.2017

Good Morning Oliver & Sela,

I have requested an entire latch module to be returned to you for detailed analysis from the MENA market. Unfortunately we have had another occurrence of a door failing to latch, but this vehicle is well outside the scope of P068 and also the exterior release handle was not jammed;

Owner returned to vehicle to dealer with a LHF door that was failing to latch. Vehicle build date is Fri 6 May 2016, therefore falls AFTER the introduction VIN for the latch with all modifications (Feb 2015) and after the introduction VIN for the RFA software fix (Dec 2015), therefore falls outside of the scope of the P068 recall action.

Immediately prior to the failure occurring the owner had unlocked the vehicle using the LHF door, therefore the assumption is that that door was unlocked using a KV actuation / KV unlock cycle. The state of the door (CL / DL) is unknown prior to this unlock event.
After opening the door the customer was then immediately unable to latch it securely.

The vehicle was returned to the dealer where the error state was still evident, with video evidence available (see attached). Neil Goulsbra attended the vehicle and the error state was still evident when he got there. The door shedder was removed and the interior release cable fed back through it to complete the release process, and the shedder was then disconnected and placed away from the vehicle.

The bolts holding the latch into the car were loosened a few turns, and the latch checked for the error state - it was still present. The bolts were then removed from the latch, and the error state was still present. During the manoeuvre to removed the latch from the door cavity, Neil was holding the interior release cable to balance the latch, and he felt a "click" come from the main latch body through the interior release cable. This click resulted in a re-setting of the latch mechanism and when the latch was completely free of the vehicle the failure mode was no longer present.

No further mechanical cycling of the latch has occurred other than a few cursory cycles to check for the error state being present or not.

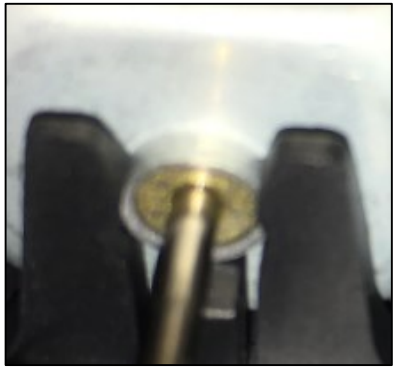
General information - [redacted]

FT LH DL PC KV LB
05.04.2016

Latch not in Critical Concern List [redacted] // KUW

Software flash: out of VIN range → repair date: **CW30 2017**

Latch received completely unwound – no leakage path visible



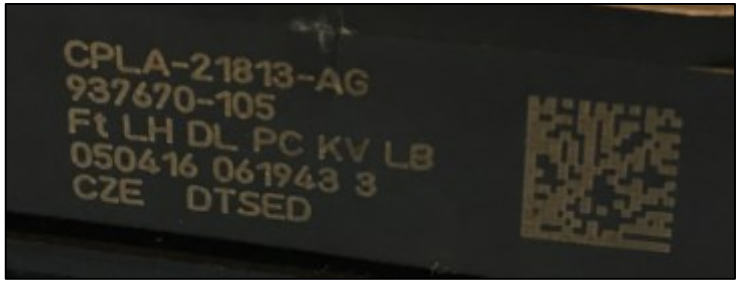
Sinter bearing shiny, no corrosion on motor housing visible

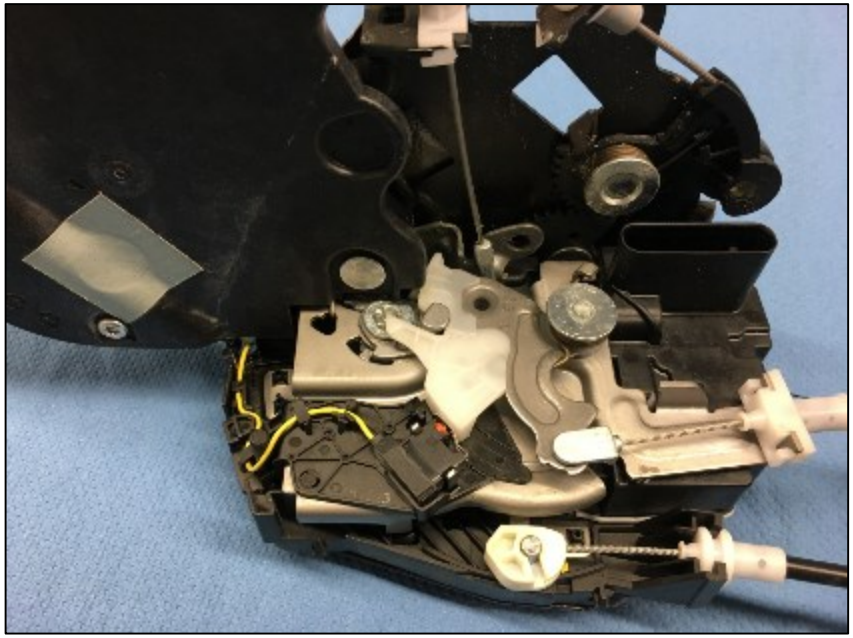
Visual inspection

Visual inspection

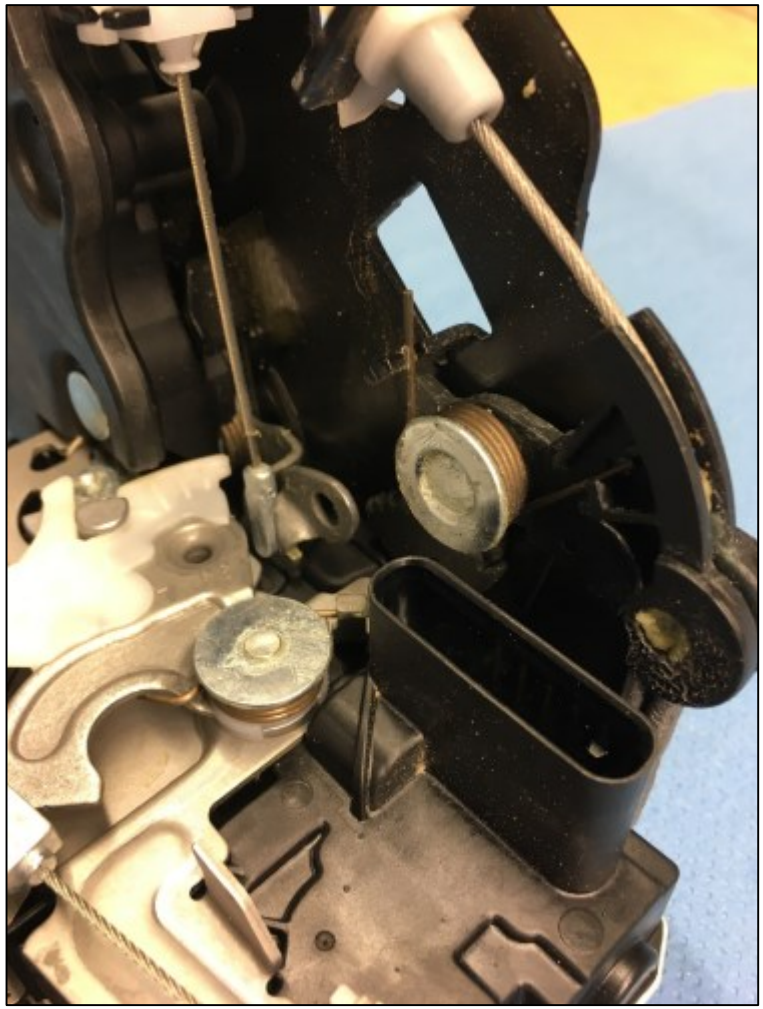
Visual inspection

- Latch received with all levers in home-position
- no sticky-behavior opening from outside
- Blue particle not present on latch or box anymore

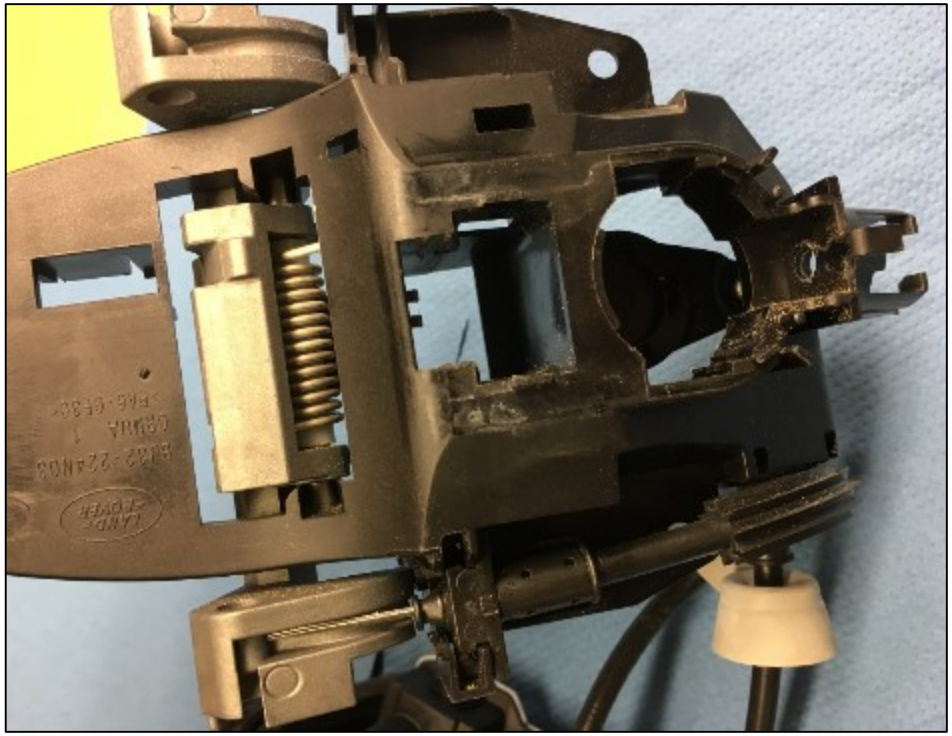


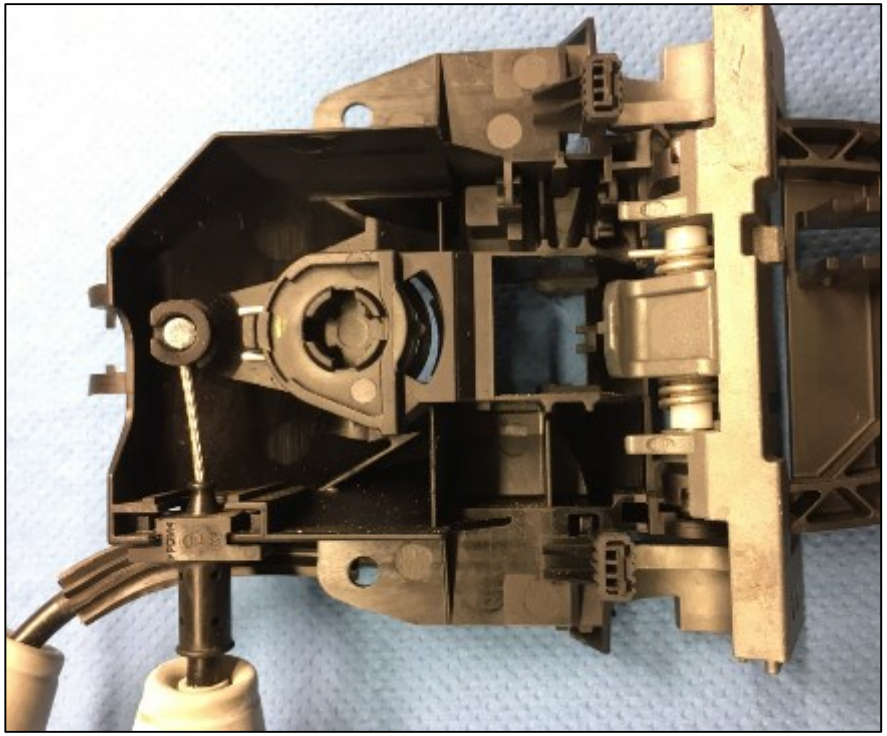


Visual inspection



Visual inspection

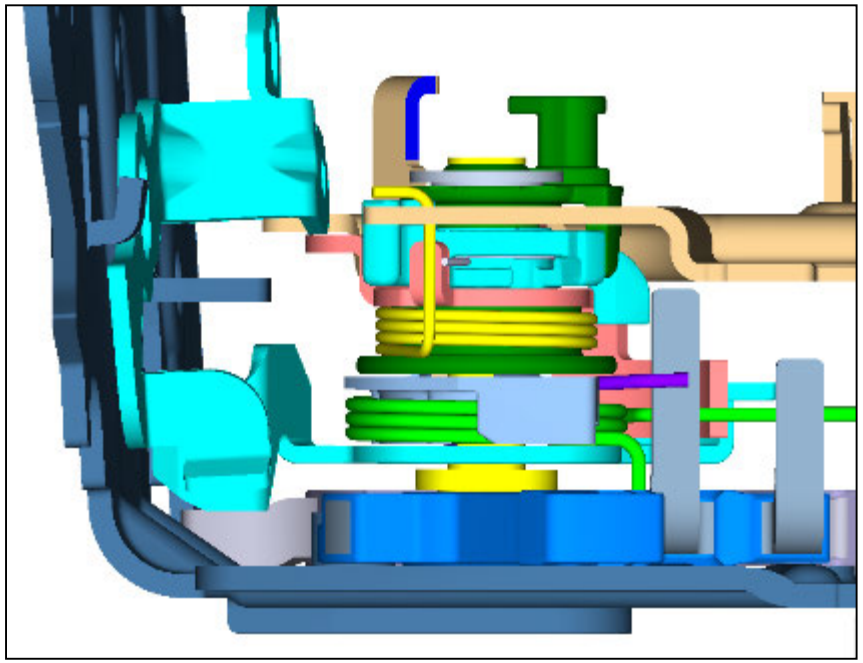


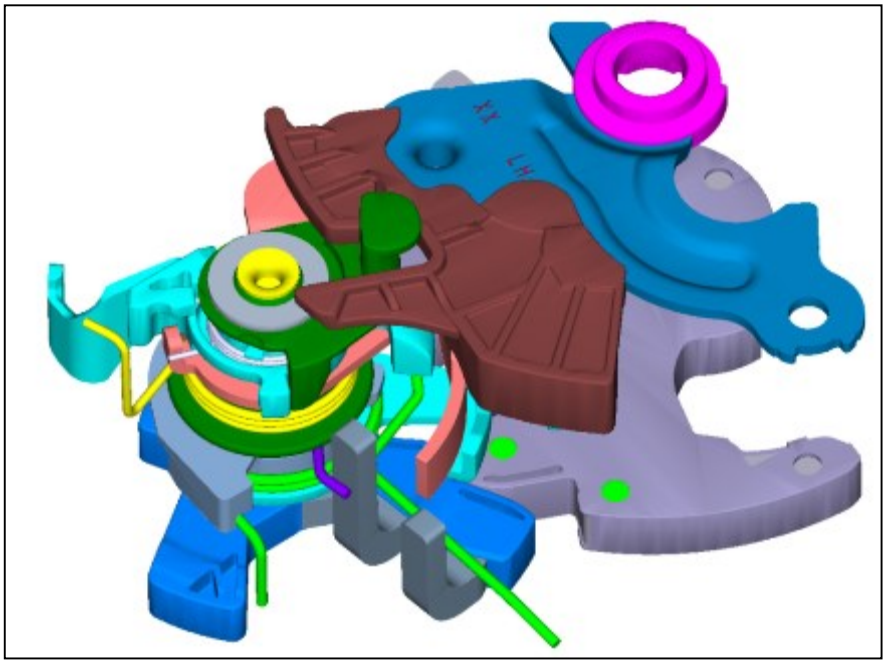


Tear down of latch – cut off retention plate with KV housing

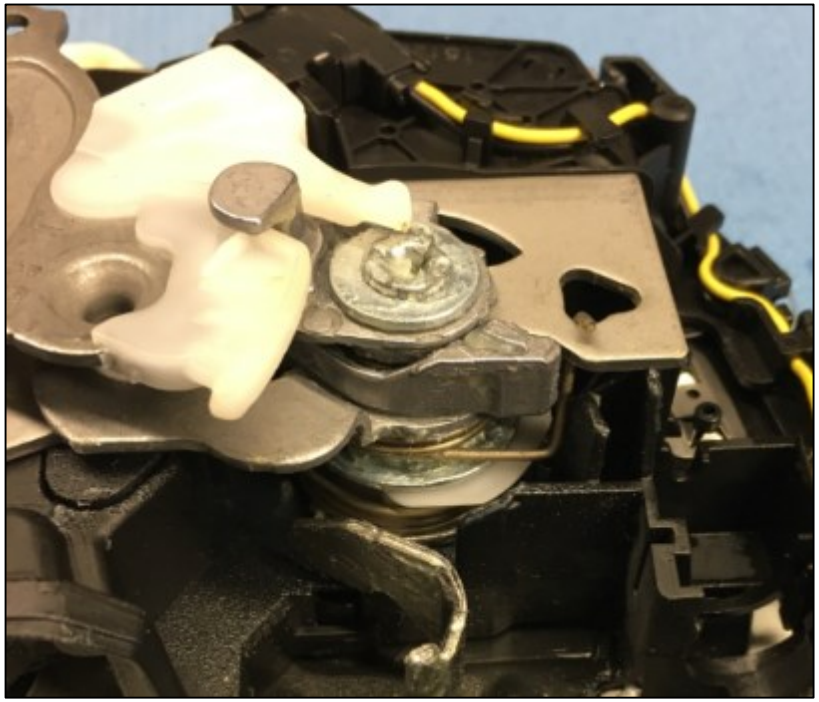
Tear down of latch – cut off retention plate with KV housing

Tear down of latch – sub-assembly backplate



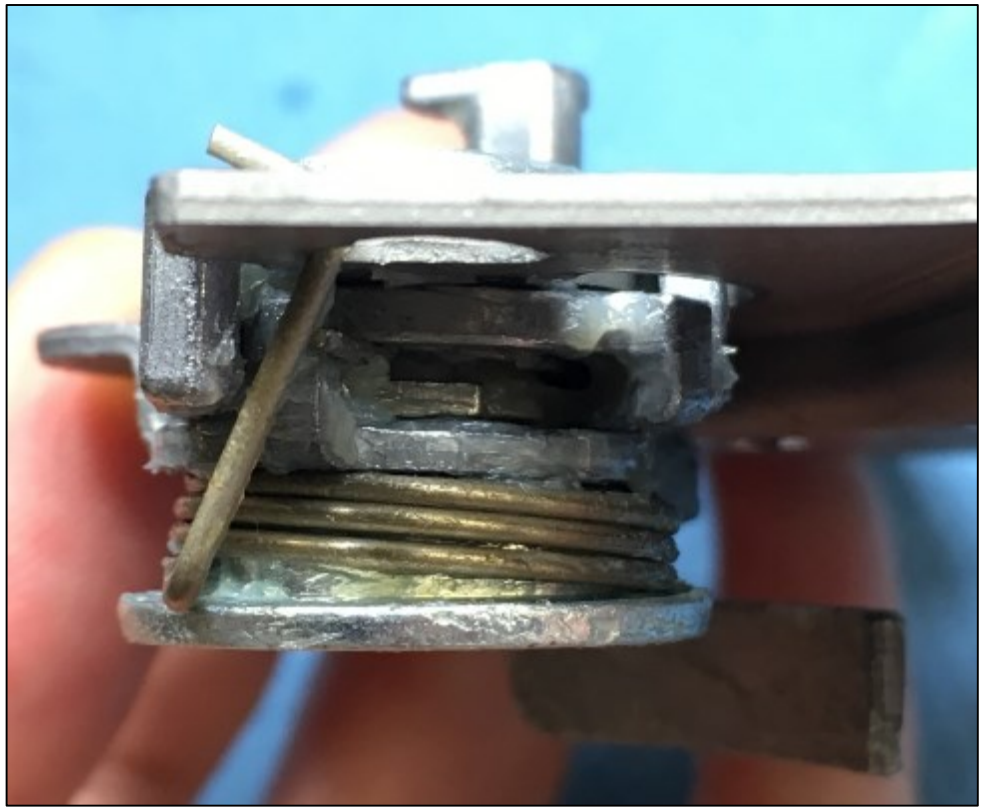


Tear down of latch – sub-assembly backplate



Tear down of latch – sub-assembly backplate dismounted from latch

Tear down of latch – sub-assembly backplate dismounted from latch



Tear down of latch – sub-assembly backplate disassembled

- **Disassemble sub-assembly backplate with grease and abrasion**






Tear down of latch – sub-assembly backplate disassembled

- **Disassemble sub-assembly backplate after cleaning**

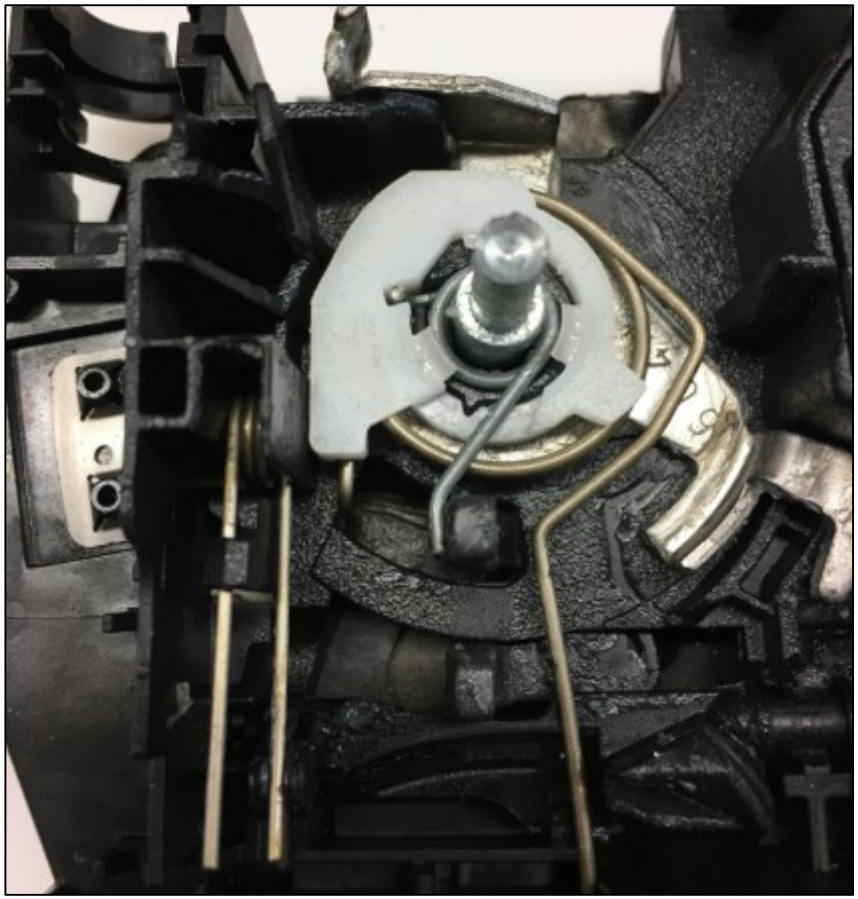





Tear down of latch – sub-assembly backplate disassembled

- **Disassemble sub-assembly backplate after cleaning**

Tear down of latch – sub-assembly striker guide and backplate with pawl and claw



Tear down of latch – sub-assembly backplate with pawl and claw

Conclusion & next steps

- **Summary:**
- **“Clicking noise” described by Neil Goulsbra could not be replicated**
- **KV motor shaft easily rotatable by finger & KV lever not jammed**
- **No foreign particle between levers on outside transmission lever bushing detected**
- **No scratch marks or obvious deformation on the parts**

- **Next steps:**
- **Compare bushing and lever pictures to [redacted] (China – KV tranmission lever jammed in operated position)**
- **Dimensional analysis for single parts**

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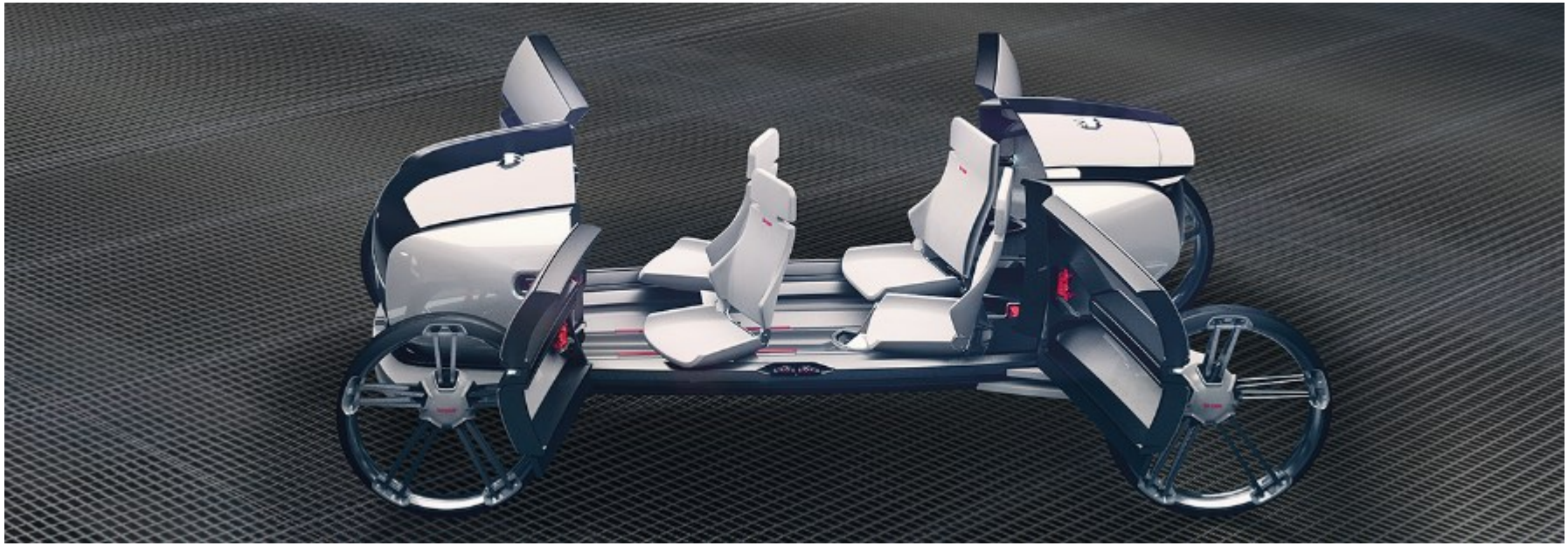
L[redacted] - China

Tear down documentation



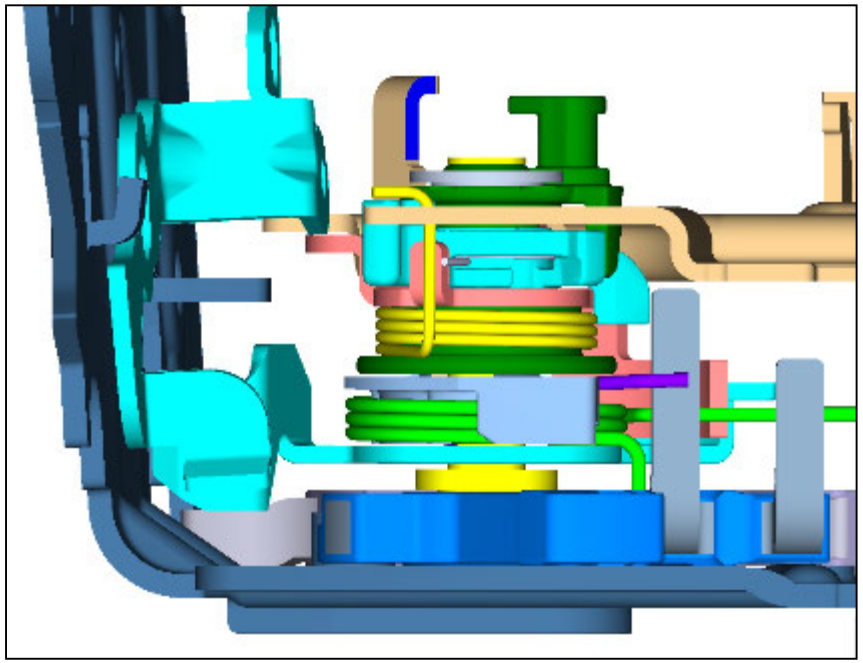
Wuppertal, 18.08.2017

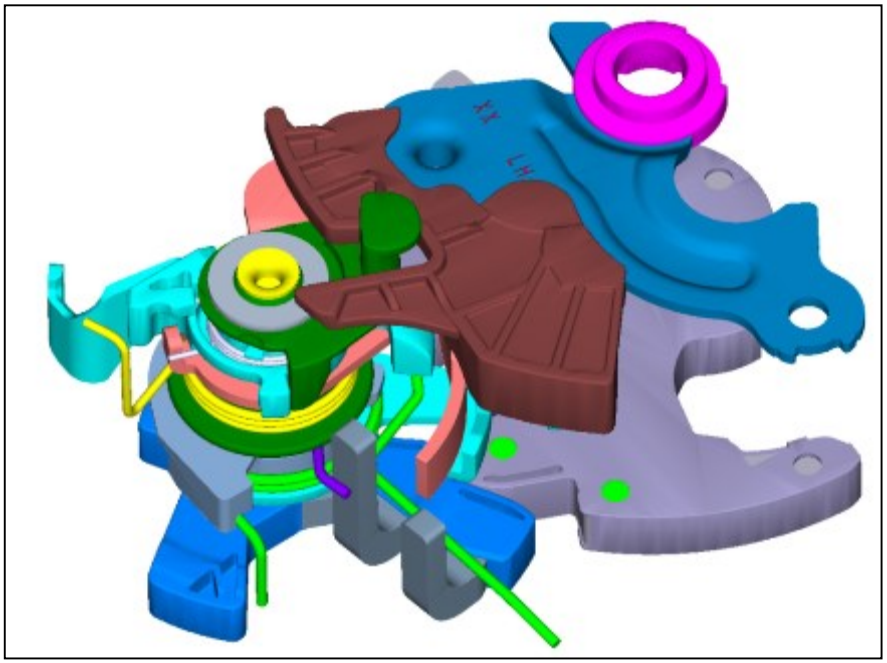
Visual inspection

- **Latch received in jammed condition (not possible to latch)**
- **KV Transmission lever (zamak) jammed / KV plastic lever in home position**

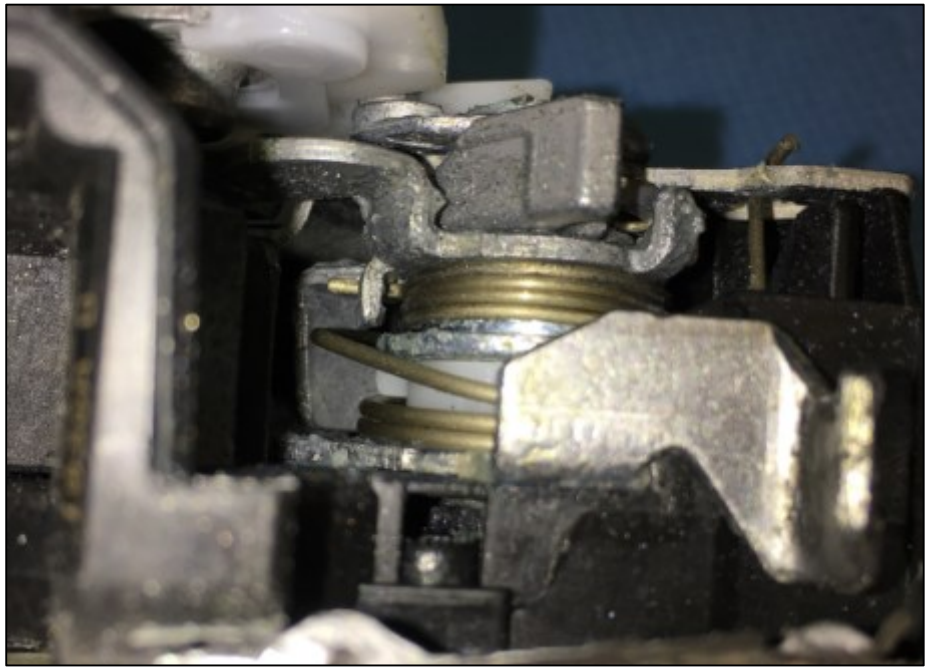
Tear down of latch – cut off retention plate with KV housing

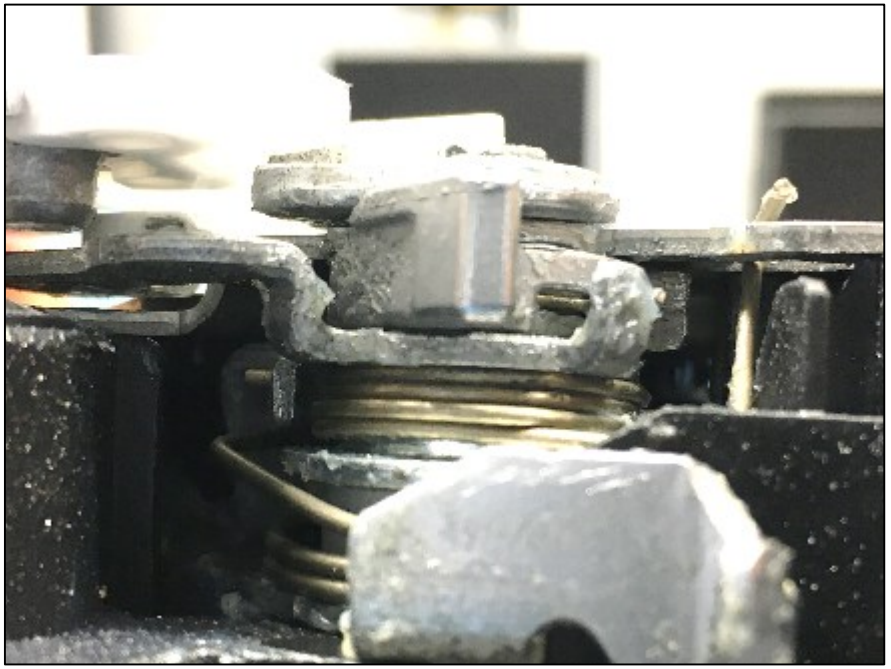
Tear down of latch – sub-assembly backplate





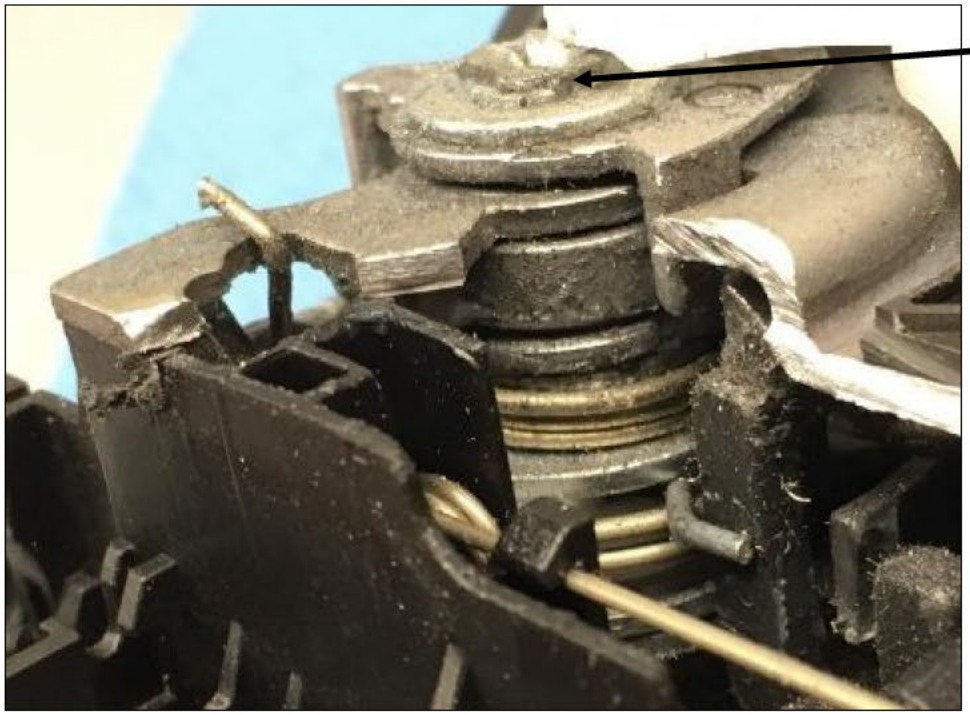
Tear down of latch – sub-assembly backplate





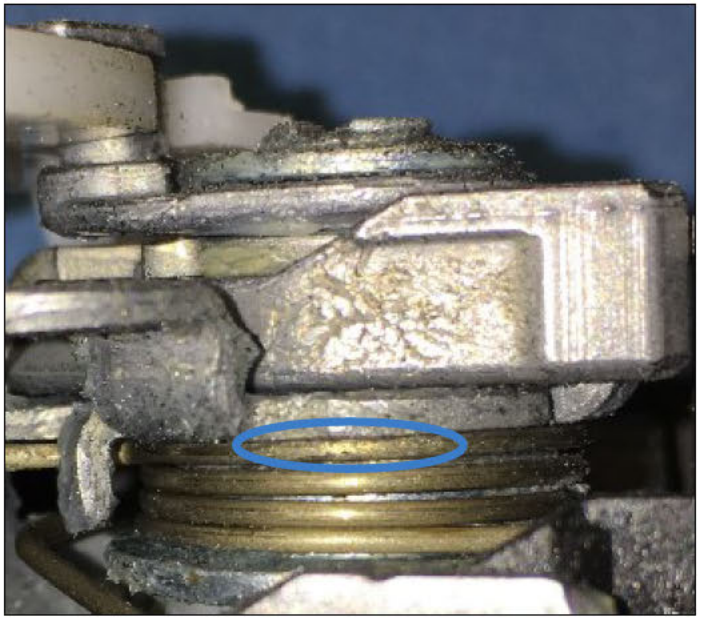
- after cutting off retention plate the failed condition is still present
- spring between O/S transmission lever and bushing

Tear down of latch – sub-assembly backplate dismounted from latch



During disconnecting the pawl pin from the backplate sub-assy the jammes condition dissolved

Tear down of latch – sub-assembly backplate dismounted from latch



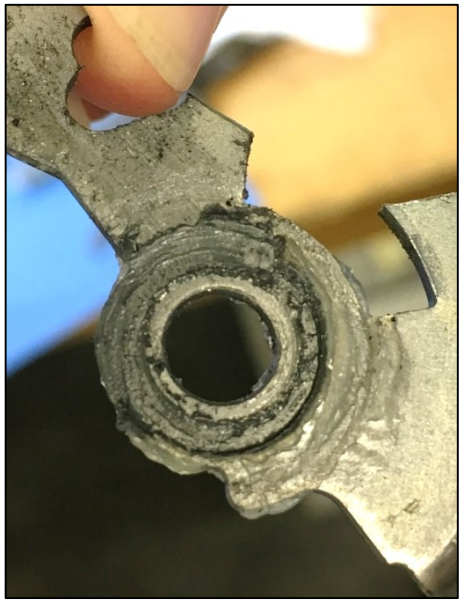
Unjammed condition KV transmission lever

Measurement of gap between bushing and o/s transmission lever with one thickness gauge :

→ 0,7 mm

Measurement area

Tear down of latch – sub-assembly backplate single parts



Abrasion of KV-transmission lever visible – residues on contact surfaces of neighbour parts as well

Tear down of latch – sub-assembly backplate single parts

Bushing height:
7 mm

Tear down of latch – sub-assembly backplate single parts

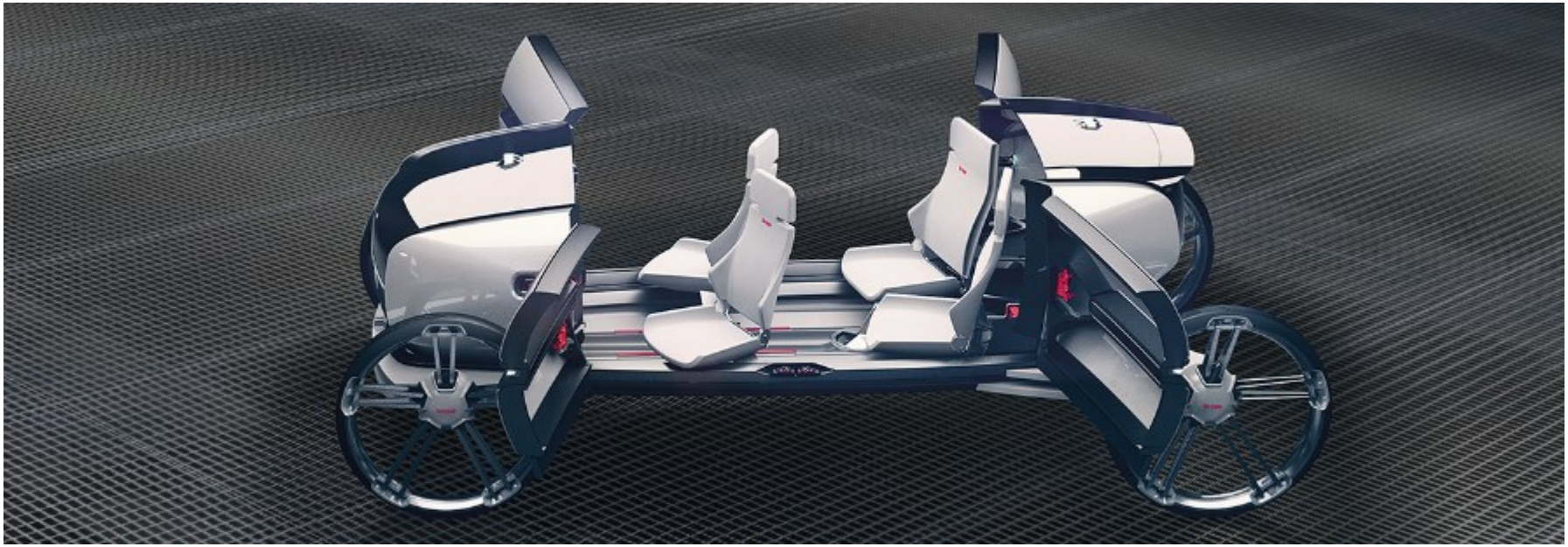
Height measurement in area of abrasion:
→ 4,92 mm

Drawing specification:
5,20 mm -0,05 mm

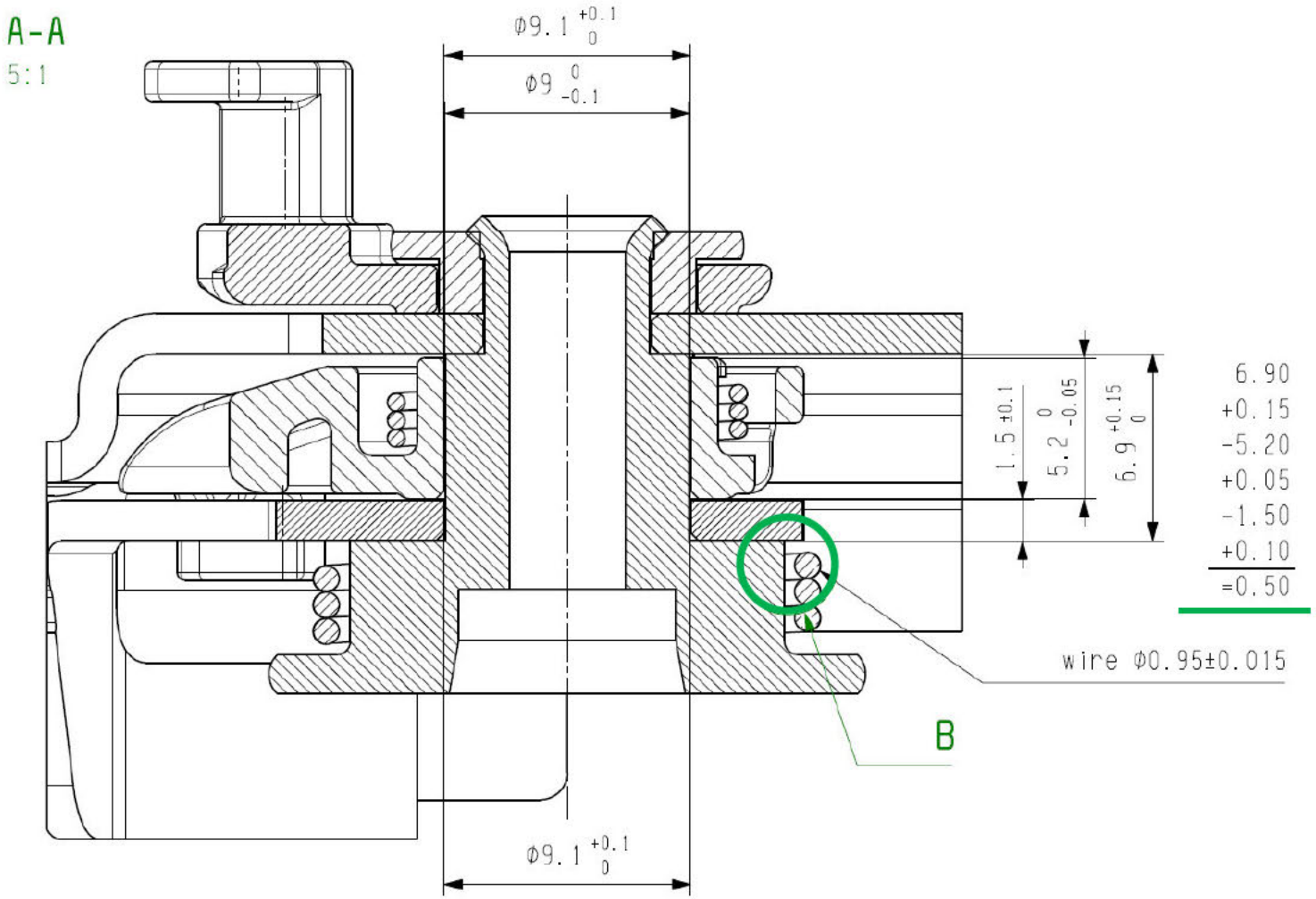
Height o/s transmission lever:
1,54 mm

Measurement area

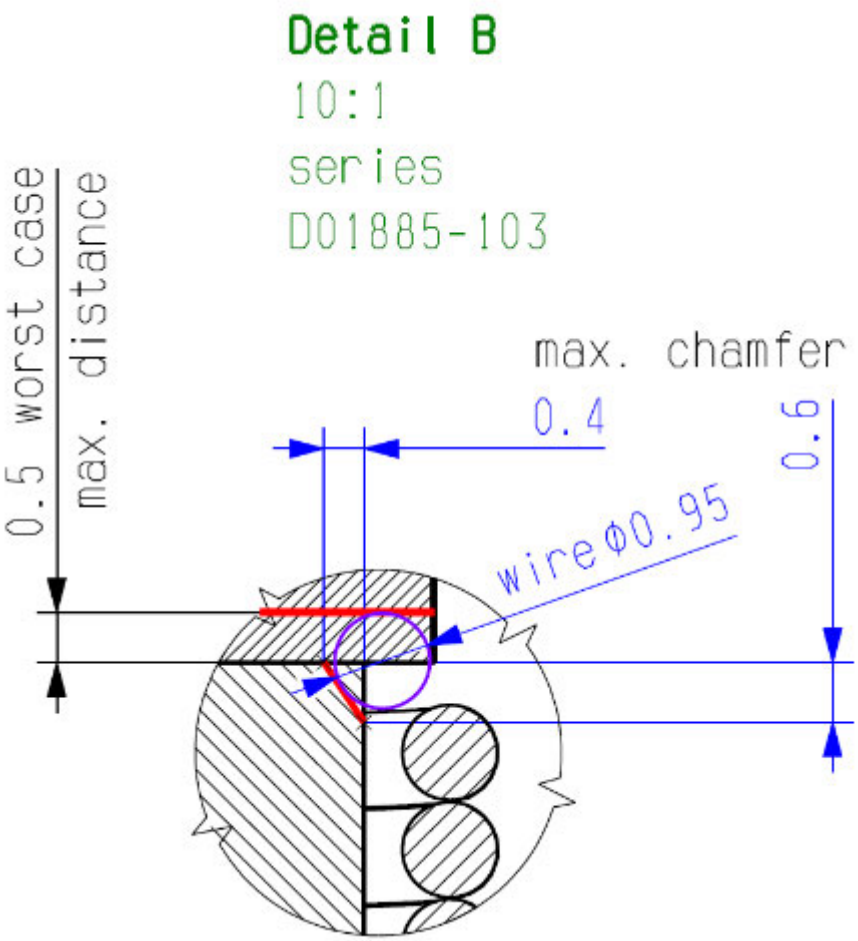
Root cause investigation Jammed subassy Backplate



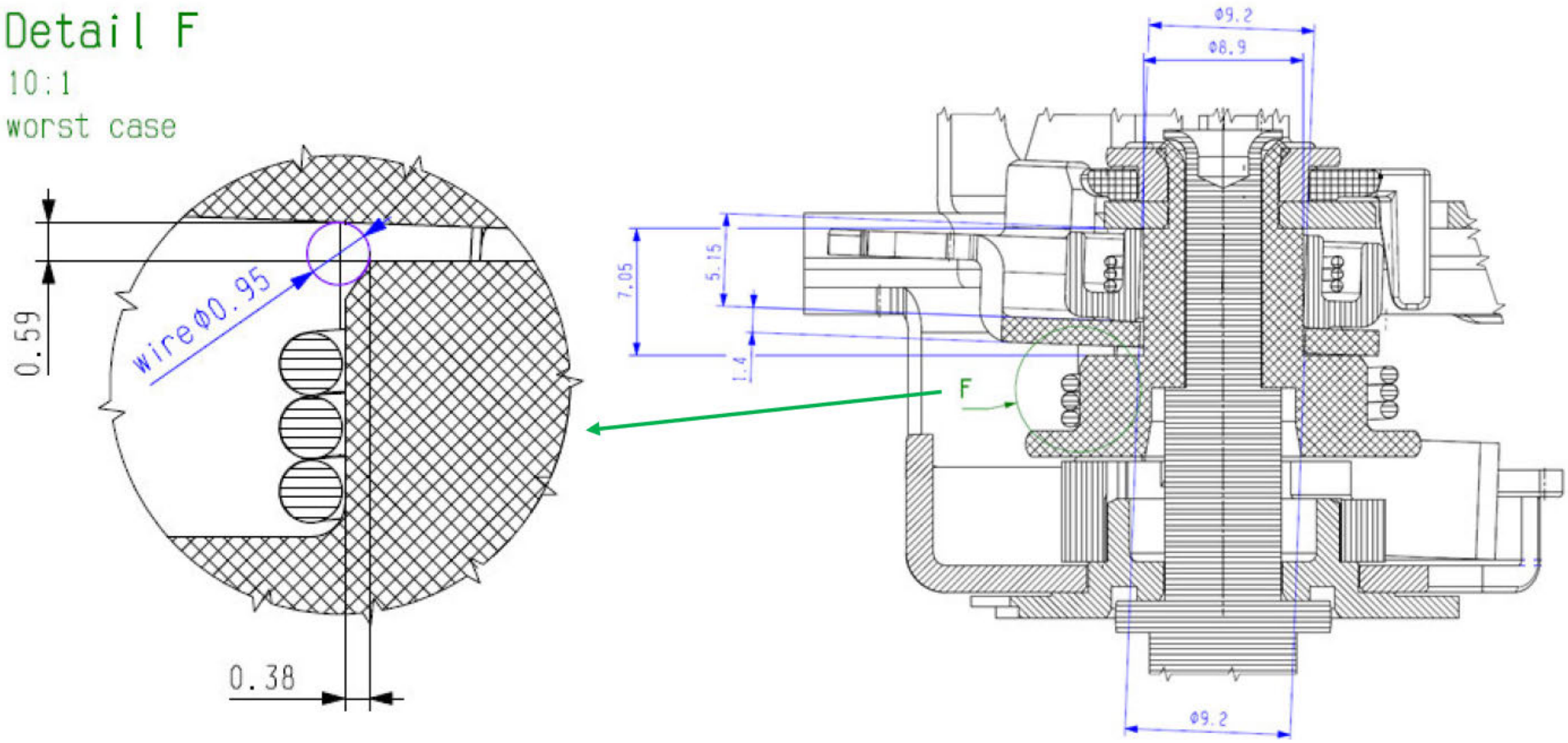
Tolerance study – worst case



Tolerance study - worst case



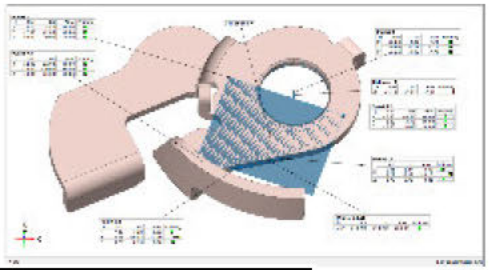
Tolerance study – tilted worst case



- Tilting increases the gap from 0,5 mm to 0,59 mm
- Spring can not fully move between bushing and lever

Single Part 3D scan
O/S transmission lever

Reference surface →



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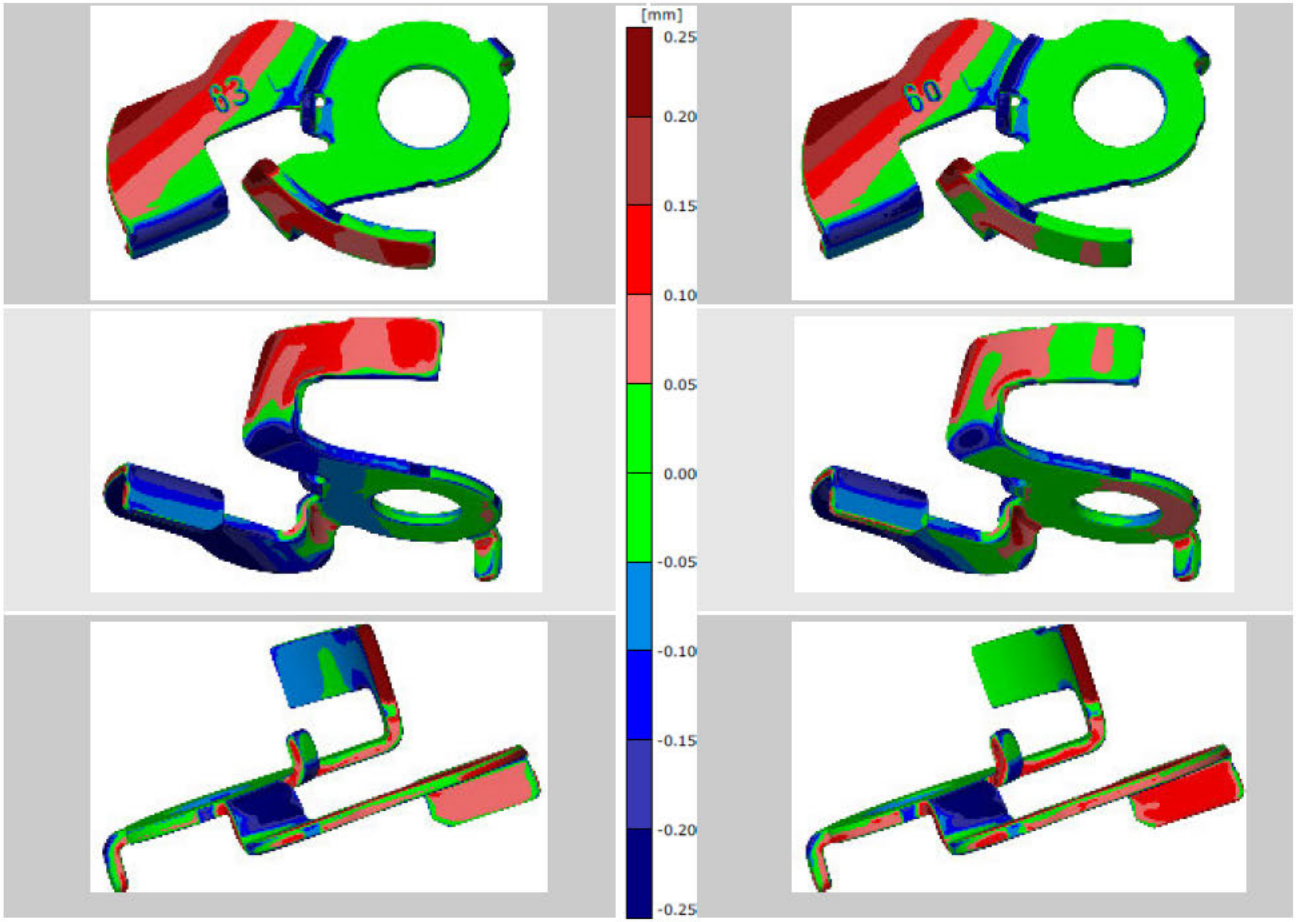
Kuwait	China

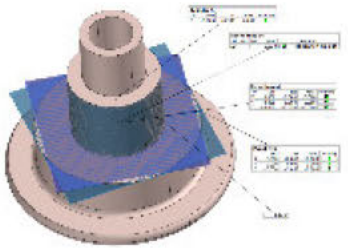


Conclusion:

- Thickness of the lever **ok**
- Rotating area of the lever **ok**

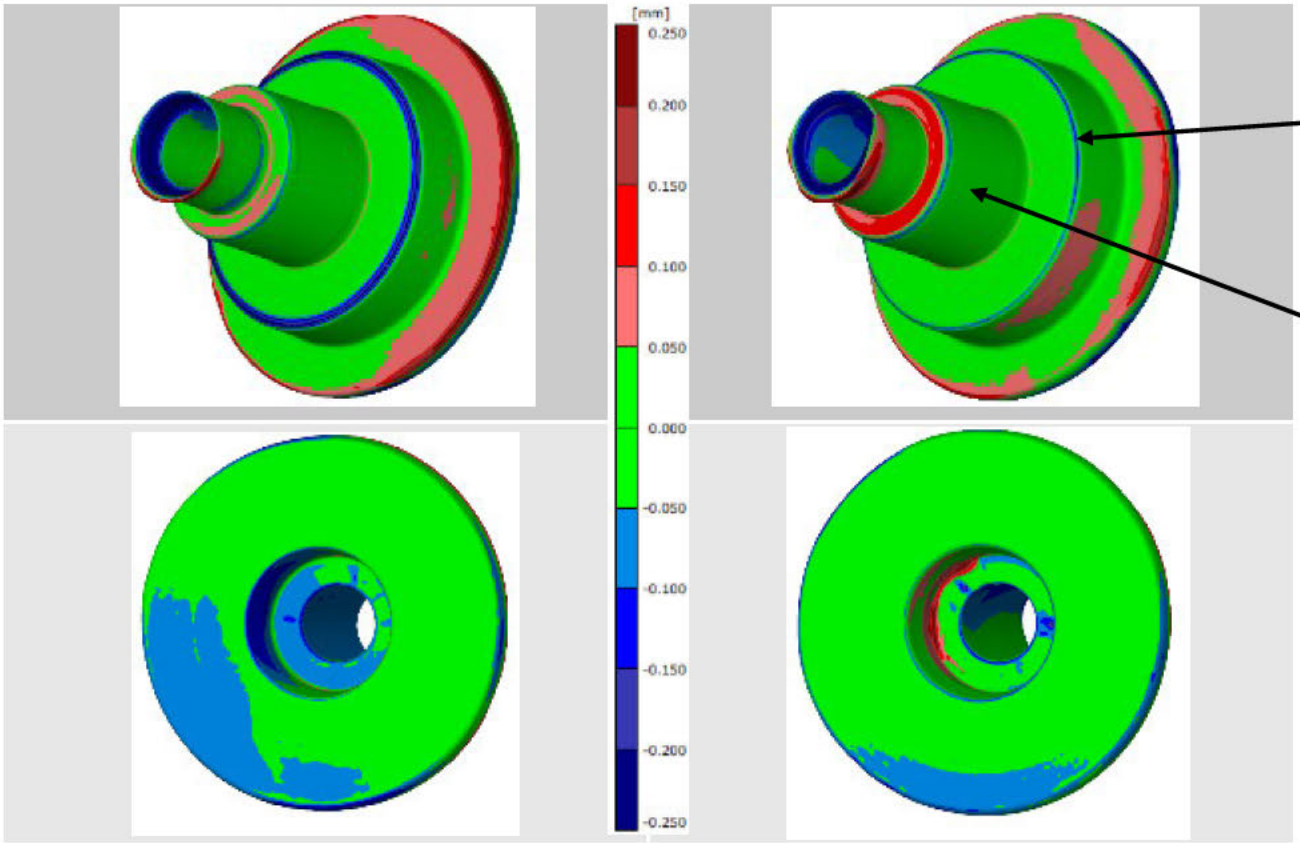
- Parts within specification **ok**

Reference surface →



Single Part 3D scan
Bushing O/S transmission

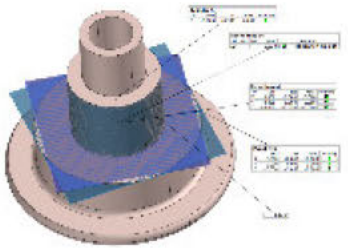
Kuwait	China



Conclusion:

- Difference in the chamfer visible – see detailed results on page 39
- Step hight on CN part higher than on KWT part – but both parts within specification ok

Single Part 3D scan
Bushing O/S transmission - cut through



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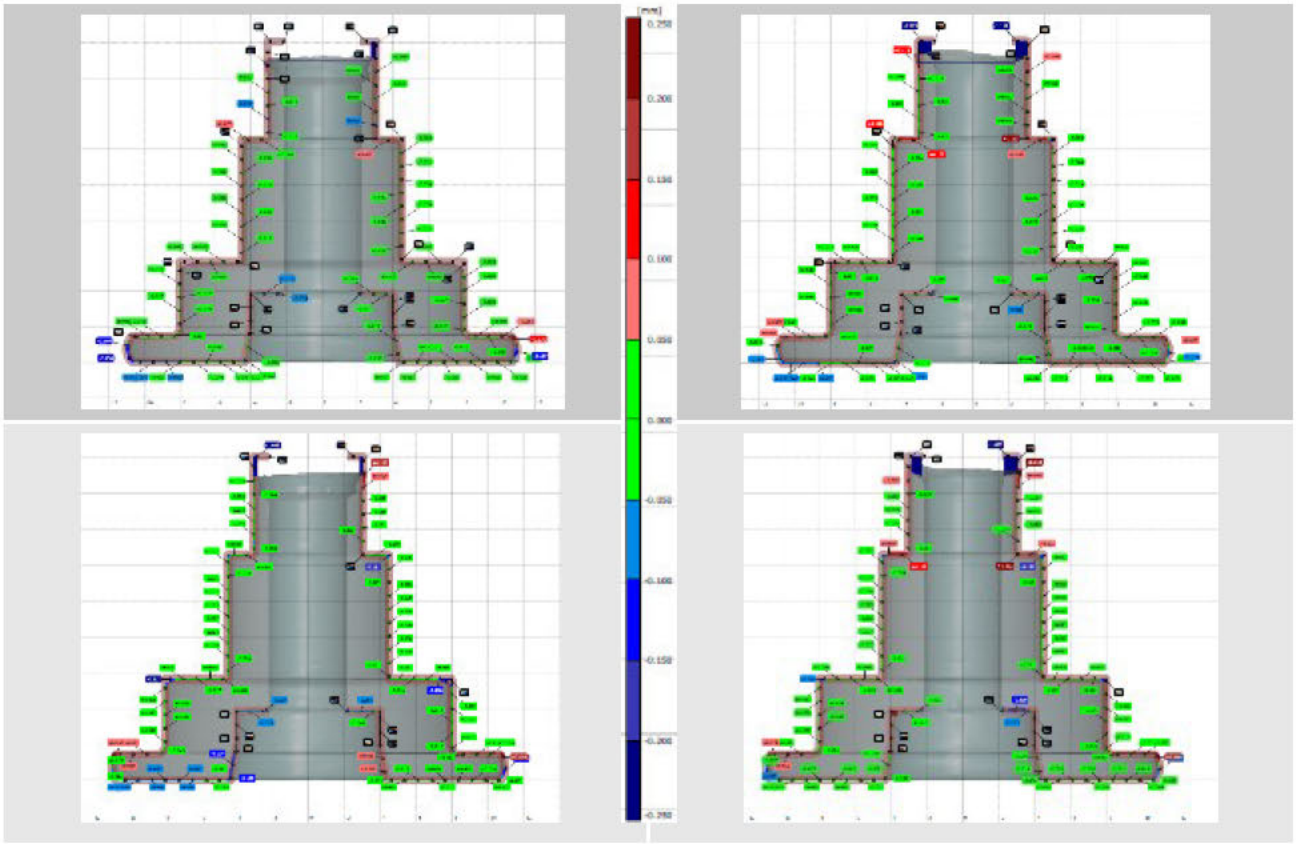
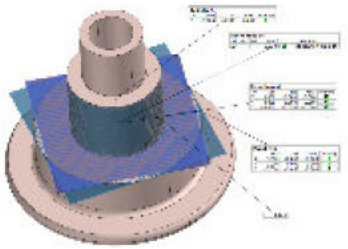
Kuwait	China



Conclusion:

- Difference in the chamfer visible – see detailed results on page 39

Single Part 3D scan
Bushing O/S transmission - Chamfer



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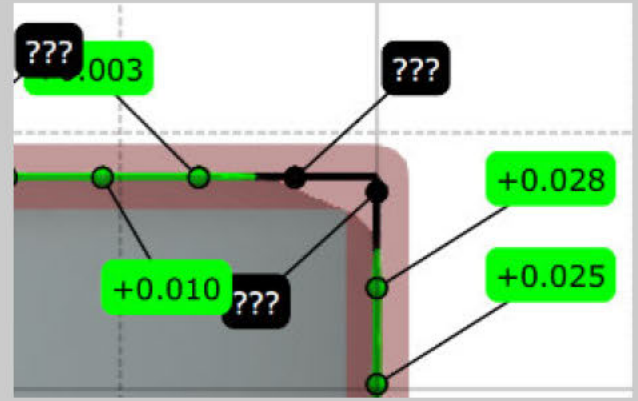
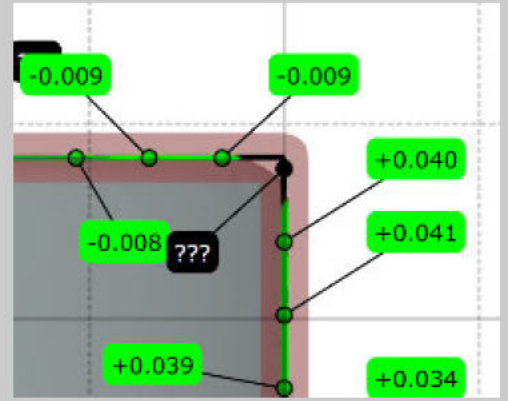
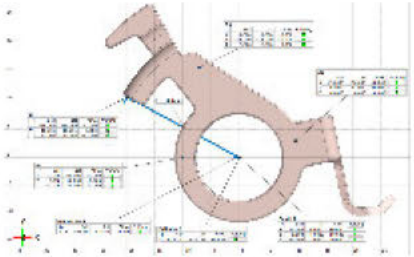
Kuwait	China
	
Measured with optical projection equipment: X-direction: 0,70 mm – 0,77 mm (nok) Y-direction: 0,50 mm – 0,53 mm (nok)	Measured with optical projection equipment: X-direction: 0,37 mm – 0,44 mm (nok – 0,04 mm out of spec) Y-direction: 0,23 mm – 0,35 mm (ok)

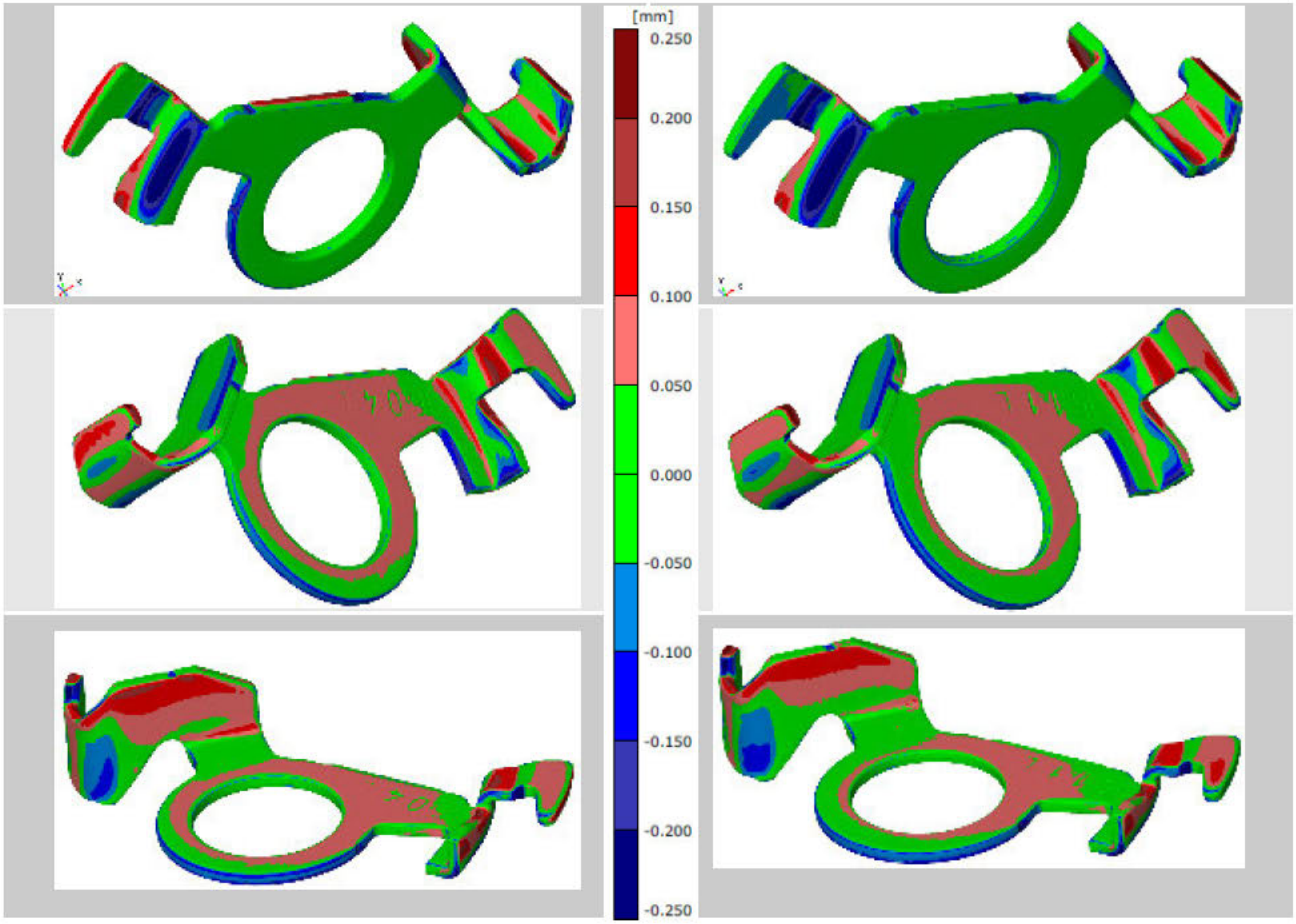
Conclusion:
- CN part (failure mode present) with borderline chamfer / KWT part (failure mode not present) with nok chamfer
- Supplier involvement to clarify quality situation

Single Part 3D scan
I/S transmission lever



brose

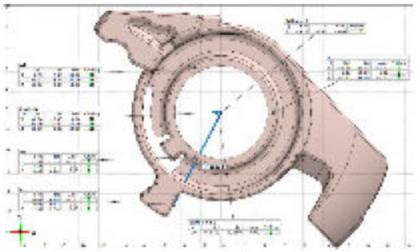
Kuwait	China



Conclusion:

- Thickness of the lever **ok**
- Scratch marks on lever not visible in scan comparison – nothing on this lever indicates why it was in contact with o/s transmission lever

Single Part 3D scan
KV transmission lever



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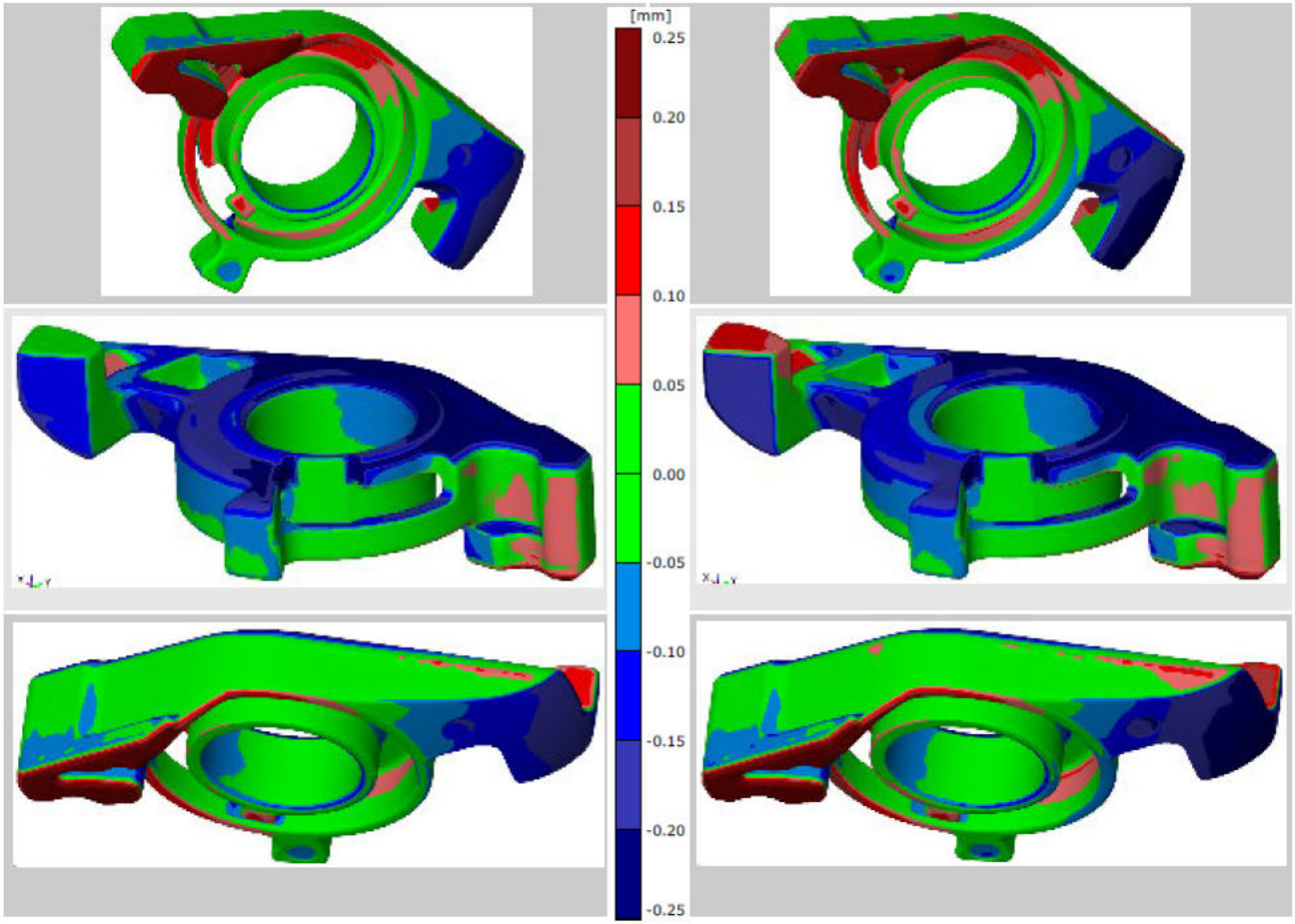
Kuwait	China



Conclusion:

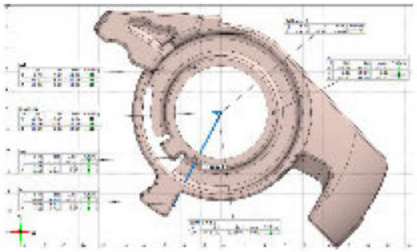
- Wear out area of the lever too thin – 4,92 **nok**
- Other area of the lever too thin – 5,06 **nok**

- Supplier involvement to clarify quality situation

Part comparison from durability test
KV transmission lever

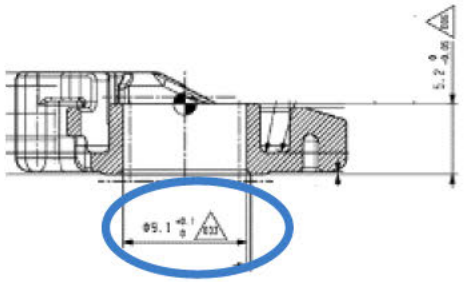
Durability test from comparable production period (beginning of 2016)	Durability test from beginning of 2017
LHF 	LHF 
	RHR 
- Test result **ok** – no function failure - High measurement result done today → 4,93 mm on wear out area	- Test result **ok** – no function failure - No wear out area

Single Part KV transmission lever
Current Production

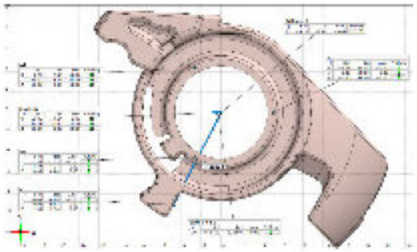


brose

#	C01888	C01889
1	9,17	9,12
2	9,17	9,13
3	9,18	9,13
4	9,17	9,12
5	9,19	9,15
6	9,18	9,15
7	9,18	9,15
8	9,19	9,14
9	9,18	9,16
10	9,18	9,17
Min	**9,17**	**9,12**
Max	**9,19**	**9,17**
Average	**9,18**	**9,14**

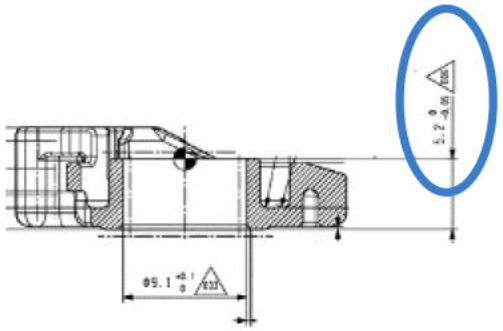


Single Part KV transmission lever
Current Production

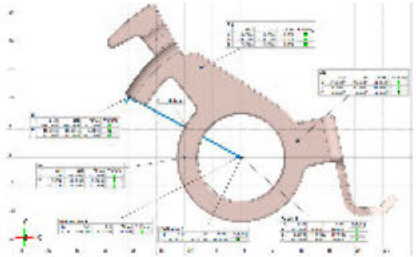


brose

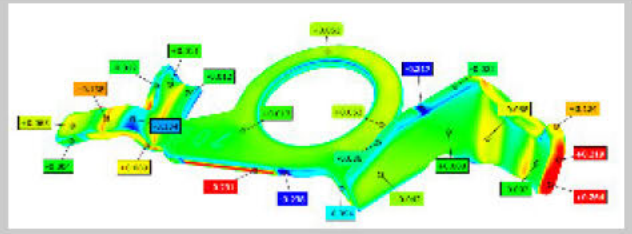
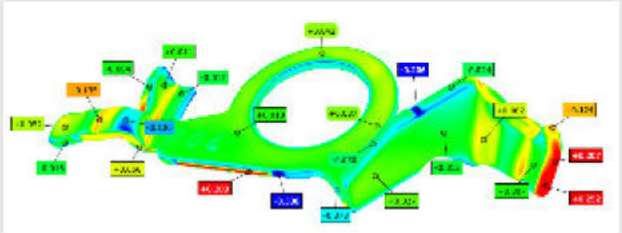
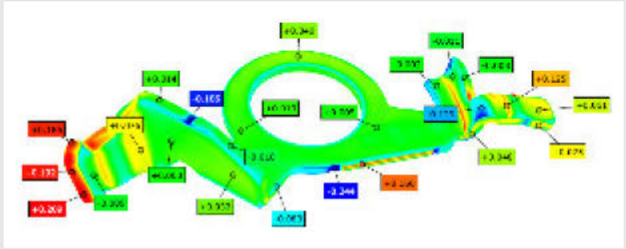
#	C01888	C01889
1	5,17	5,17
2	5,18	5,18
3	5,19	5,18
4	5,18	5,18
5	5,19	5,18
6	5,19	5,18
7	5,19	5,18
8	5,18	5,18
9	5,18	5,18
10	5,17	5,18
Min	5,17	5,17
Max	5,19	5,18
Average	5,18	5,18

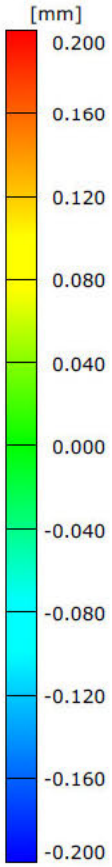


Single Part 3D scan – Current Production
I/S transmission lever double pull



brose

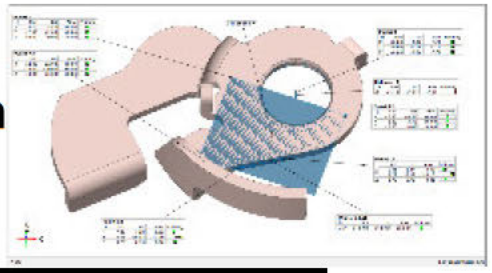
C36086	C36087
 Part 1	 Part 1
 Part 2	 Part 2



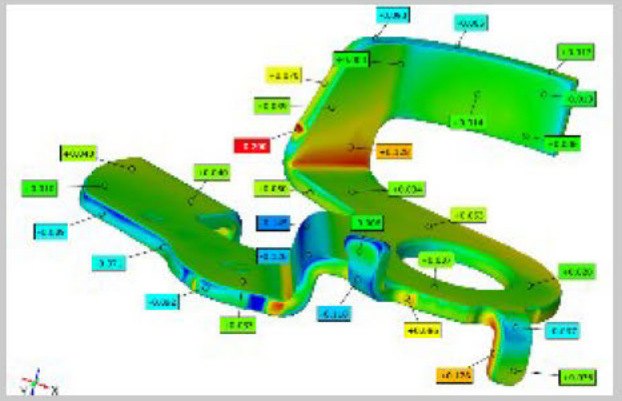
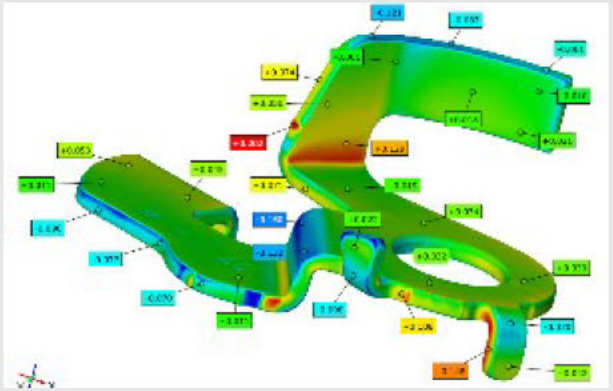
Conclusion:

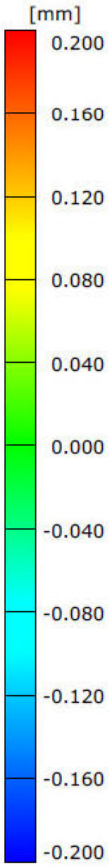
- Parts have no deviation

Single Part 3D scan–Current Production
O/S transmission lever



brose

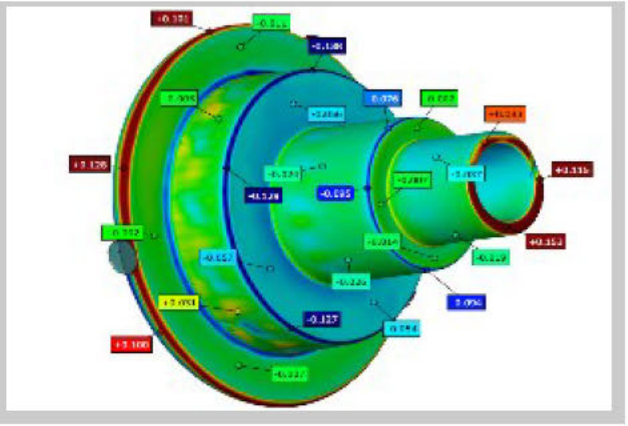
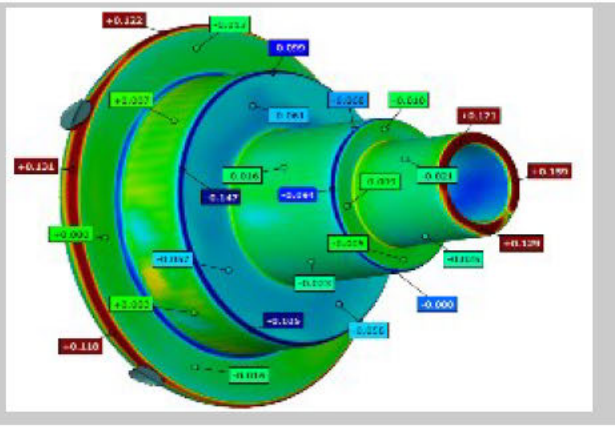
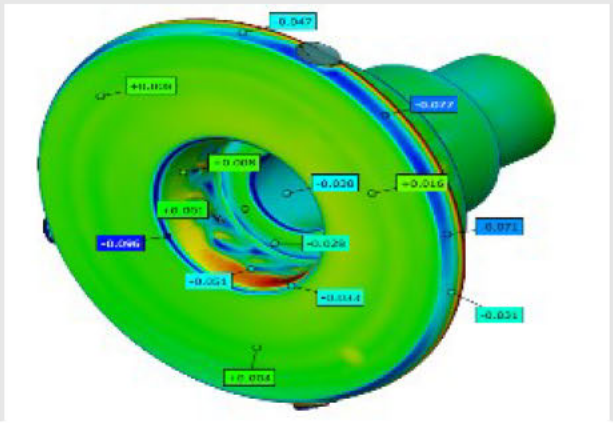
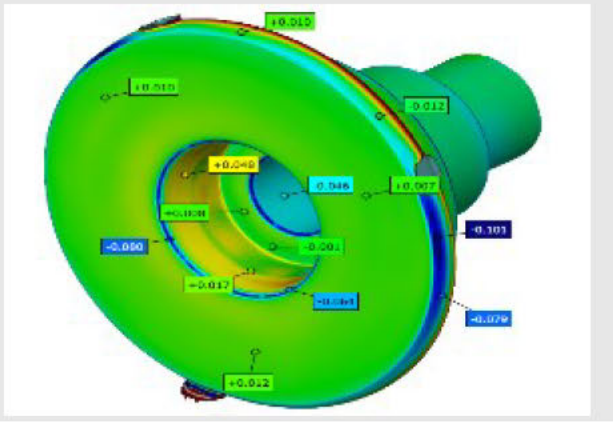
938820	938819
	
	

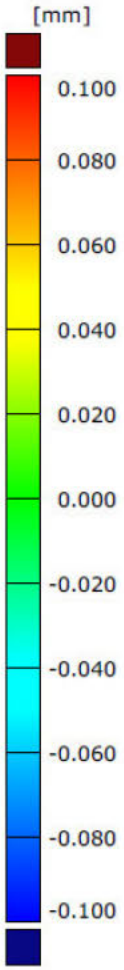


Conclusion:

- Parts have no deviation

Single Part 3D scan–Current Production
Bushing

C01885	C01885
	
	

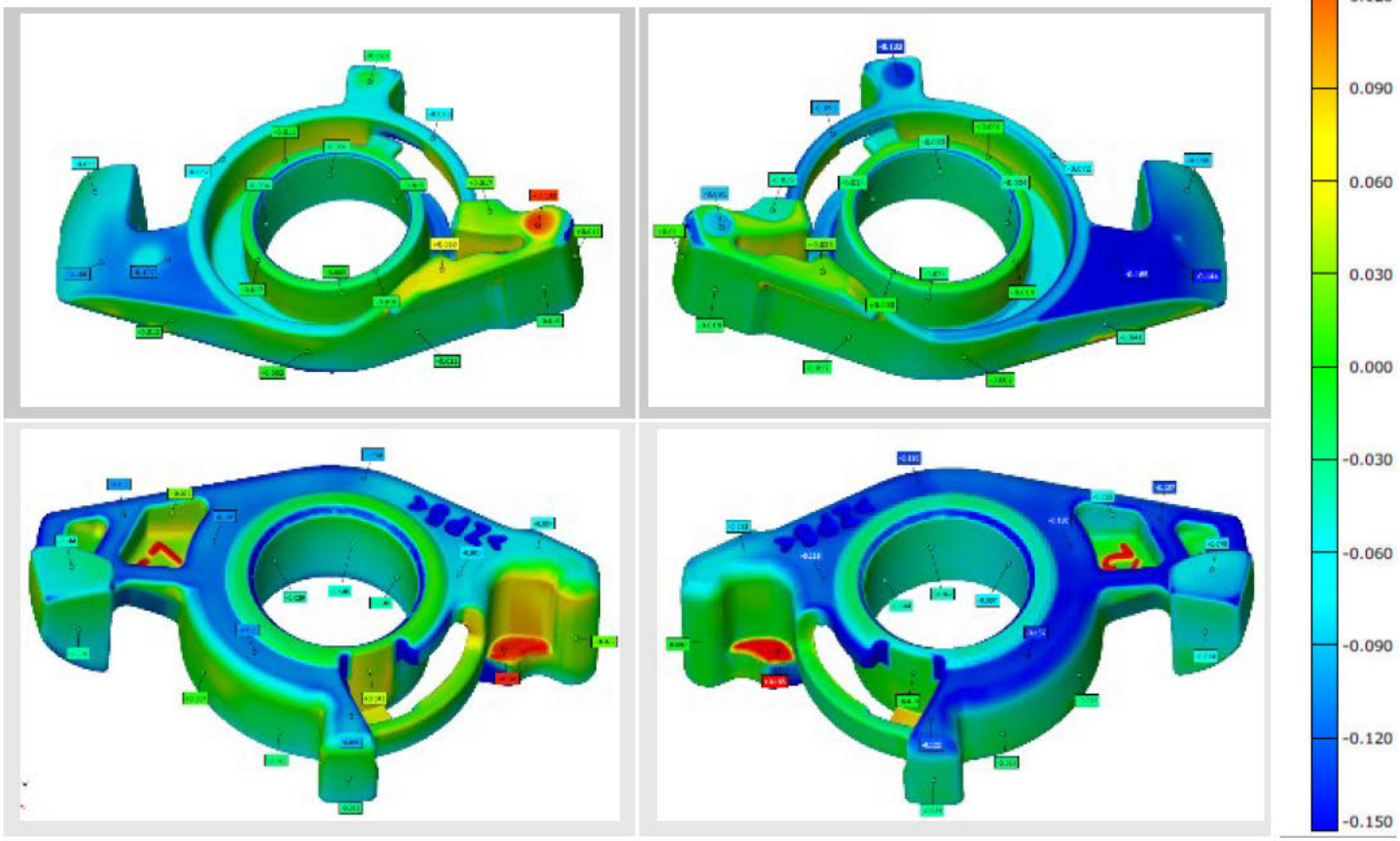


Conclusion:

- Parts have no deviation

Single Part 3D scan–Current Production
KV transmission lever

C01888	C01889



Conclusion:

- Parts have no deviation

Material analysis of KV transmission lever

Spec.	Current CZ 8/2017	Durability V10.627 No 6 LH	Durability V10.627 No 7 RH	Reference part PD as field part
Cavity	L1/L3/R2/R3	L2	R3	L1/L2/R3/R4
GD ZN Al 4 Cu1	Ok	Ok	Ok	Ok
Hardness HV1: 97	114-118	112-114	108-113	108-112
Density Min 6,4 g/cm3	6,419-6,447	6,445	6,451	6,412-6,437
Porosity (no spec.)	Ok	Ok	Ok	Ok
Microstructure	homogeneous	homogeneous	homogeneous	homogeneous
Summary	Ok	Ok	Ok	Ok

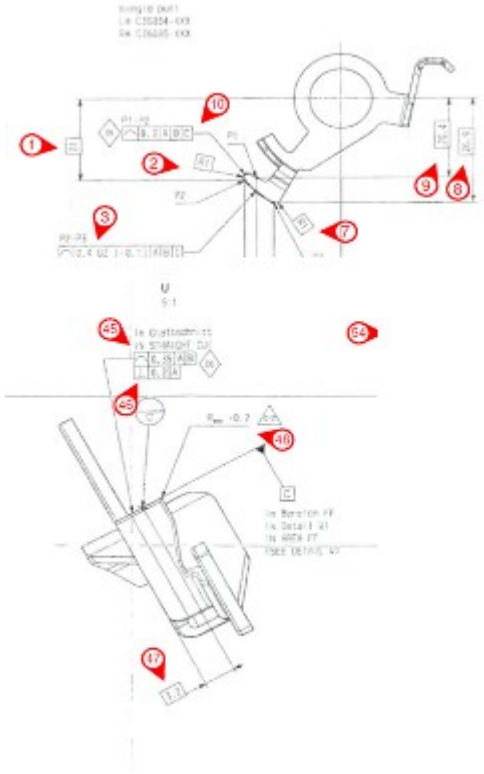
Conclusion:

- Material is ok. (COB Lab Report 5806)
- The abrasion is not based on a material failure

KV transmission lever – abrasion
Requalification latches 2017 (durability test)

No	5,2-0,05 Max	5,2-0,05 Min	Picture
1 LH 	5,15	5,14	
2 LH 	5,15	5,14	
3 LH 	5,15	5,04	
4 RH 	5,19	5,18	
5 RH 	5,16	5,15	
6 RH 	5,16	5,15	
7 RH 	5,19	5,18	
8 RH 	5,19	5,18	
9 RH 	5,16	5,15	
Average LH	5,15	5,11	
Average RH	5,17	5,17	

Single part measurement - Current production
IBH-Innen: C36085/84

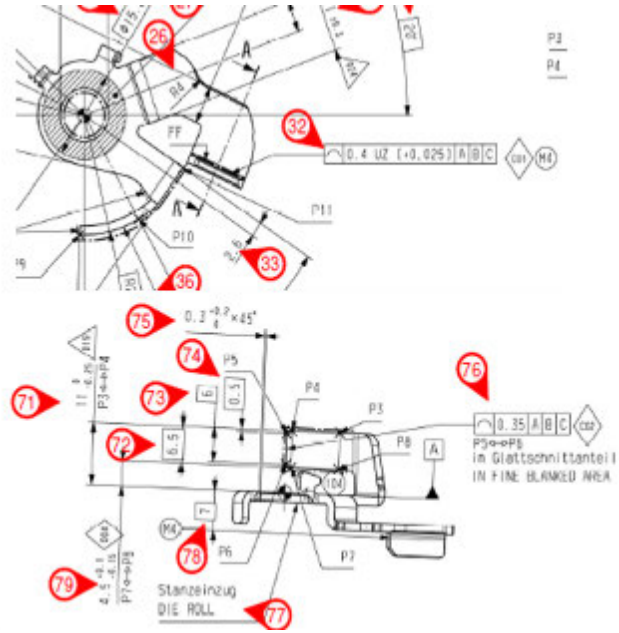


C36085-102	Linienform bis 0,3	Linienform bis 0,35		Rechtwinkligkeit 0,2
Datum	**No. 10**	**No. 45_1**	**No.45_2**	**No. 46**
10.1.2017 - 5.8.2017 n=70 average	**0,160**	**0,006**	**-0,024**	**0,057**

C36084-102	Linienform bis 0,3	Linienform bis 0,35		Rechtwinkligkeit 0,2
Datum	**No. 10**	**No. 45_1**	**No.45_2**	**No. 46**
10.1.2017 - 5.8.2017 n=70 average	**0,185**	**0,011**	**-0,042**	**0,046**

Conclusion:
Series production ok

Single part measurement - Current production
ABH-Innen: 738819/20



738819-104	Linienform bis 0,4	Linienform 0,35		4,5 +0,1 / -0,15	
Datum	**No. 32**	**No. 76 (2 Punkte)**		**No. 79 (2 Punkte)**	
3.10.2016- 9.8.2017 n = 68 average	**0,158**	**-0,073**	**-0,090**	**4,515**	**4,531**

738820-104	Linienform bis 0,4	Linienform 0,35		4,5 +0,1 / -0,15	
Datum	**No. 32**	**No. 76 (2 Punkte)**		**No. 79 (2 Punke)**	
3.10.2016- 9.8.2017 n = 68 average	**0,083**	**-0,010**	**-0,009**	**4,539**	**4,515**

Conclusion:
Series production ok

KV transmission lever
Control plan content for height dimension

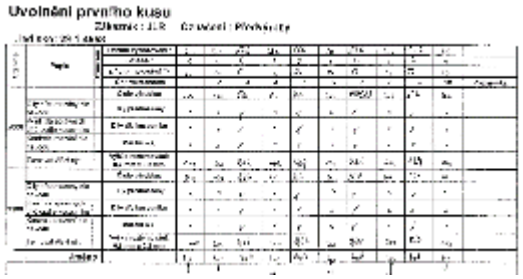
GENERAL CONTROL PLAN				Control plan nr: 17	Status:	x For serial production Prototype Pre-Launch		Compilation Date: 07/11/2013	Revision nr: 002	Core Team: F.Bertini, G.Sopetto
PART NR: C01888-104		DESCRIPTION: LEVER LH				DRAWING: D01888-104				INDEX: 104
process	machine	characteristic			methods					
		product	process	special characteristic classification	specification	measuring system	quantity	frequency	control method	registration	responsibility
		thickness 5,15÷5,20 (3)		△	According to "ciclo di collaudo" (mod. 004)	Caliper	1 complet shot	every 8 hours	random check	ciclo di collaudo (mod. 004)	Quality Dept.

Process walk investigation

Check serial random inspection
- checked -> ok

Check NRFT documents
- checked -> ok

Check assembly line CV
- checked -> ok



Next steps

No	Action	Start	End	Status
1	Bush chamfer check	17.08.2017	22.08.2017	done
2	3D scan of all subassy components - KV transmission lever - outside transmission lever - bushing O/S transmission lever - I/S transmission lever	17.08.2017	22.08.2017	done
3	material analysis of KV transmission lever from failed part Update: use comparable parts from other latches – parts from failed parts to be conserved for possible future testing (see slide 49)	30.08.2017	12.09.2017	done
4	comparison abrasion from durability test parts with failed part from the field – Update: further parts to be investigated - 5 field parts China arrived 29.08.2017 - Requalification parts 2017 (2 carsets) (done see slide50) - Warranty parts with failure mode pot. Sticky lever - PD Latch 2014 – 2016	17.08.2017	~~25.08.2017~~ ~~08.09.2017~~ 22.09.2017	In progress
5	Build up new latches with KV transmission lever from failed parts (switch it on – switch it off)	15.09.2017	20.10.2017	In progress
6	Single part measurements current production and supplier data for delivered parts	22.08.2017	tbd	Done

Next steps

No	Action	Start	End	Status
7	KV transmission lever Control plan content for height dimension	28.08.2017	05.09.2017	done
8	Process walk investigation - Check serial random inspection - Check changeover process traceability documents - Check NRFT documents - Check assembly line CV	28.08.2017	~~05.09.2017~~ 15.09.2017	done
9	Design options: What pot. design solutions are available to reduce gap or avoid abrasion?	15.09.2017	22.09.2017	In progress

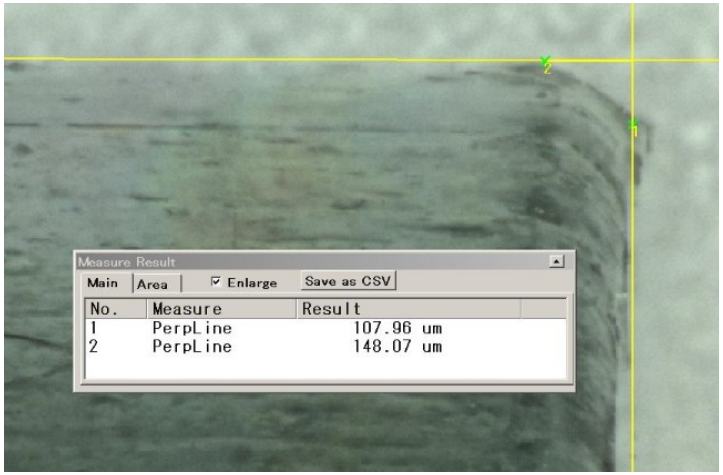
Warranty parts
Component measurement

					KV-Transmision Lever			Bush				Subassembly Backplate		
					Height 5,2-0,05 at max.	Height 5,2-0,05 at min.	Inner Diameter 9,1	Chamfer -0,6	Chamfer -0,4	Diameter 9 -0,1	Height 6,9 +0,15	Height between bush to	Height between bush to bush max	Build on Line 1,2 3?
No.	VIN	Build Date	Initial inspection result	Variante				axial 2	radial 1			zu 3.1	zu 3.1	
16-047	[redacted]	12.09.2013	NTF	Rear LH	5,17	5,08	9,14	0,23	0,45	8,96	6,99	17,3	17,36	1
17-004	[redacted]	18.10.2013	NTF	Rear LH	5,16	5,13	9,15	0,44	0,17	8,94	6,96	17,31	17,36	1
16-16	[redacted]	12.05.2014	NTF	Front LH	5,21	5,18	9,14	0,15	0,11	8,94	6,99	17,21	17,25	1
6	[redacted]	31.10.2014	NTF	Front LH	5,16	5,03	9,15	0,2	0,19	8,94	6,99	17,19	17,25	1
16-133	[redacted]	25.11.2014	NTF	Front LH	5,16	5,03	9,15	0,25	0,18	8,94	6,97	17,18	17,22	2
16-024	[redacted]	30.03.2015	NTF	Front LH	5,15	5,12	9,15	0,32	0,21	8,93	7,00	17,37	17,41	3
16-226	[redacted]	12.08.2015	NTF	Rear LH	5,12	5,08	9,16	0,28	0,27	8,93	6,99	17,25	17,27	3
16-188	[redacted]	24.09.2015	NTF	Front LH	5,15	4,98	9,16	0,49	0,52	8,94	7,02	17,38	17,41	3
17-49	[redacted]	06.04.2016	NTF	Front LH	5,15	5,04	9,17	0,62	0,86	8,95	6,95	17,18	17,21	3
16-223	[redacted]	13.12.2012	NTF	Front RH	5,18	5,08	9,15	0,3	0,21	8,96	6,94	17,2	17,25	1
17-64	[redacted]	18.02.2013	NTF	Rear RH	5,17	5,12	9,16	0,28	0,18	8,95	6,95	17,11	17,14	1
17-062	[redacted]	20.12.2013	NTF	Rear RH	5,16	5,17	9,16	0,19	0,16	8,94	6,94	17,21	17,27	1
16-064	[redacted]	13.05.2014	NTF	Rear RH	5,16	5,15	9,16	0,21	0,33	8,94	6,99	17,36	17,48	2
16-061	[redacted]	11.09.2014	NTF	Rear RH	5,15	5,11	9,17	0,32	0,28	8,93	6,97	17,18	17,22	2
16-009	[redacted]	05.11.2014	NTF	Rear RH	5,19	5,17	9,16	0,14	0,12	8,93	6,98	17,21	17,23	2
16-68	[redacted]	06.01.2015	NTF	Front RH	5,20	5,17	9,17	0,3	0,28	8,94	6,99	17,29	17,32	1
16-046	[redacted]	20.01.2015	NTF	Front RH	5,19	5,17	9,16	0,23	0,15	8,93	7,00	17,31	17,33	2
16-063	[redacted]	10.02.2015	NTF	Front RH	5,16	5,13	9,17	0,21	0,14	8,94	6,98	17,29	17,32	1
16-229	[redacted]	11.08.2015	NTF	Rear RH	5,17	5,10	9,11	0,24	0,15	8,93	6,98	17,29	17,3	3
16-225	[redacted]	19.08.2015	NTF	Rear RH	5,18	5,15	9,13	0,26	0,18	8,96	6,94	17,27	17,3	3
16-086	[redacted]	22.09.2015	NTF	Rear RH	5,17	5,15	9,12	0,45	0,67	8,94	7,00	17,42	17,46	3
16-095	[redacted]	26.11.2015	NTF	Rear RH	5,19	5,15	9,13	0,3	0,17	8,93	7,01	17,36	17,48	3
16-222	[redacted]	15.12.2015	NTF	Rear RH	5,18	5,16	9,12	0,33	0,28	8,93	7,00	17,27	17,34	3
17-063	[redacted]	18.05.2016	NTF	Rear RH	5,19	5,16	9,13	0,57	0,89	8,94	6,94	17,2	17,24	2

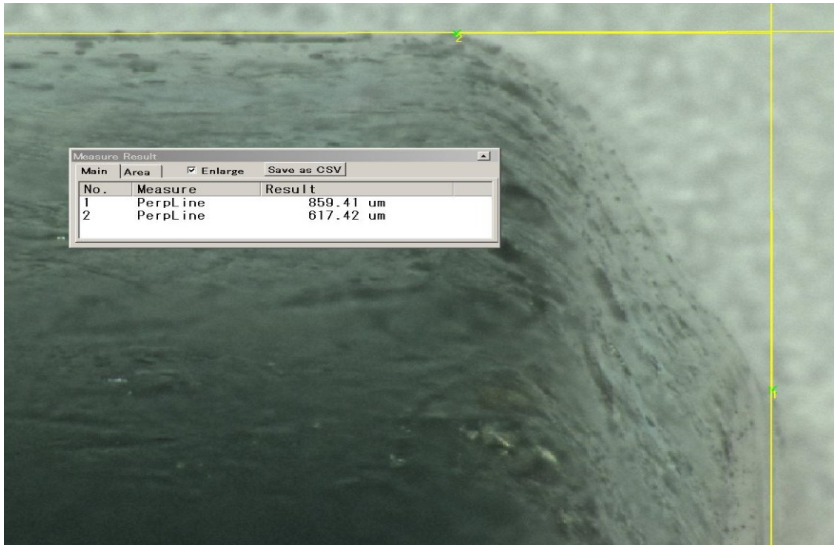
-> nok chamfer (red) detected in field parts (NTF)

Warranty parts
Component measurement chamfer

Example: 16-16



Example: 17-49



Risk evaluation
Bush -chamfer

- Measured components from field parts with NTF

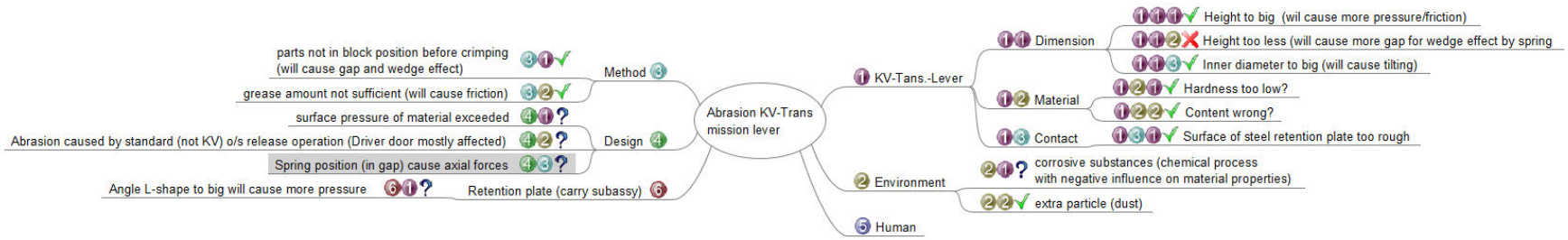
- Bush / chamfer
  - Clarification with logistcs for relevant production dates 9/15-5/16 Brose 6.10.17
  - Supplier is informed
    Needs shipping notes from Brose

Risk evaluation
KV-Transmission Lever

- Transmission Lever max. nok
  - 8/2015 - 4/2016

			Height 5,2-0,05 at max.	Height 5,2-0,05 at min.		
VIN	Build Date	Variant	KV-Tr-Lever max	KV-Tr-Lever m	Bemerkung	Befund
[redacted]	13.12.2012	Front RH	5,18	5,08	Feldteile WUP	
[redacted]	18.02.2013	Rear RH	5,17	5,12	Feldteile WUP	
[redacted]	22.05.2013	Front LH	5,17	5,01	Feldteile WUP	
[redacted]	12.09.2013	Rear LH	5,17	5,08	Feldteile WUP	
[redacted]46	18.10.2013	Rear LH	5,16	5,13	Feldteile WUP	
[redacted]	18.12.2013	Rear RH	5,16	5,15	Feldteile WUP	
[redacted]	20.12.2013	Rear RH	5,16	5,17	Feldteile WUP	
[redacted]2	12.05.2014	Front LH	5,21	5,18	Feldteile WUP	
[redacted]	13.05.2014	Rear RH	5,16	5,15	Feldteile WUP	
[redacted]	11.09.2014	Rear RH	5,15	5,11	Feldteile WUP	
[redacted]	31.10.2014	Front LH	5,16	5,03	Feldteile WUP	
[redacted]	05.11.2014	Rear RH	5,19	5,17	Feldteile WUP	
[redacted]	25.11.2014	Front LH	5,16	5,03	Feldteile WUP	
[redacted]	06.01.2015	Front RH	5,20	5,17	Feldteile WUP	
[redacted]5	20.01.2015	Front RH	5,19	5,17	Feldteile WUP	
[redacted]	10.02.2015	Front RH	5,16	5,13	Feldteile WUP	
[redacted]	30.03.2015	Front LH	5,15	5,12	Feldteile WUP	
[redacted]	11.08.2015	Rear RH	5,17	5,10	Feldteile WUP	
[redacted]	12.08.2015	Rear LH	5,12	5,08	Feldteile WUP	
[redacted]	19.08.2015	Rear RH	5,18	5,15	Feldteile WUP	
[redacted]	22.09.2015	Rear RH	5,17	5,15	Feldteile WUP	
[redacted]	24.09.2015	Front LH	5,15	4,98	Feldteile WUP	
[redacted]	26.11.2015	Rear RH	5,19	5,15	Feldteile WUP	
[redacted]	15.12.2015	Rear RH	5,18	5,16	Feldteile WUP	
[redacted]	18.01.2016	Front LH	5,06	4,92	China Feldteil	sticky behaviour
[redacted]	07.03.2016	Front LH	5,04	4,95	China Feldteil	sticky behaviour
[redacted]	30.03.2016	Front LH	5,05	4,95	China Feldteil	sticky behaviour
[redacted]	05.04.2016	Front LH	5,07	4,95	Kuweit Feldteil	sticky behaviour
[redacted]	06.04.2016	Front LH	5,15	5,04	Feldteile WUP	
[redacted]	18.05.2016	Rear RH	5,19	5,16	Feldteile WUP	
n/a	03.01.2017	Front RH	5,16	5,15	Requali-Test 2017	
n/a	04.01.2017	Rear LH	5,15	5,14	Requali-Test 2017	
n/a	04.01.2017	Rear RH	5,16	5,15	Requali-Test 2017	
n/a	04.01.2017	Rear RH	5,16	5,15	Requali-Test 2017	
n/a	04.01.2017	Rear RH	5,19	5,18	Requali-Test 2017	
n/a	04.04.2017	Rear RH	5,19	5,18	Requali-Test 2017	
n/a	11.04.2017	Rear LH	5,15	5,14	Requali-Test 2017	
n/a	12.04.2017	Front LH	5,15	5,04	Requali-Test 2017	
n/a	12.04.2017	Front RH	5,19	5,18	Requali-Test 2017	

Abrasion KV-Lever
Ishikawa



Remark:
4.3 added

Reproduce failure mode
Test procedure

Test:	Reproduce failure mode "sticky KV-transmission lever"				
Latches with:	KV-Transmission lever from field parts approx 5mm (Spec. 5,2 -0,05)				
	Bush with champfer similar to field part - 0,5 (Spec. -0.4) and -0,7 (Spec. -0.6)				
	Rest: current series components				
Variant:	LH latches				
Amount:	2				
	2	total series parts for comarison			
Procedure:					
	7.6.5 Temperature cycling				
	ORL operation at RT 2.500 cycles on rapid device				
	Wet-Dust Application after 2.500 cycles				
	ORL operation at RT 2.500 cycles on rapid device				
	Salt spray test 24h after 5.000 cycles with mounted watercaps				
	ORL operation at 38°C/ 95% humidity 5.00 cycles on Durability test rig				
	(overnight (>8h) storage at 38°C/ 95% humidity with latch closed and CL engaged on Durability test rig				
	After 8h storage opening the latches via KV				
	Function check, consisting of:				
	- Latch opened after KV?				
	- Pawl latches again?				
	- KV transmission lever free rotating?				
	- KV transmission lever back to home position?				
	- O/S transmission lever release free rotating?				
	- O/S transmission lever release back to home position?				
	- Latch opens via KV without O/S release pull?				
	- Test: Intermittent unlock issue successful?				
Timing					
	Procedure	22.09.2017	done		
	Test duration	approx 3 weeks			
	Test end	20.10.2017			

Design options

	Component	What to change?	Expected Effect	pot. Negative effect	Status	Process
1	Bush	Reduce champfer	Axial force of spring (wedge effect) will be reduced	process limits due cold-forming turned part	Request to supplier (cold-forming process): - Process technically possible? - Possible amount of rejects in chamfer reduction without change in process? 05.10.2017: Still under investigation with Supplier regarding feasibility --> Timing: 20.10.2017	- increased test effort - sorting and scrapping
2	Bush	Step height -tolerance reduction	Axial force of spring (wedge effect) will be reduced	process limits due cold-forming turned part	- Process technically not possible - Request to supplier whether a smaller tolerance would be possible with increased inspection effort. 05.10.2017: Still under investigation with Supplier regarding feasibility --> Timing: 20.10.2017	
3	KV-Transmission-Lever	Material properties increase e.g. MIM / Zamak ZP2	less/no abrasion		- ZP2 has slightly better strength properties. - MIM = Prio 2 (new process, new tools, new validation) 05.10.2017: Improved material specification see next page feasibility and dimensional behavior has to be evaluated. --> First result expected 20.10.2017	Comparison tests with parts made of ZP5 and ZP2
4	KV-Transmission-Lever	Change bearing dimension (ring)	reduce tilting; increase contact area	higher friction due to bigger diameter	Work out a concept: -> what is possible new spring calculate, design change at lever 05.10.2017: No new update - Less priority	
5	spring	square cross-section	less/no entrance into gap	assembly problems / lifetime performance	Spring with similar torque with wire 0.85x0.85 possible. (Spring behavior can not be estimated) 05.10.2017: Will be evaluted together with design solution 6 + 8	Request to supplier: - Sample preparation Brose: - validation
6	forced resetting of outside transmission lever	connection between the o/s transmission lever and o/s release lever	to support resseting of KV-ler and o/s transmission lever		Design idea 05.10.2017: See next page. Prototype assembled. Possible Idea - reduce winding of outside transmission lever spring. Based on the investigation results of Point 8 might be considered additionaly.	Request to supplier: - Sample preparation Brose: - validation
7	spring	coating of spring	bigger diameter to avoid entrance		05.10.2017: After internal discussion with commoditiy expertes, idea rejected due to feasiblity and durability	
8	Additional part	downhold of spring	No gap entrance		Work out a concept: -> what is possible new spring calculate, design a bush 05.10.2017: Will be evaluted together with design solution 5 + 6	

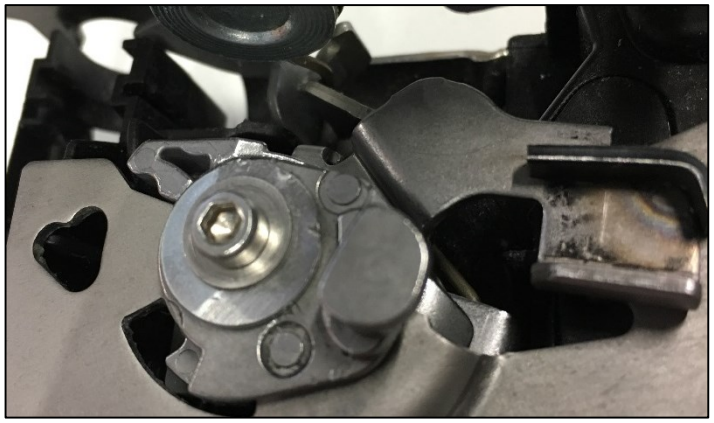
Design Idea material properties Point 3

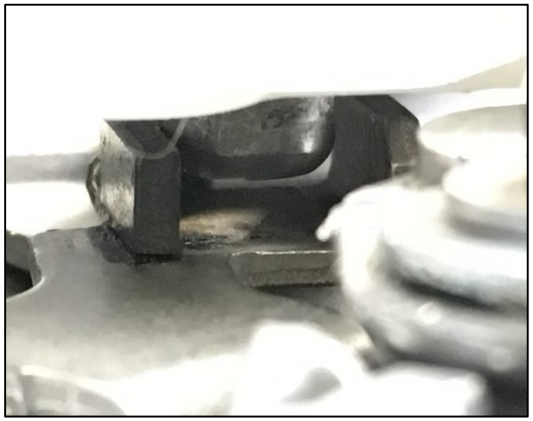
Properties	Current Material [ZP 5]	Other possible Material [ZP 2]
Tensile strength	331 MPa	397 MPa
Shear strength	262 MPa	317 MPa
Compressive strength	600 MPa	641 MPa
Hardness (Brinell)	114	130

Abrasion test for direct comparison under investigation by central laboratory

Design Idea forced resetting Point 6

- Prepared prototype sample
  - Welded wall onto serial outside transmission lever
- Solution creates forced resetting of outside transmission lever
- See Video for the behavior of the lever – part build up without o/s transmission lever spring and without KV transmission lever spring





Video

O/S release chain interactions

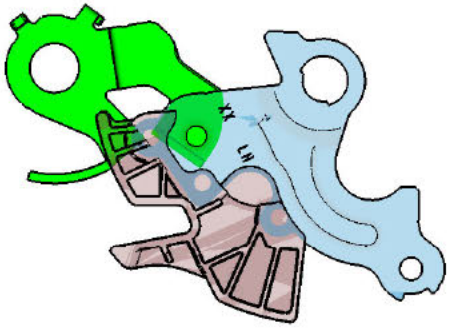
brose

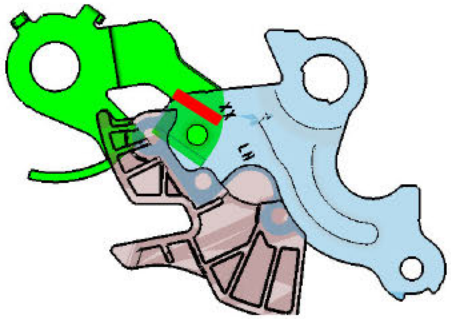
Current

New (forced resetting)

Modification of O/S transmission lever generates linkage also in resetting direction

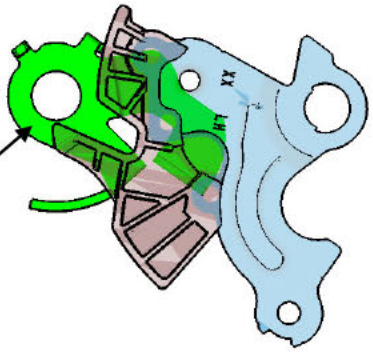
Operated O/S release lever



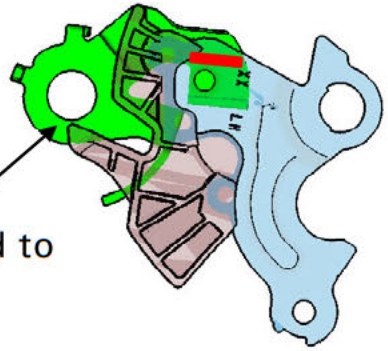


After resetting in case of jammed O/S transmission lever

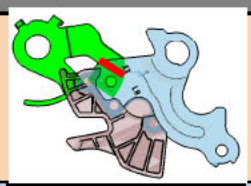
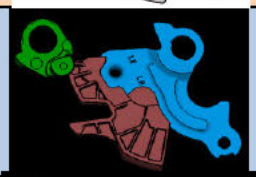
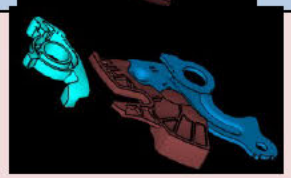
Lever can stay in jammed position



Lever is forced to move back in home position

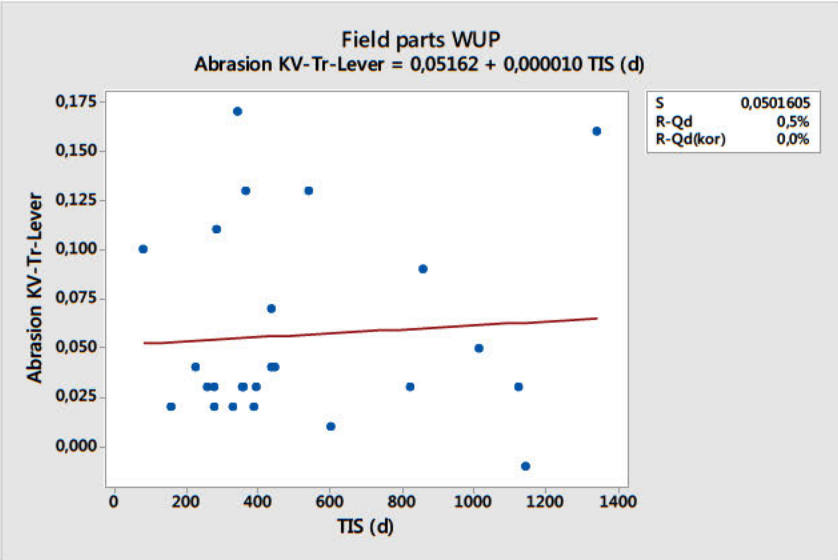


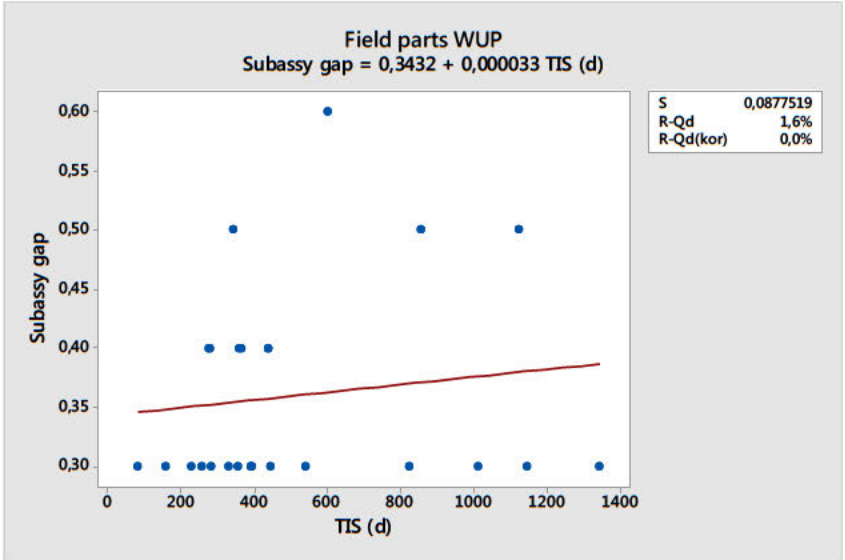
O/S release chain interactions with forced resetting

Ser. No		1	2	3	4
	Part	O/S release lever	O/S transmission lever	Coupling lever	KV transmission lever
1	O/S release lever		+ + modification	+ +	-
2	O/S transmission lever			-	s
3	Coupling lever				+
4	KV transmission lever				

+ + = Connection in both directions
+ = Connection only in operation direction
s = Interaction by spring support / bearing
- = No direct connection

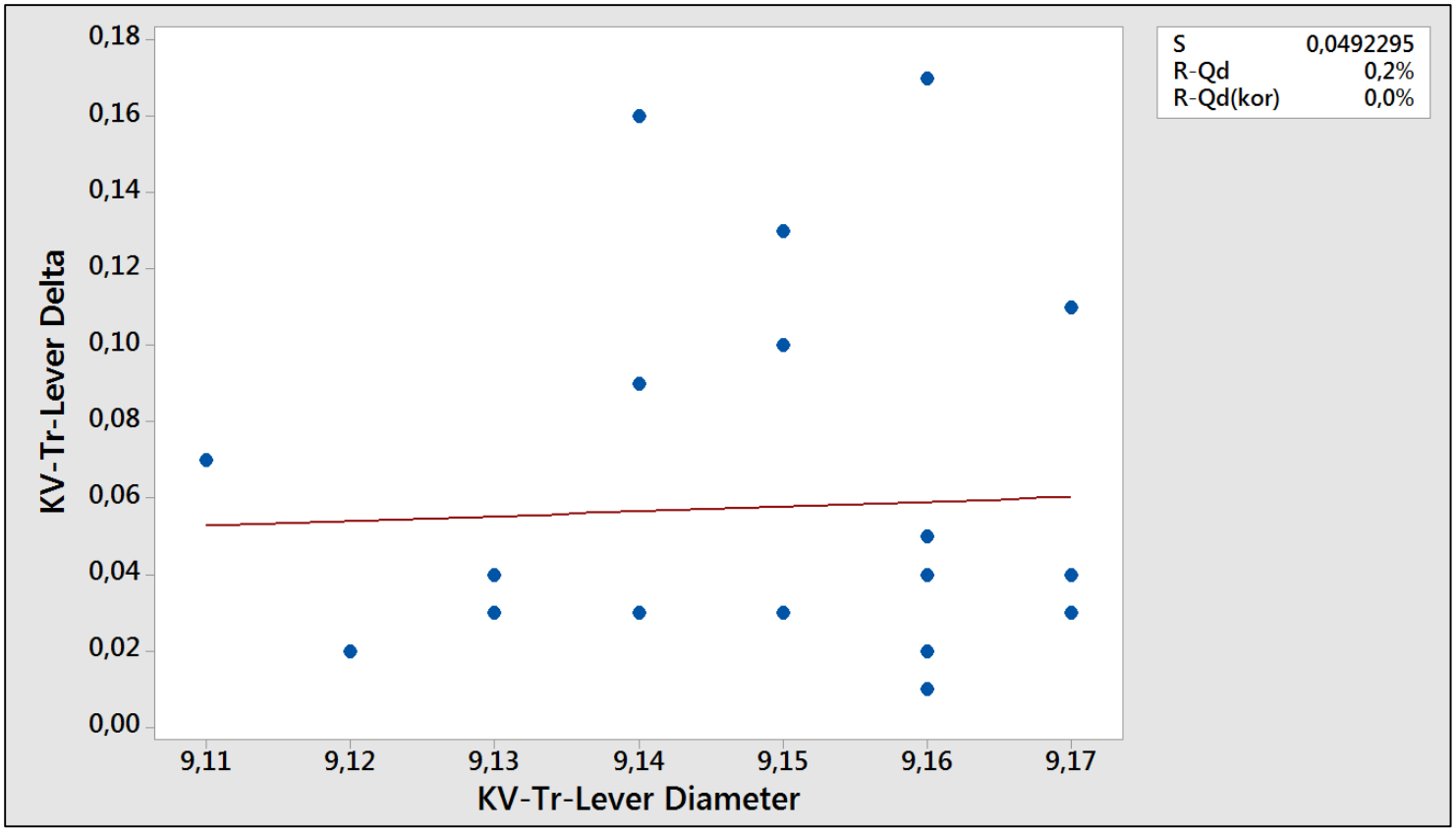
Mini-Tab Investigation





Conclusion: No influence of TIS for abrasion or gap

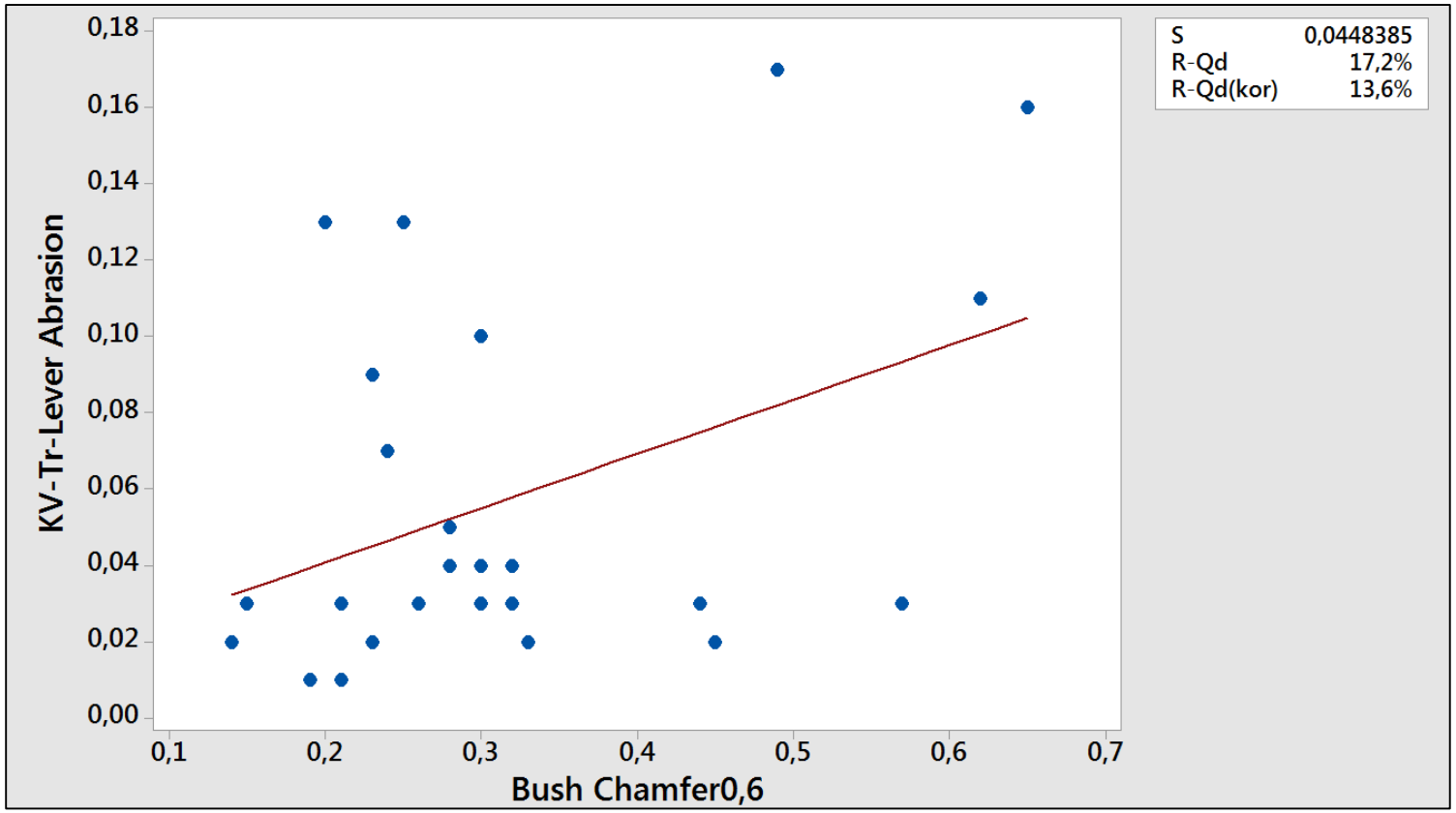
Mini-Tab Investigation



Based on current investigation, diameter KV transmission lever differences has no influence to abrasion

→ This has to be confirmed with more data

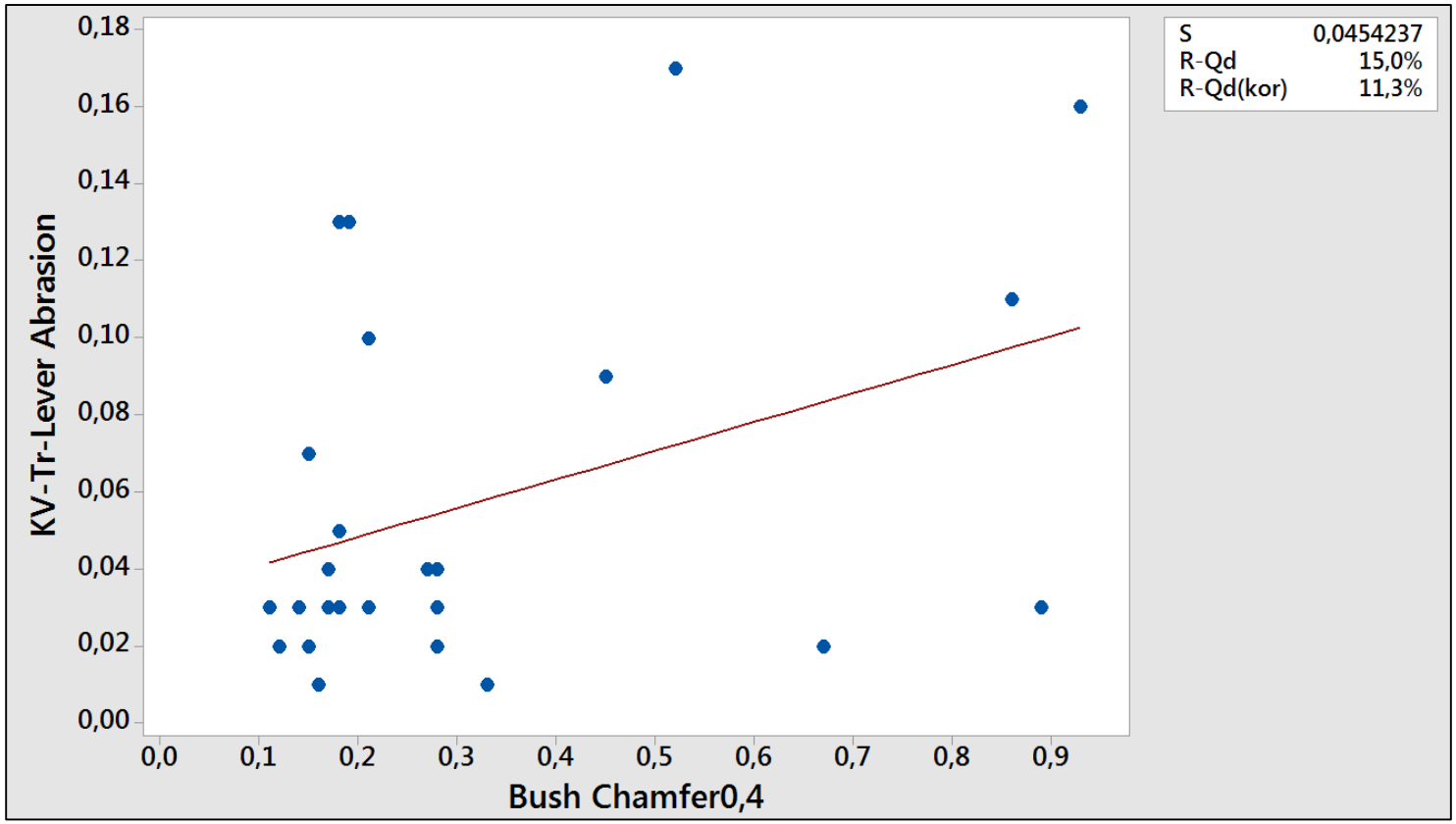
Mini-Tab Investigation



Based on few available data: bigger axial chamfer leads to more abrasion

→ This has to be confirmed with more data

Mini-Tab Investigation



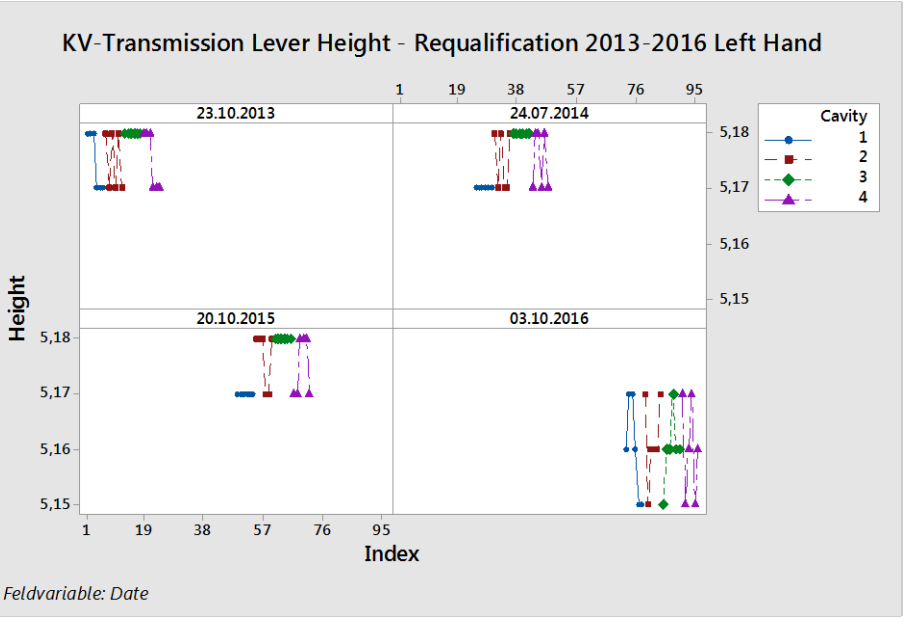
Based on few available data: bigger radial chamfer leads to more abrasion

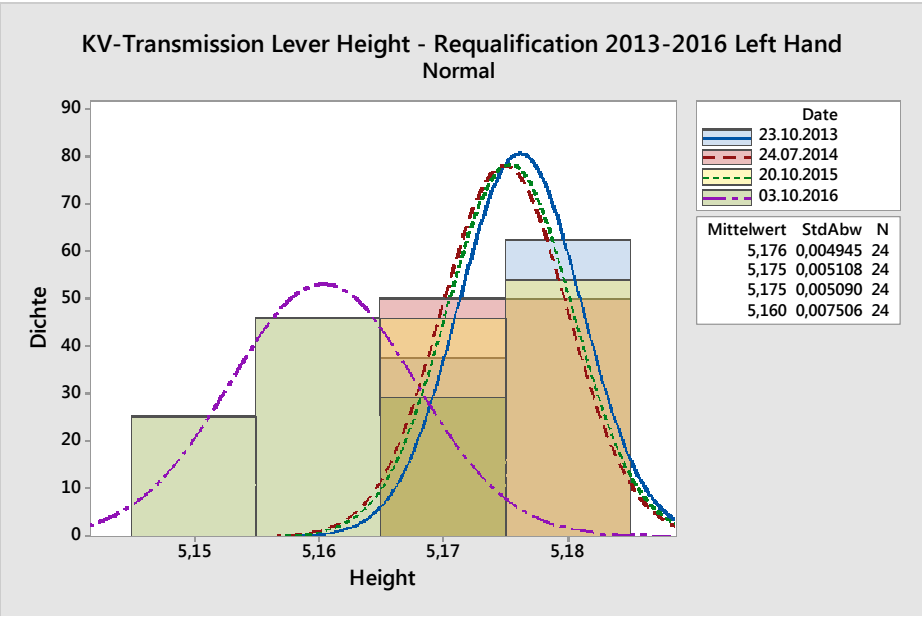
→ This has to be confirmed with more data

Affective production period

- Deliveries from 30. May 2016 onwards → OK
- Deliveries before May 2016 → still under investigation

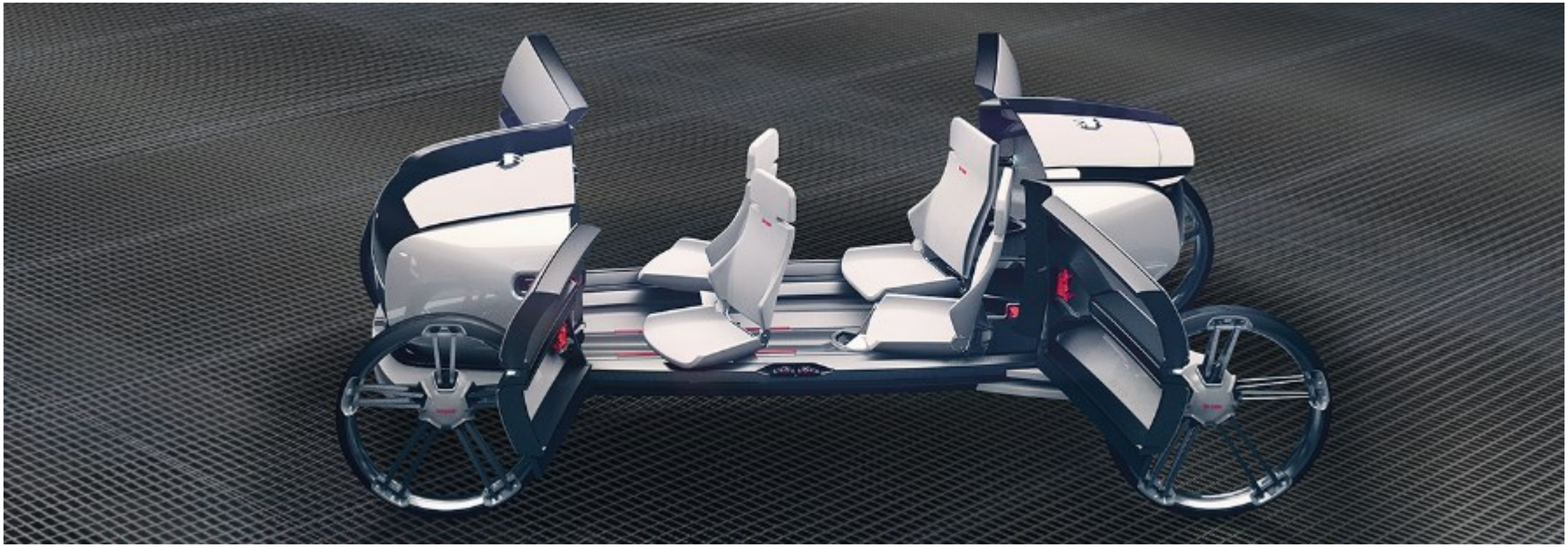
Mini-Tab Investigation





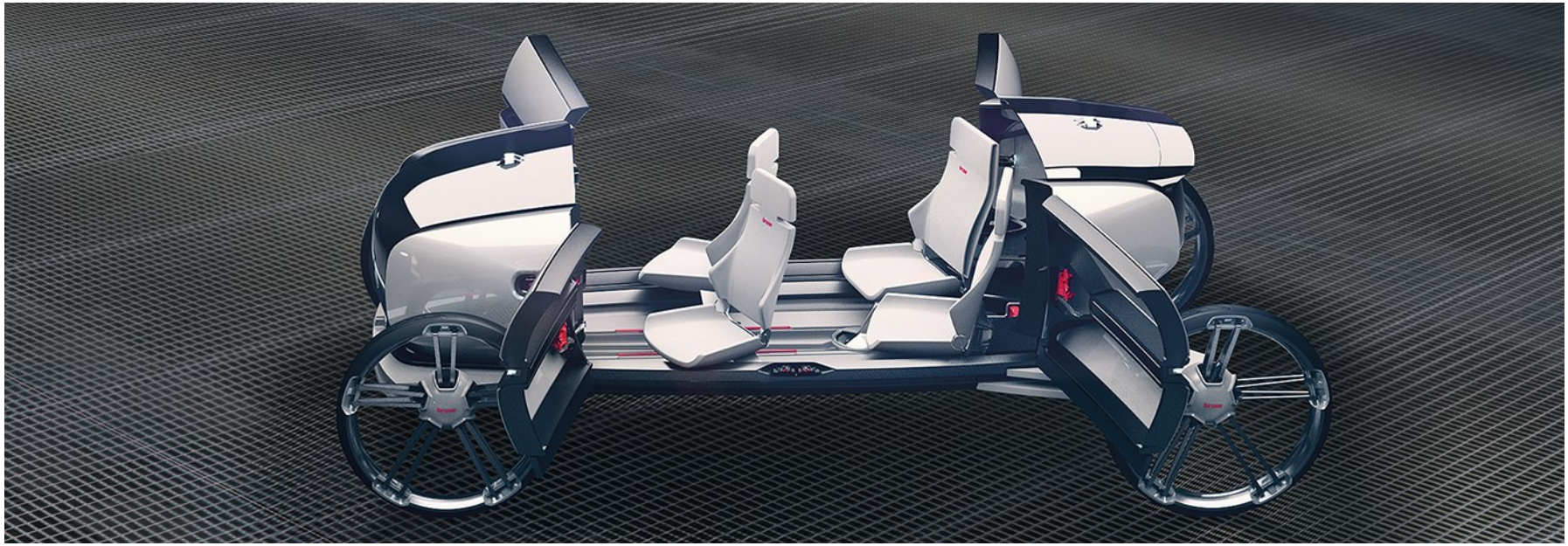
Requalification 1/year at supplier, 2016 different

brose



DoE Status 06.04.2018

Unilatch High end



DoE
Planning

DOE Planning						
Target:	Evaluation of latch production before Mai 2016					
Response:	1	2				
	KV-Transmission Lever jammed	Abrasion of KV-Transmission Lever				
	Attributive Status: yes / no	variable (mm)				
Test procedure:	see procedure					
Latch variant	FT LH and RR RH					
Influence factors	Description	Effect	Specification	Level 1	Level 2	Remark
1	KV-Transmission Lever Height	Height below 5,15 will cause gap.	5,2 -0,05	5,2	5,05	Level 1: max Tolerance Level 2: min from measured field parts
3	Bush Champfer -0,6	Allows that the spring gets into the gap and causes an axial force.	-0,6 axial	-0,3	-0,9	Level 1: average current production Level 2: max from measured field parts
3	Bush Champfer -0,4	allows that the spring gets into the gap and causes an axial force.	-0,4 radial	-0,2	-0,8	Level 1: average current production Level 2: max from measured field parts
4	Bush Step height	Designed freeplay, part of the gap	6,9 +0,15	6,9	7,05	Level 1: min Tolerance Level 2: max Tolerance

DoE
Procedure

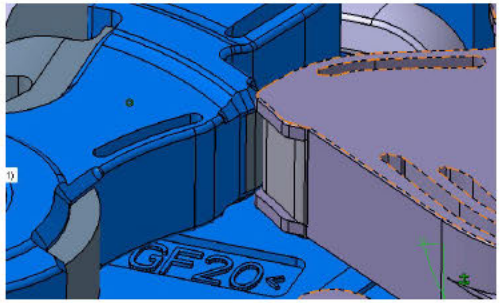
Latches with:	acc DOE Level (4 factors, 2 Level)					
Variant:	FT LH and RR RH					
Amount:	8 + 8	16				
Equipment	Durability test rack (4 latches)					
	Climatic chamber					
Procedure:	**Operating by**	**Cycles**	**Conditions**	**Spec:**	**Check**	Loop
Preperation						
	ORL + KV open, close	2500	5°C	Latches on test-rack	Jammed condition detect via pawl microswitch	
	Climate change					
	ORL + KV open, close	2500	60°C / 95% rH	Latches on test-rack	Jammed condition detect via pawl microswitch	
						1
	no	> 8h (overnight) storage	60°C / 95% rH latch closed and CL engaged	Latches on test-rack		
	ORL + KV	1	60°C / 95% rH latch closed and CL engaged	Latches on test-rack	Function check	
			Salt spray test 24h with mounted watercaps	Salt test chamber	Function check	**Extended Step**
			Drying 4h RT Humidity 60°-95% over night (12h) Drying 4h RT	Latches on test-rack	Function check	**Extended Step**

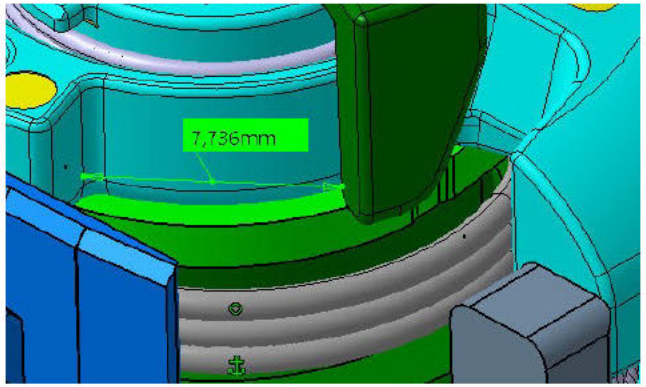
DoE
Response Criteria: Gap home position

Position of KV-transmission lever
after passing test procedure

Home position
No Gap

Home position
With Gap





Critical Gap > 7,7mm

DoE
Plan + Results

Position 1 + 2
DoE – Results
after extended
procedure
(5000cycles +
corrosion)

Position3 + 4
Pre-Test Results
after test
(35000cycles +
corrosion)

StdRfol	DlaufRf	ZtrlPu	Blöcke	KV-Tr-Lever Height	Bush Chamfer0,6	Bush Chamfer0,4	Bush Step Height	Gap home position 1	Gap home position 2	Gap home position 3	Gap home position 4
2	1	1	1	5,20	-0,9	-0,8	6,90	3	*	*	*
1	2	1	1	5,05	-0,9	-0,8	6,90	3	4	*	*
15	3	1	1	5,05	-0,3	-0,2	7,05	0	3	*	*
8	4	1	1	5,20	-0,3	-0,2	6,90	3	*	8	0
12	5	1	1	5,20	-0,3	-0,8	7,05	2	*	*	*
11	6	1	1	5,05	-0,3	-0,8	7,05	0	*	*	*
4	7	1	1	5,20	-0,3	-0,8	6,90	5	2	*	*
13	8	1	1	5,05	-0,9	-0,2	7,05	0	2	*	*
9	9	1	1	5,05	-0,9	-0,8	7,05	4	4	0	3
10	10	1	1	5,20	-0,9	-0,8	7,05	2	*		
3	11	1	1	5,05	-0,3	-0,8	6,90	0	*		
7	12	1	1	5,05	-0,3	-0,2	6,90	0	3		
16	13	1	1	5,20	-0,3	-0,2	7,05	0	*		
5	14	1	1	5,05	-0,9	-0,2	6,90	4	0		
6	15	1	1	5,20	-0,9	-0,2	6,90	4	2		
14	16	1	1	5,20	-0,9	-0,2	7,05	0			

Pre-Test Results: 1 Latch failed (8mm)
DoE Results: No latch failed with extended procedure

DoE
Model for Result average gap home position 1-2

Residuendiagramme für Gap home position average1-2 5t

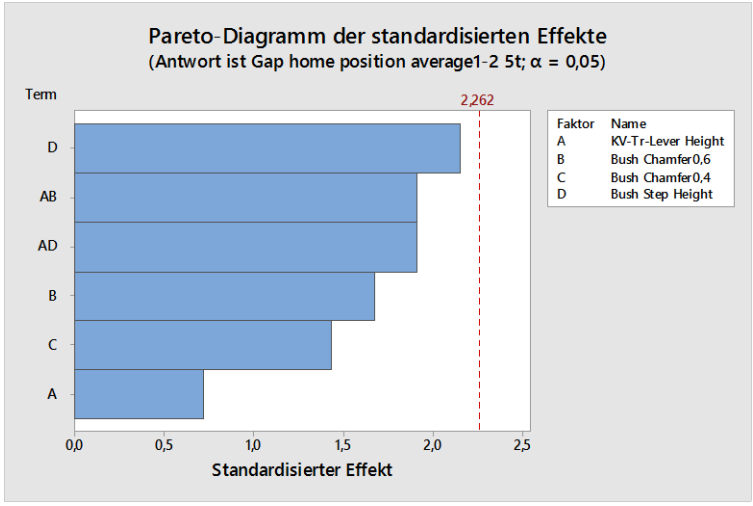
Faktorielle Regression: Gap home pos vs. KV-Tr-Lever ; Bush Chamfer; Bush Chamfer; ...

Varianzanalyse

Quelle	DF	Kor SS	Kor MS	F-Wert	p-Wert
Modell	6	18,9375	3,1563	2,89	0,074
Linear	4	10,9375	2,7344	2,51	0,116
KV-Tr-Lever Height	1	0,5625	0,5625	0,52	0,491
Bush Chamfer0,6	1	3,0625	3,0625	2,81	0,128
Bush Chamfer0,4	1	2,2500	2,2500	2,06	0,185
Bush Step Height	1	5,0625	5,0625	4,64	0,060
2-Faktor-Wechselwirkungen	2	8,0000	4,0000	3,67	0,068
KV-Tr-Lever Height*Bush Chamfer0,6	1	4,0000	4,0000	3,67	0,088
KV-Tr-Lever Height*Bush Step Height	1	4,0000	4,0000	3,67	0,088
Fehler	9	9,8125	1,0903		
Gesamt	15	28,7500			

Zusammenfassung des Modells

S	R-Qd	R-Qd(kor)	R-Qd(prog)
1,04416	65,87%	43,12%	0,00%



R-Qd: 65,87% < 80%

-> DoE factors not complety explaining the result.

-> Additional factor(s) to consider.

2-factor interferance in model (p-value >0,05 but contribution is relevant)

DoE
Model for Result average Gap home position 1-4

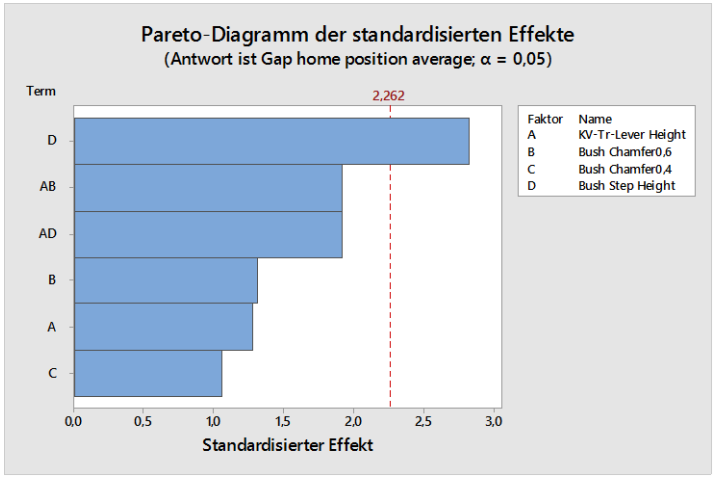
Faktorielle Regression: Gap home pos vs. KV-Tr-Lever ; Bush Chamfer; Bush Chamfer; ...

Varianzanalyse

Quelle	DF	Kor SS	Kor MS	F-Wert	p-Wert
Modell	6	18,492	3,0820	3,29	0,053
Linear	4	11,616	2,9041	3,10	0,073
KV-Tr-Lever Height	1	1,511	1,5109	1,61	0,236
Bush Chamfer0,6	1	1,615	1,6150	1,72	0,222
Bush Chamfer0,4	1	1,042	1,0421	1,11	0,319
Bush Step Height	1	7,448	7,4484	7,95	0,020
2-Faktor-Wechselwirkungen	2	6,876	3,4379	3,67	0,068
KV-Tr-Lever Height*Bush Chamfer0,6	1	3,438	3,4379	3,67	0,088
KV-Tr-Lever Height*Bush Step Height	1	3,438	3,4379	3,67	0,088
Fehler	9	8,431	0,9368		
Gesamt	15	26,923			

Zusammenfassung des Modells

S	R-Qd	R-Qd(kor)	R-Qd(prog)
0,967872	68,69%	47,81%	1,03%



R-Qd: 68.69% < 80%

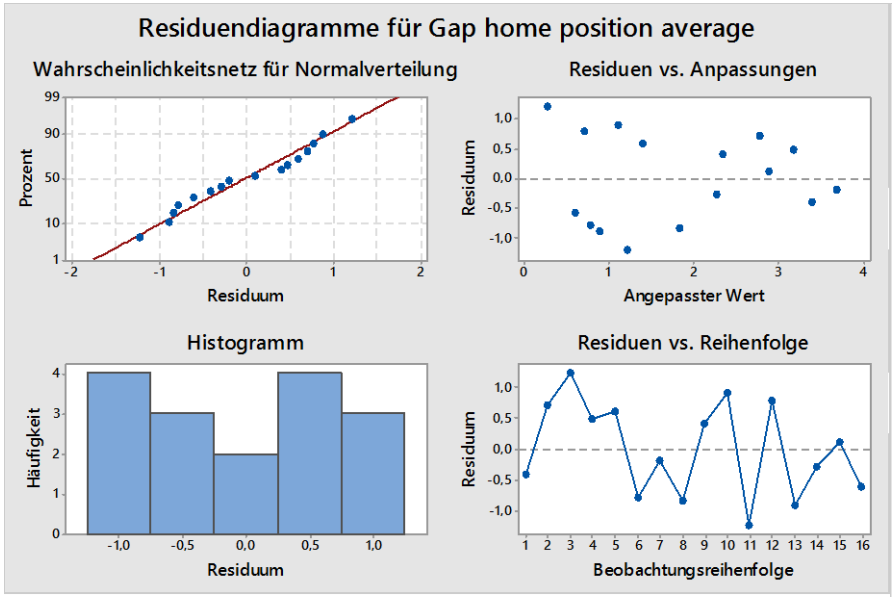
-> DoE factors not complety explaining the result.

-> Additional factor(s) to consider.

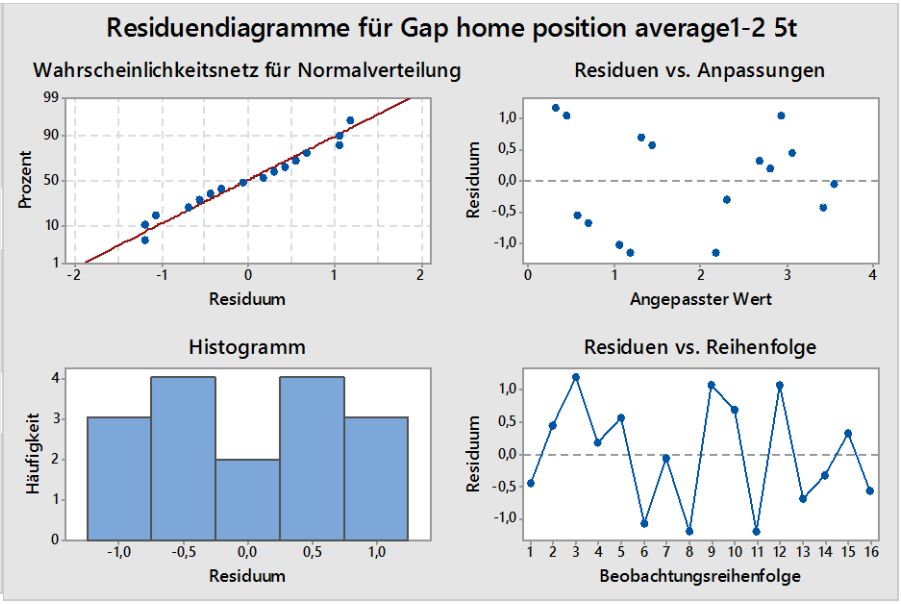
2-factor interferance in model (p-value >0,05 but contribution is relevant)

DoE
Graphical evaluation

Result average gap home position 1-4



Result average gap home position 1-2

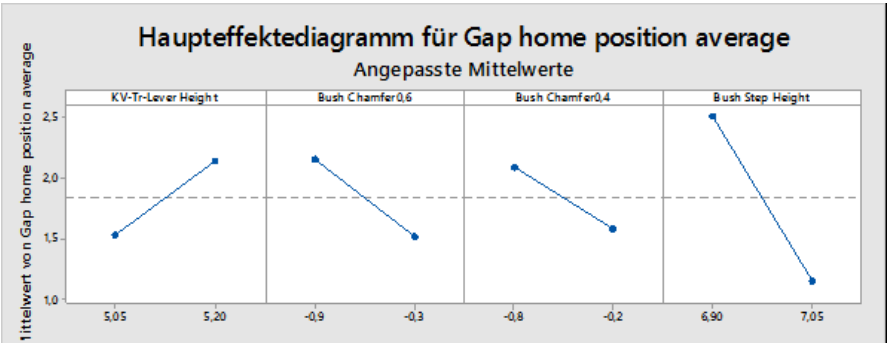


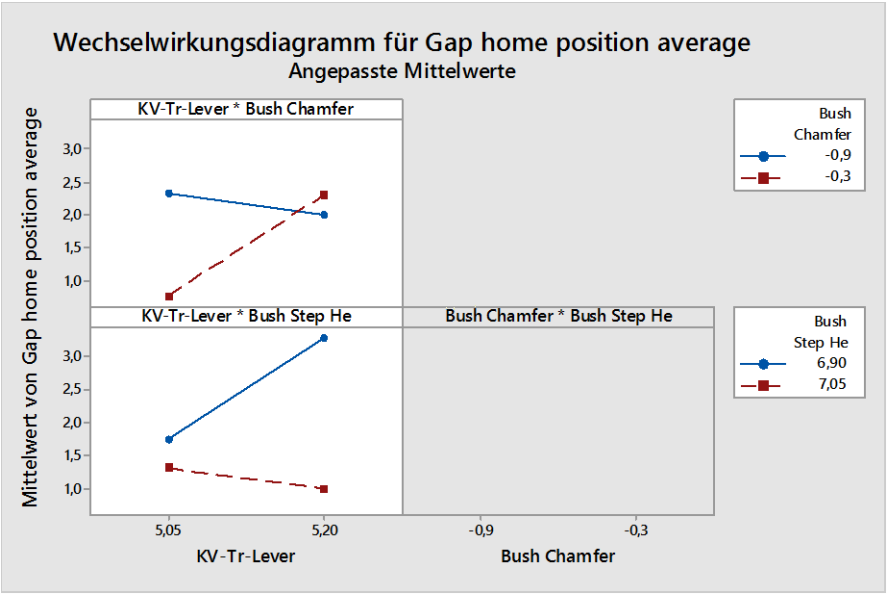
Conclusion: Residual Charts sufficient

Histogram : shape with two „peaks“ at ends

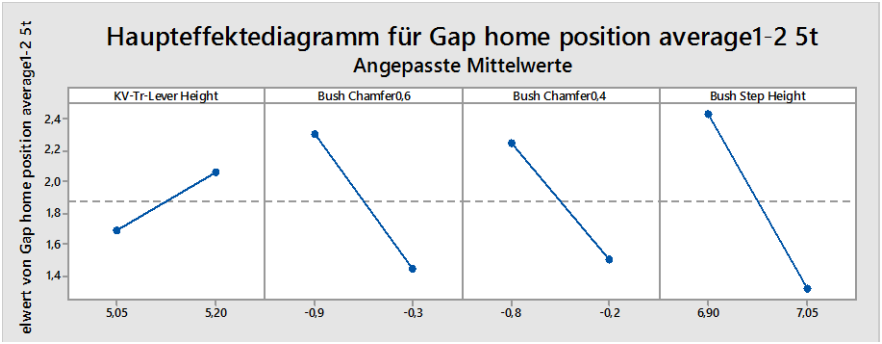
DoE
Effects diagram

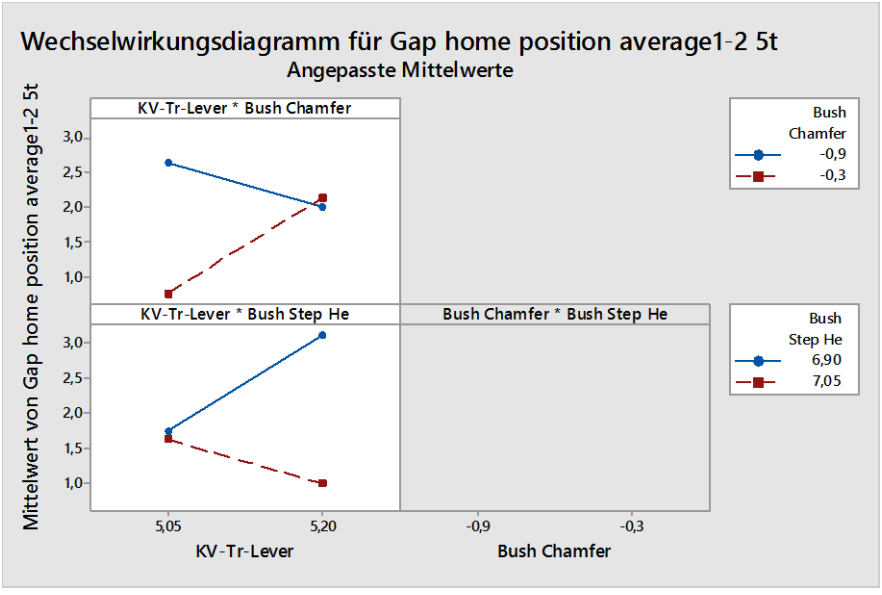
Result average gap home position 1-4





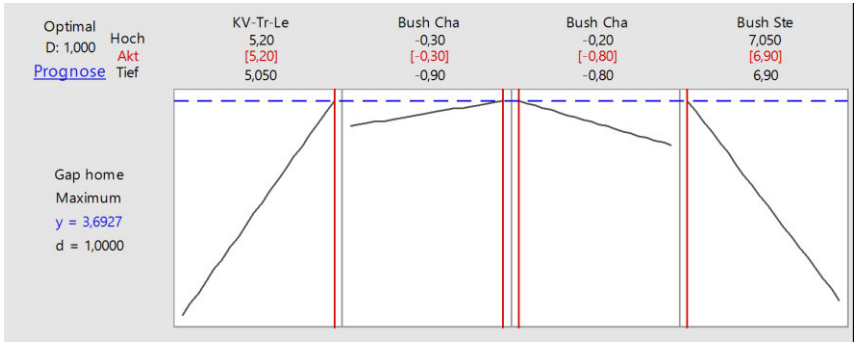
Result average gap home position 1-2



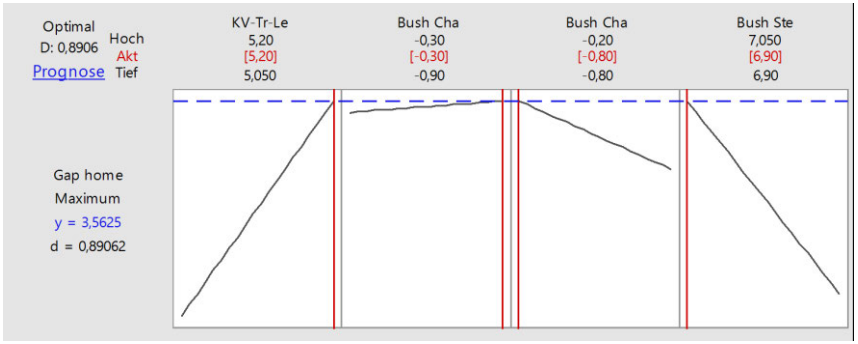


DoE
Maximum optimisation graph

Result average gap home position 1-4



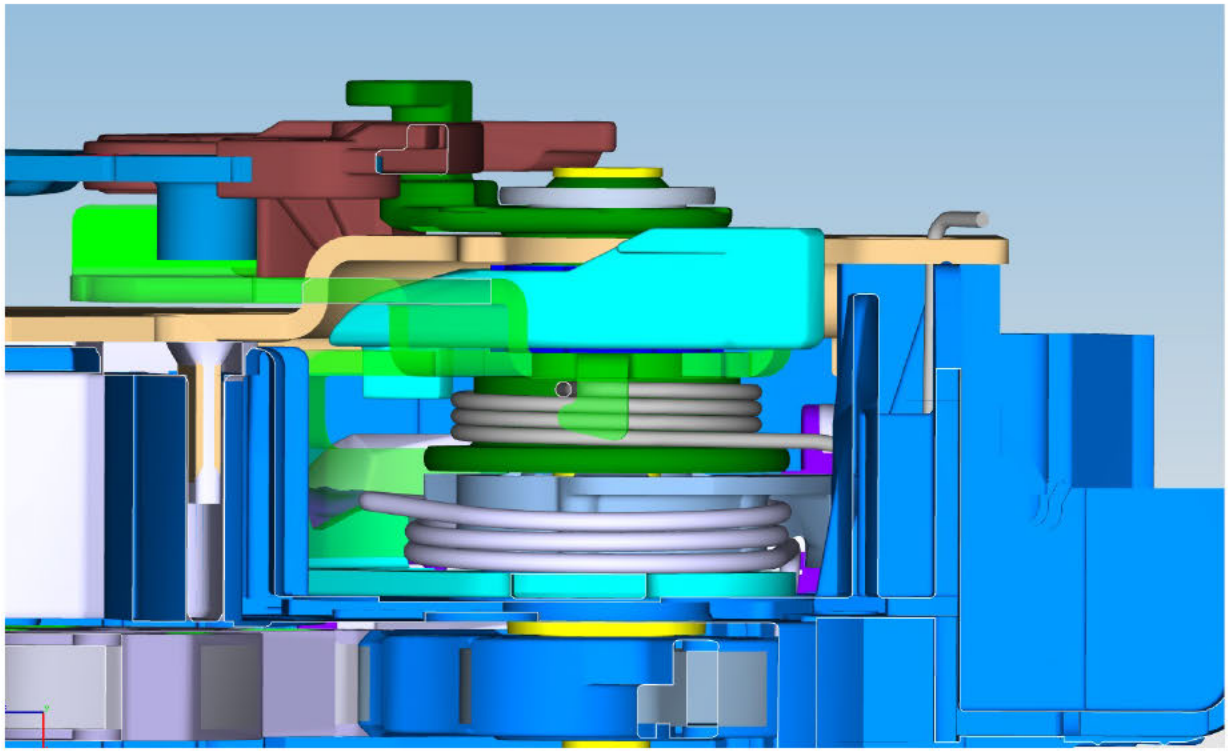
Result average gap home position 1-2



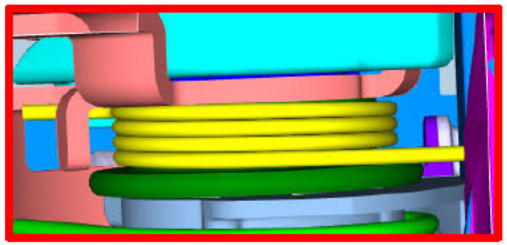
- Both models are showing the same potential maximum gap position of approx 3,6 mm. Less than critical gap 7,7mm
- Maximum of 3,6 mm less than measured single value (5 or 8mm) shows that additional factor is to contribute. (see R-Qd value approx 65% < 80%)

DoE
Potential additional factor - Spring

Unilatch Highend/ 937670-106



Unilatch Highend/ 937670-105



DoE
Summary

- DoE factors do not fully explain the response variation. (R-Qd < 80%)
- DoE factors within the tested levels are not causing a gap to home position of KV-transmission lever higher than critical. (max 3,6mm < critical 7,7mm)
- Field failure:
  3 corrective actions (bush chamfer, KV-transmission lever height, spring design (index 105 load abuse change) are in place since production date 6/2016. No failure occured after PD 6/2016.
- Next step: Parking of DoE activities, observation of field.

Exterior Door Open Unexpectedly Whilst In Motion

NHTSA Review 15 November 2017

Problem Description

Problem Definition:

Post-P068 software flash failures reported where the customer verbatim indicates that one or more of the doors on their vehicle has opened whilst the vehicle was in motion. Issue affects mainly the MENA region in terms of incidence rate however a few reports have also been observed elsewhere in the world. P068 software dealt with the KV actuator in the latch being placed into a short circuit condition immediately following de-energising the KV motor. The P068 software flash eliminated the short circuit condition for the first 900ms following de-energising the motor, allowing the KV lever to return to its home position without any resistance from the motor. The latch was updated with a stronger KV return spring (August 2015), grease applied to the sinter bearing (Dec 2015), and a patch to resolve the leak path to the sinter bearing (Feb 2016). The grease has since been deleted as the leak path is no longer an issue therefore the sinter bearing is no longer compromised (July 2016).
With all these fixes in place by definition it cannot be the KV actuator fault that is causing the latch to be held in a released condition. Therefore the fault must lie elsewhere in the system.

Issue First Discovered:

From the Critical Concerns identified the issue first appeared in the USA 2 days after P068 was launched. From the analysis conducted it appears that the exterior release handle was the cause of the failure on this vehicle.

Vehicle Specs/Markets Affected:

Failure mode can affect any vehicle as per the below chart. However, Markets affected are ARE (26), GBR (3), USA (3), CAN (2), KWT (2), and CHN (1). Historically it is only high handle vehicles (L405 and L494) that exhibit this error state as the tendency is deploy the handle downwards. No verbatim indicating failure mode exists on any other vehicle lines, despite the reinforcement being common.

Supporting Graphical Evidence Where

Build Month

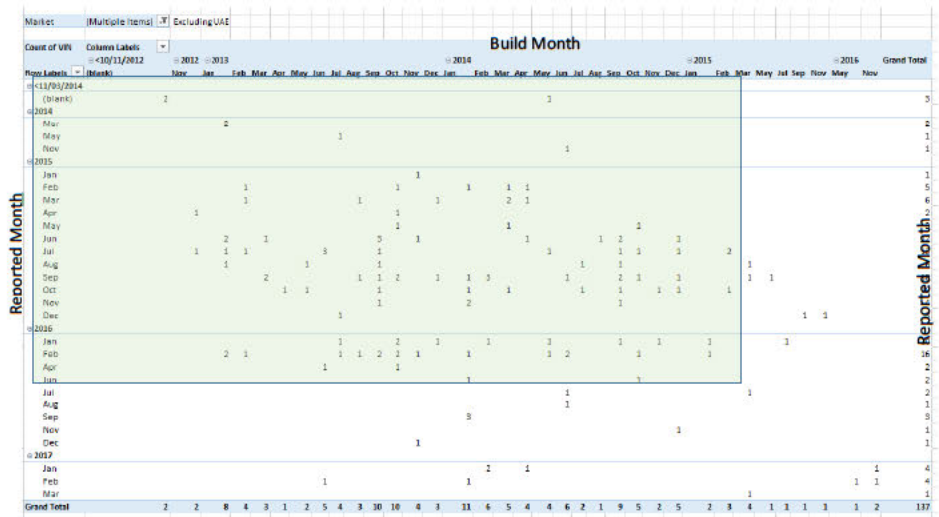
Count of VIN	Column Labels																																						
	<10/11/2012	2012	2013												2014												2015										2016			Grand Total
Row Labels	(blank)	Nov	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jul	Sep	Oct	Nov	Jan	May	Nov	
AUSTRALIA(AUS)												1		1						1																			3
AZERBAIJAN(AZE)																							1																1
CANADA(CAN)				1				1						1			2														1						1		7
CHINA(CHN)											1													1														1	3
FINLAND(FIN)																		1			1		1	1															4
FRANCE(FRA)			1																						1														2
KUWAIT(KWT)					1					1	1																		1			1							5
LEBANON(LBN)										1										1																			2
LITHUANIA(LTU)					1																																		1
OMAN(OMN)																2										1													3
POLAND(POL)																							1																1
PORTUGAL(PRT)													1																										1
QATAR(QAT)															1		1									1													3
RUSSIAN FEDERATION(RUS)		1	3	3	1	1	1	1	2	1	5	3	1		4	3		1	3	1		1	1	2		1	1												41
SAUDI ARABIA(SAU)												1			3																								4
SOUTH AFRICA(ZAF)															1																								1
SPAIN(ESP)									1																														1
TURKEY(TUR)															1																								1
UKRAINE(UKR)											1																												1
UNITED ARAB EMIRATES(ARE)	1		1	2				4	3	5	3	7	3	1	5	3	6			1	1		4	5	6	5	4	6	6	3	1		6	6	1	3			102
UNITED KINGDOM(GBR)			3					1									1	2		1													1		1			1	11
UNITED STATES(USA)		1	1				1	2	1		2	5	2	1	1	1	1		1	2	1		5	1	1	2	1	3	3										39
(blank)	2																																						2
Grand Total	**3**	**2**	**9**	**6**	**3**	**1**	**2**	**9**	**7**	**8**	**13**	**17**	**7**	**4**	**16**	**9**	**11**	**4**	**4**	**7**	**3**	**1**	**13**	**10**	**8**	**10**	**6**	**9**	**10**	**3**	**2**	**1**	**7**	**6**	**2**	**3**	**1**	**2**	**239**

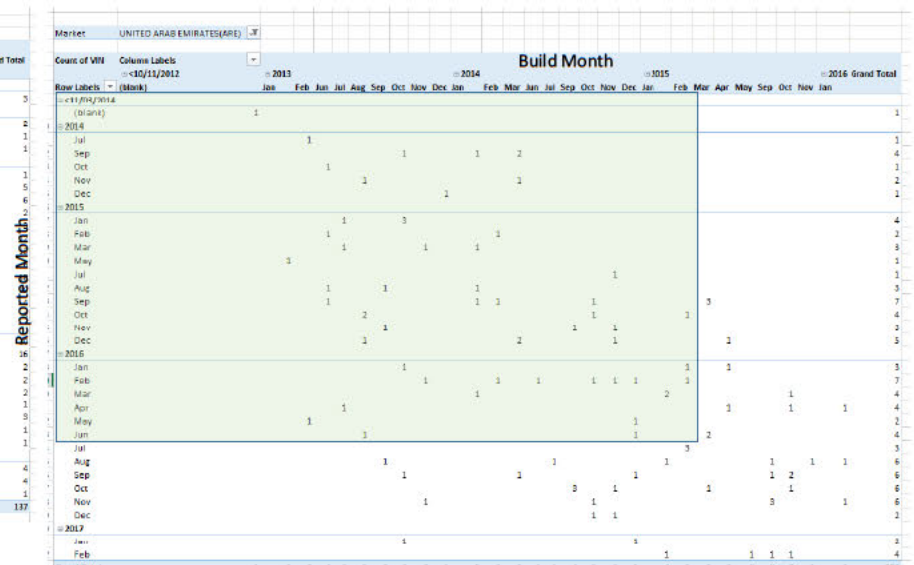
Significant failure rate in MENA markets post latch modification in production.

P068 population indicates that following the software flash the recall was effective in negating most of the failures seen previously.

In MENA markets, there is still a failure rate observable that can be attributed a separate root cause.

Supporting Graphical Evidence When

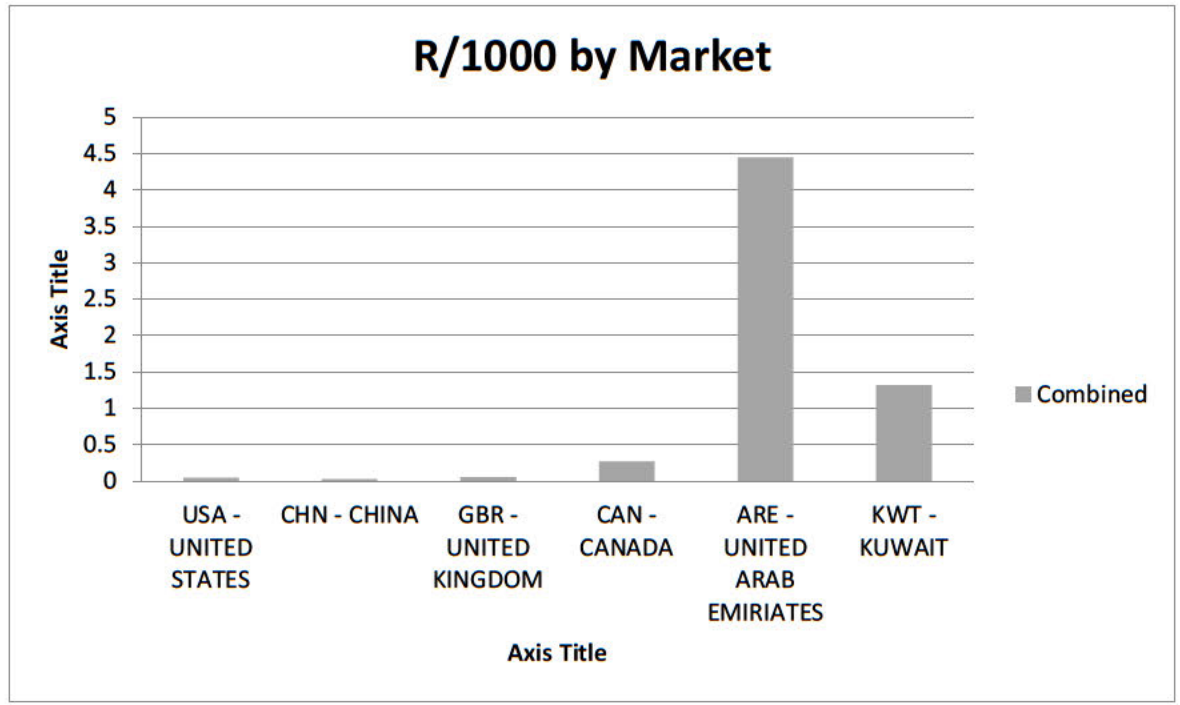




ROW indicates that the recall action was successful in mitigating the failure mode, with the exception of some special cause failures. Without in-depth investigation being performed on every vehicle it is impossible to conclusively say what the failure mode was

MENA markets did not see a dissipation in the incidence level post P068 software flash. The rate of reported failure remained more or less constant, despite the indicators from the rest of the world.
We can therefore attribute this to a special cause variation localised to this market specifically

R/1000 Normalisation By Market



- Data from the vehicle population post production cut-off date (Mar 2015 onwards)
- Markets in descending order of sold vehicles in service
- Minimal R/1000 values everywhere except ARE and KWT
- However, other markets that have reported an occurrence are not identical climatic conditions to either ARE or KWT

Similar Markets
Power and Sample Size Analysis

Minimum market sample size of ~500 cars for a 90% confidence of seeing the defect

Hot markets with similar climatic conditions isolated from ROW
Volumes shown are combined L405 and L494

Any market with a volume >500 vehicles should see the failure

Markets such as ZAF, AUS, SAU, QAT, MAR are all very similar climatic and environmental conditions to ARE and KWT

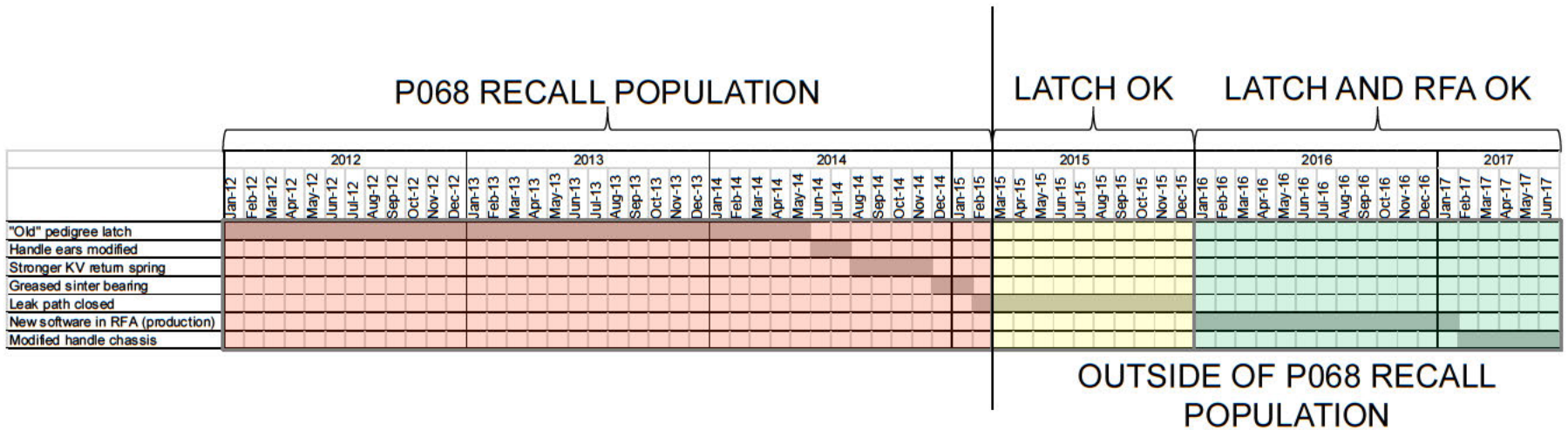
No failures reported in these markets

	Combined		
Country Sold	Build	Reports	R/1000
USA - UNITED STATES	69860	3	0.042943
CHN - CHINA	44369	1	0.022538
ITA - ITALY	8074		
ARE - UNITED ARAB EMIRIATES	6518	29	4.449218
AUS - AUSTRALIA	6285		
KOR - KOREA, REP OF (South)	4107		
ESP - SPAIN	3109		
SAU - SAUDI ARABIA	2936		
GIB - GIBRALTAR	2799		
ZAF - SOUTH AFRICA	2283		
TUR - TURKEY	1543		
KWT - KUWAIT	1518	2	1.317523
BRA - BRAZIL	1317		
QAT - QATAR	1251		
MAR - MOROCCO	931		
PRT - PORTUGAL	680		
GRC - GREECE	554		
BGR - BULGARIA	455		
MEX - MEXICO	437		
OMN - OMAN	417		
CHL - CHILE	285		
LBN - LEBANON	281		
IRQ - IRAQ	265		

Market Specifics
Speculation on Localisation

- Why only in the ARE and KWT Markets?
- Market demographic of owners
- Relative affluence of these markets compared globally
- Particularly strong local feedback networks within a relatively small community, accelerating awareness of potential issues
- Specific climatic conditions
  > Dust
  > Heat
  > Humidity
  > Solar Load

Timeline

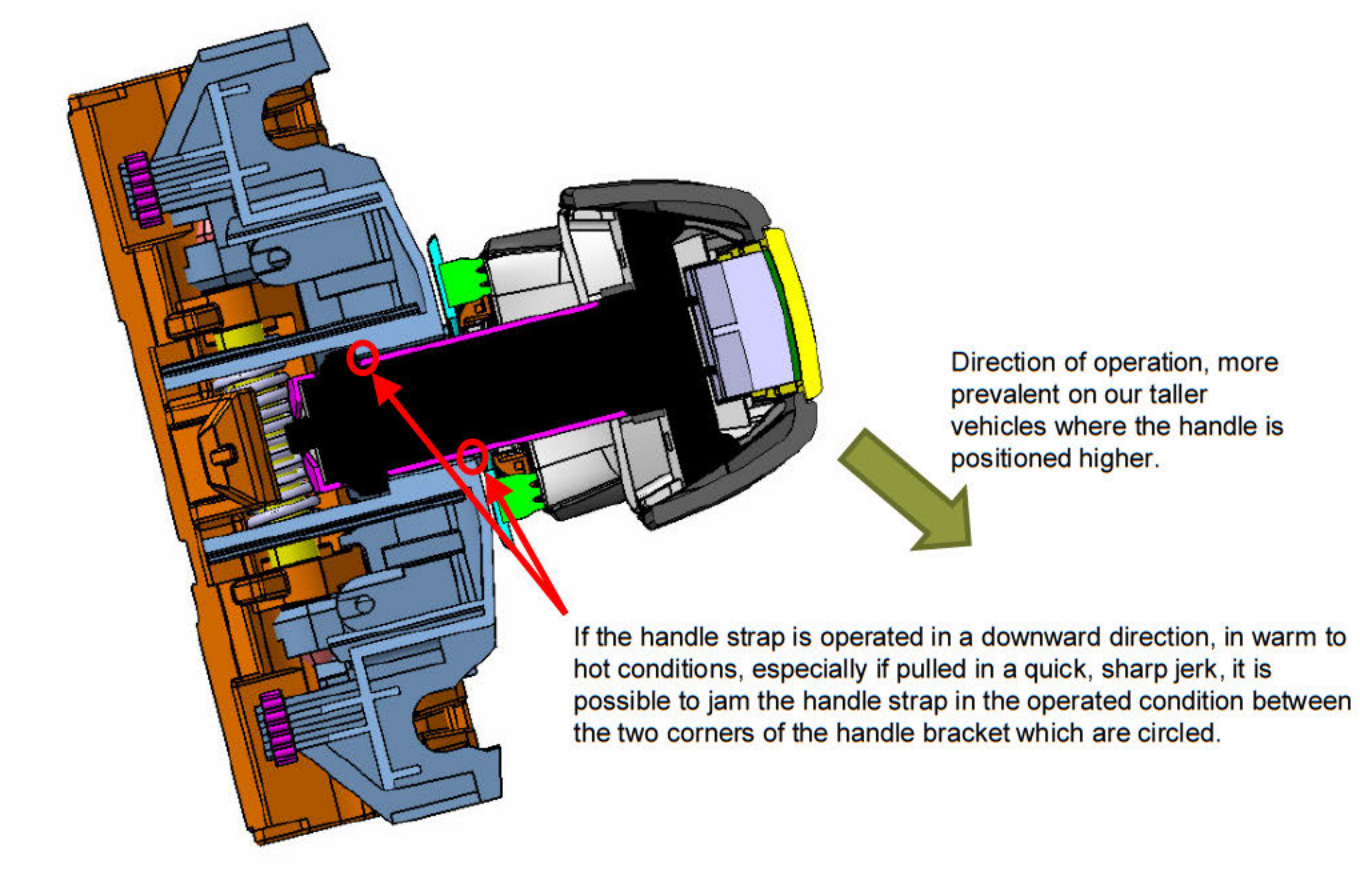

P068 RECALL POPULATION
LATCH OK
LATCH AND RFA OK
2012
2013
2014
2015
2016
2017
"Old" pedigree latch
Handle ears modified
Stronger KV return spring
Greased sinter bearing
Leak path closed
New software in RFA (production)
Modified handle chassis
OUTSIDE OF P068 RECALL POPULATION

Problem Investigation/Verification

Problem Investigation/Verification: Visit to vehicle in Dubai August 2016. Customer reported a door opening post P068, vehicle held for investigation. Vehicle tested by JLR UK Engineer in market and unable to fault the latch. Open circuit condition evident on the vehicle, therefore P068 flash was a success. Vehicle in workshop, ambient temp circa 25°c. Unable to jam the handle in the workshop. Placed vehicle onto roof, high solar load, ambient temp 48°c. Soaked vehicle for two hours, and then able to jam three of the four handles on the vehicle on the first attempt.

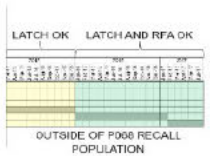
Root Cause Hypothesis

Exterior release handle jammed in the actuated position due to diametrically opposing contact points, increasing friction to the point where the counter balance spring cannot return the handle to rest position.

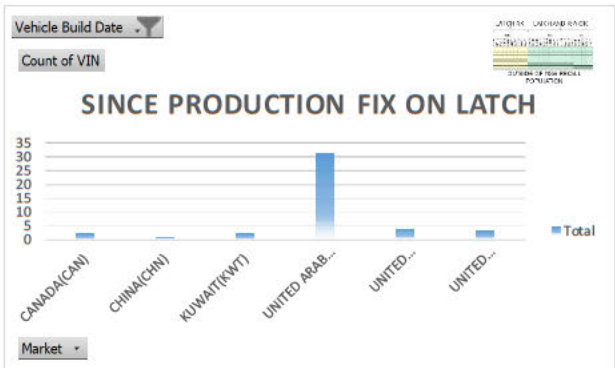


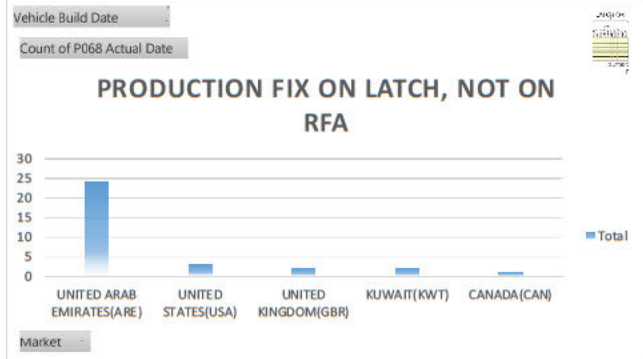
Please add attachments to support the root cause here:

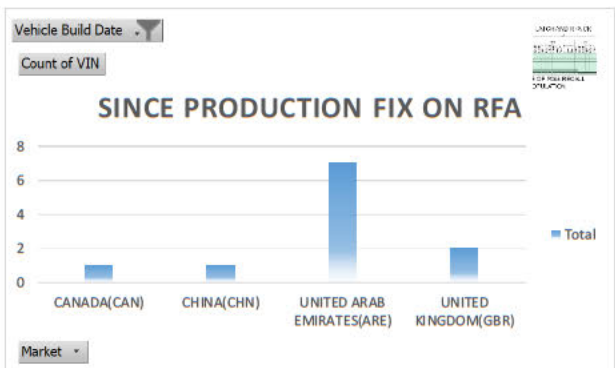
Critical Concern Analysis
Failures Since Production Fixes



Considering the timeline, the parts we examine on this slide are outside of the recall population, therefore the latch is the latest level, but there is a population of vehicles without the RFA fix, and a subsequent population with both the latest latch and the latest RFA

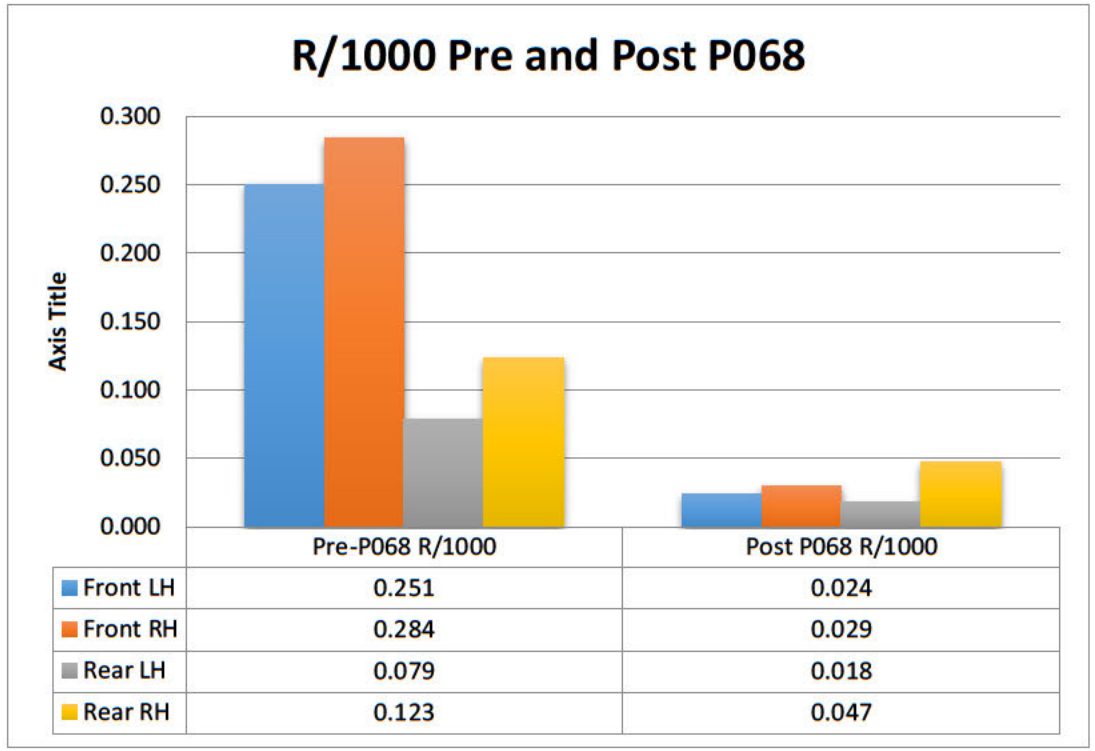






Sum of Vehicles	Sold/Unsold	
Country Sold	Sold	Grand Total
ITA - ITALY	5048	5048
AUS - AUSTRALIA	3585	3585
ARE - UNITED ARAB EMIRIATES	3238	3238
GIB - GIBRALTAR	2361	2361
ESP - SPAIN	2122	2122
SAU - SAUDI ARABIA	1606	1606
TUR - TURKEY	981	981
MAR - MOROCCO	568	568
KWT - KUWAIT	560	560
GRC - GREECE	309	309
MEX - MEXICO	192	192
JOR - JORDAN	191	191
QAT - QATAR	158	158
LBN - LEBANON	143	143
CYP - CYPRUS	131	131
OMN - OMAN	121	121
MLT - MALTA	105	105
BHR - BAHRAIN	105	105
CRI - COSTA RICA	100	100
IND - INDIA	98	98
IRQ - IRAQ	57	57
TUN - TUNISIA	54	54
EGY - EGYPT	49	49
MKD - MACEDONIA	43	43
CIV - COTE D'IVOIRE	28	28
SEN - SENEGAL	21	21
ARG - ARGENTINA	16	16
KEN - KENYA	13	13
PAK - PAKISTAN	10	10
LKA - SRI LANKA	7	7
NGA - NIGERIA	6	6
GHA - GHANA	5	5
BRN - BRUNEI DARUSSALAM	5	5
TZA - TANZANIA	2	2
ECU - ECUADOR	1	1
Grand Total	22039	22039

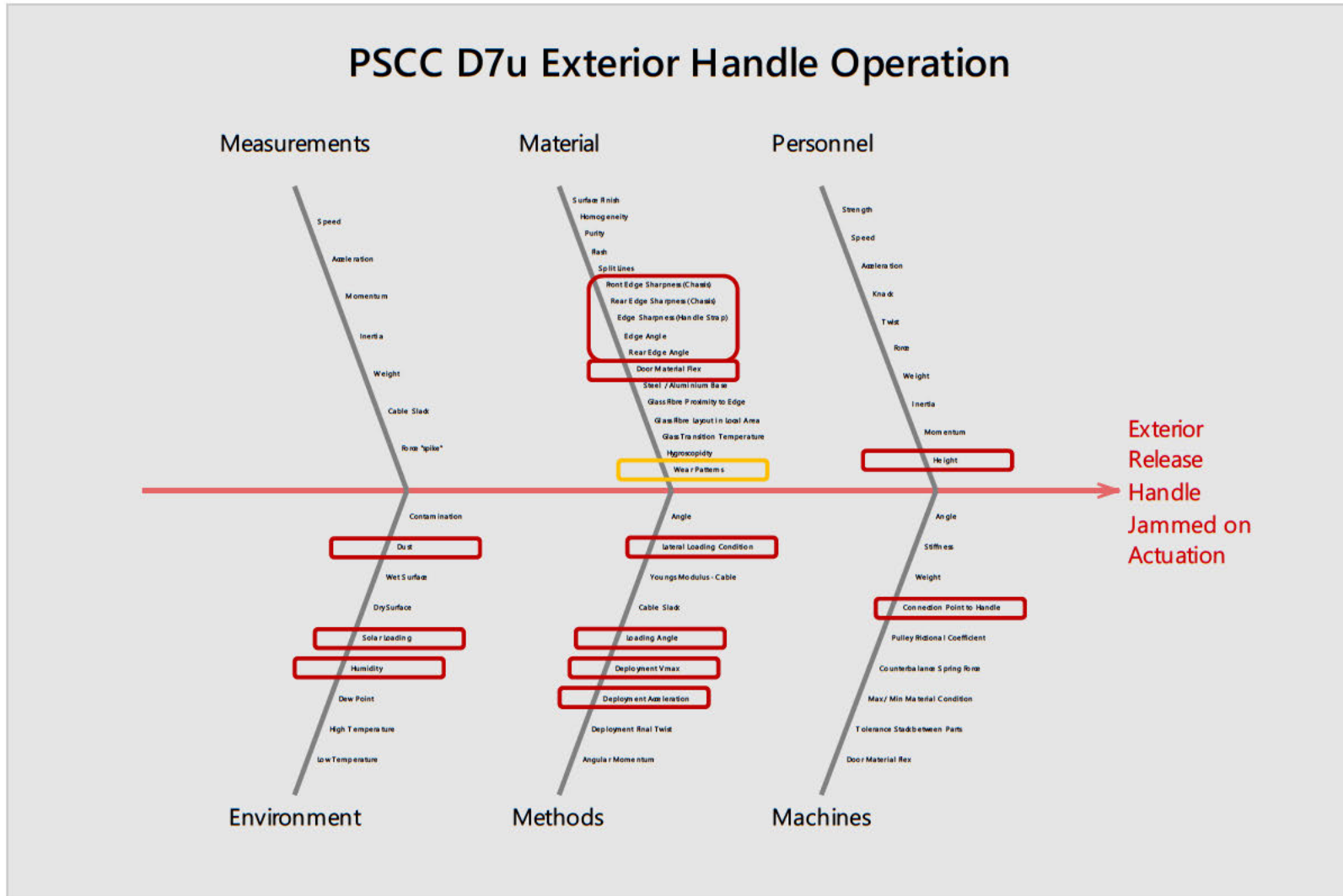
Normalised Data



- Once the data was normalised, an order of magnitude can be seen on front doors pre/post P068
- The same cannot be said of the rear doors, where the improvement has not been as significant

		Before		After
	Failures	Pre-P068 R/1000	Failures	Post P068 R/1000
Front LH	67	0.251	8.000	0.024
Front RH	76	0.284	10.000	0.029
Rear LH	21	0.079	6.000	0.018
Rear RH	33	0.123	16.000	0.047

Root Cause Analysis
Ishikawa / Cause and Effect



Root Cause Analysis
Measurement Methodology

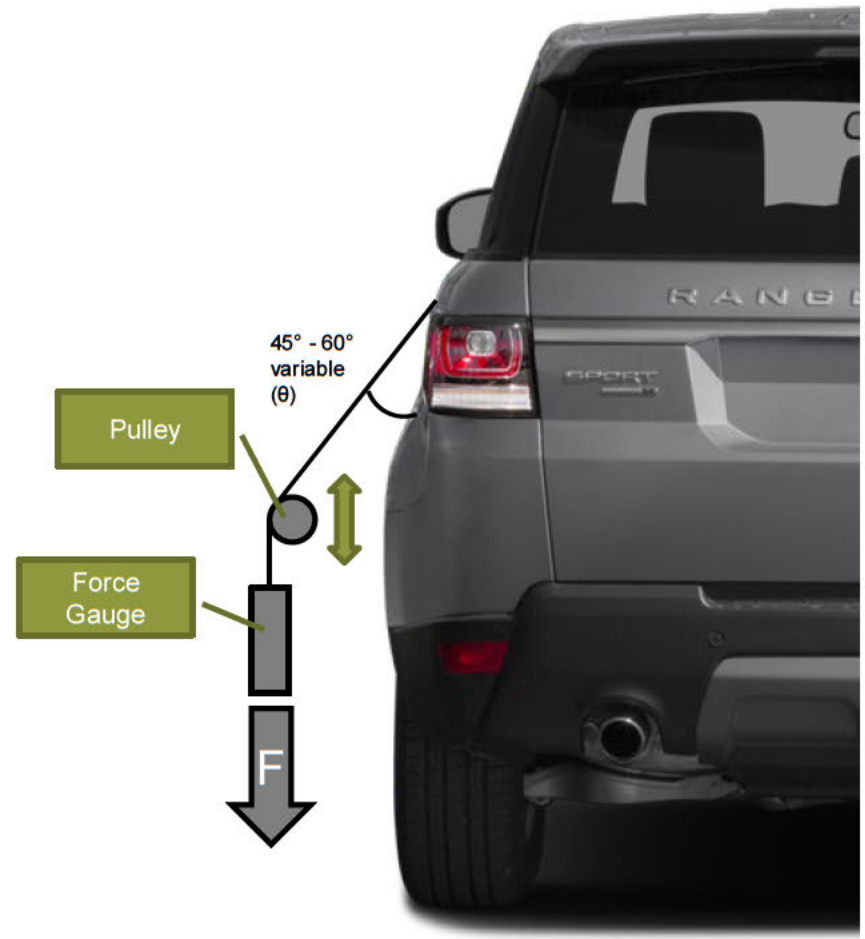
Steel cable attached to the vehicle exterior release handle

Cable then runs around a pulley that can be varied in height relative to the door

The variance in height allows for angle adjustments from 45° to 60°

Force gauge used to measure force – force applied directly downwards

Resolution of actual force = Fsinθ



Root Cause Analysis
Operational Definition

Measurements indicate jamming is hard to achieve at under 200N

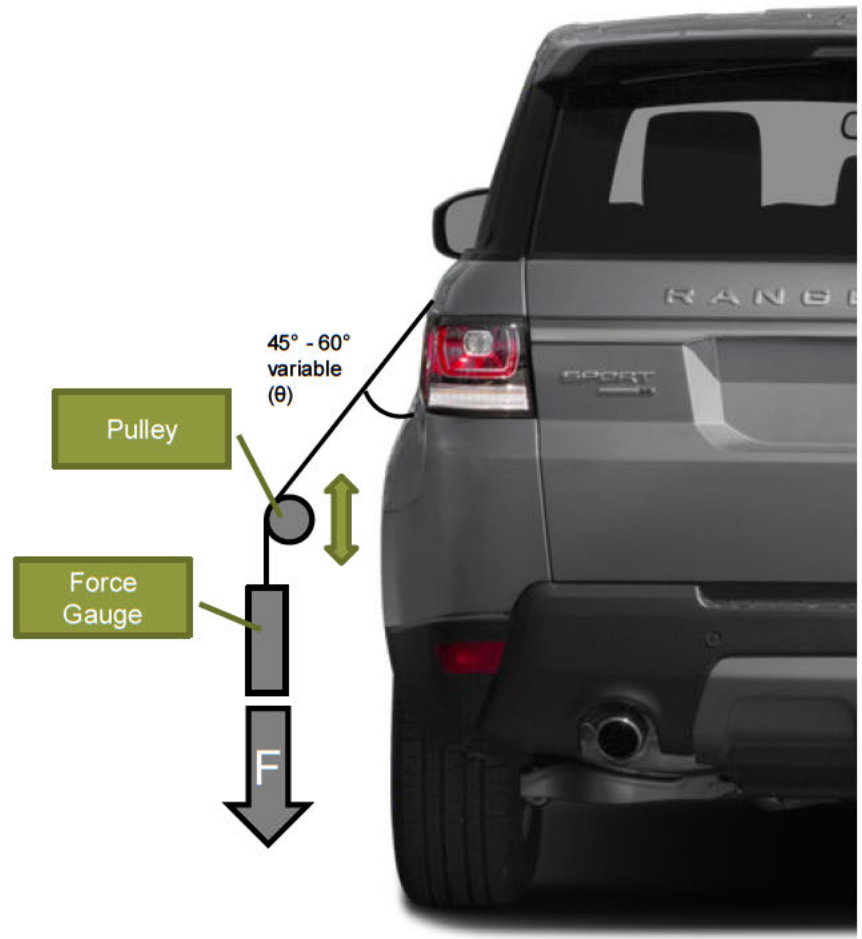
Beginning at 200N, operate the rig and release

Check for jammed handle condition

If handle doesn't jam, repeat operation with additional 10N increments

Repeat until handle jams

Record the result of the lowest force required to jam the handle

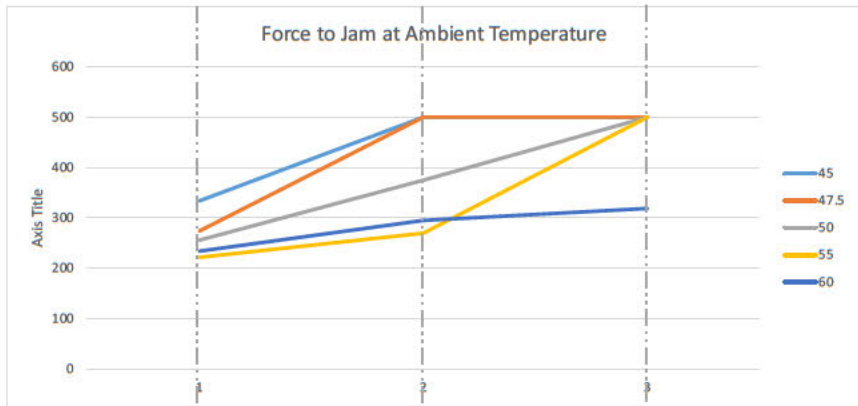


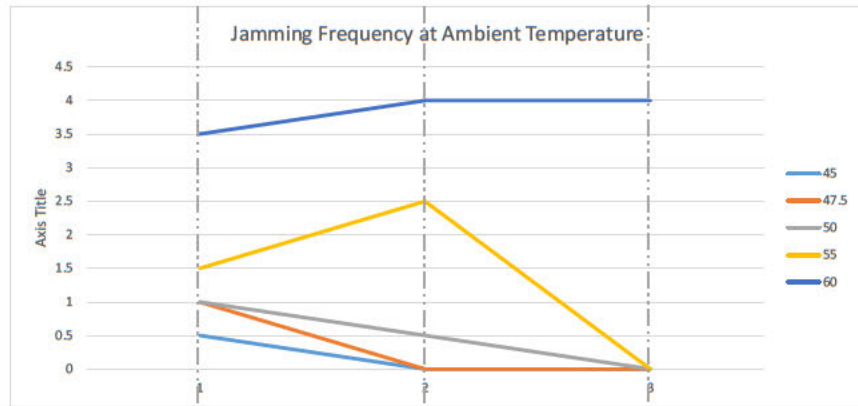
Root Cause Analysis
Test Plan (KLT and Wear Out)

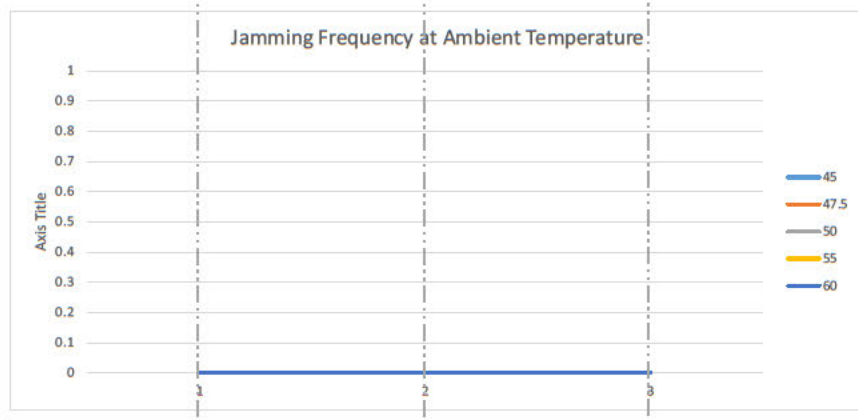
- Perform three temperature tests – ambient (20°c), high ambient (50°c), and high ambient + high solar load (80°c)
- Conduct 21,000 cycle durability with slight lateral loading condition
- Repeat the baseline tests at the three temperature ranges
- Conduct a further 21,000 cycle durability with slight lateral loading
- Repeat the baseline tests one final time

- *The results will tell us if the likelihood of failure increases or decreases with time and customer use*
- *NB; Glass Transition Temperature (T_g) of PA66 GF30 (handle chassis material) is 80*°c – POM (handle strap material) is always used above the T_g as this is -50°c to -30 °c

Root Cause Analysis
KLT Results - Ambient



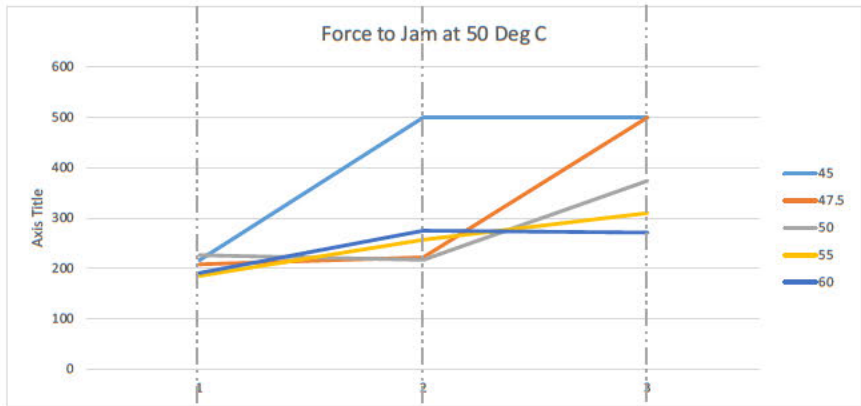


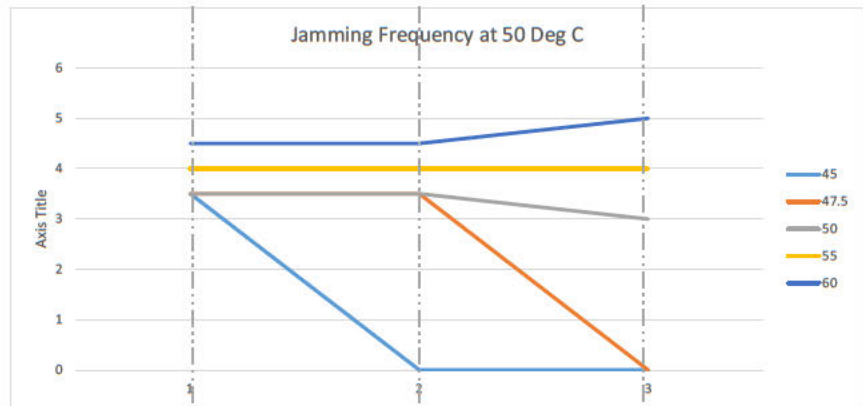


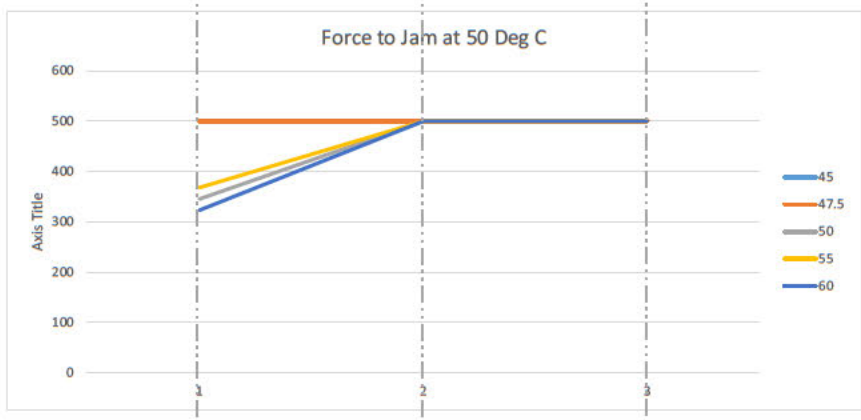
0 Cycles 21k Cycles 42k Cycles

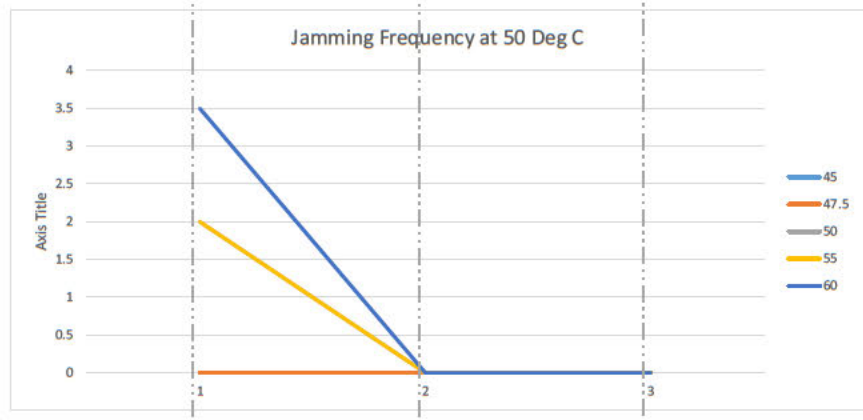
0 Cycles 21k Cycles 42k Cycles

Root Cause Analysis
KLT Results - 50°c





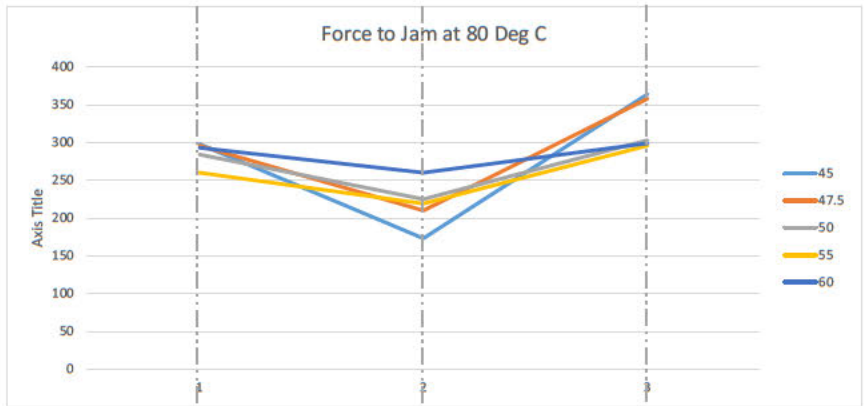


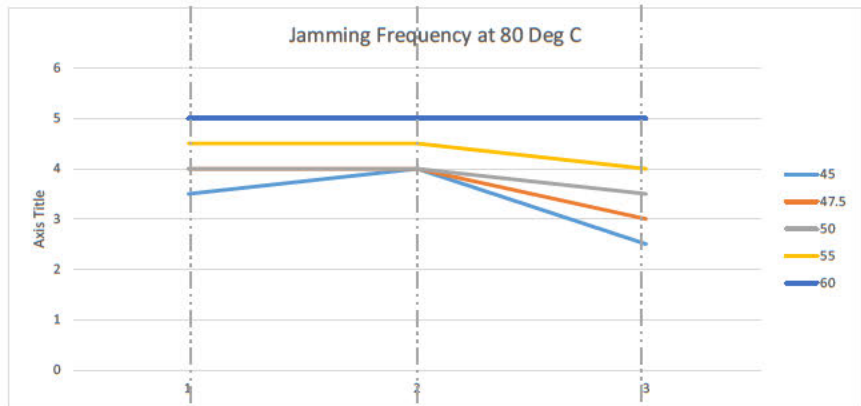


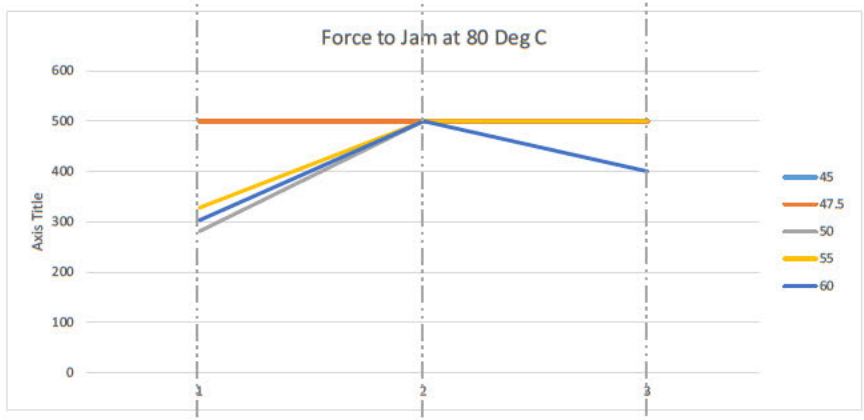
0 Cycles 21k Cycles 42k Cycles

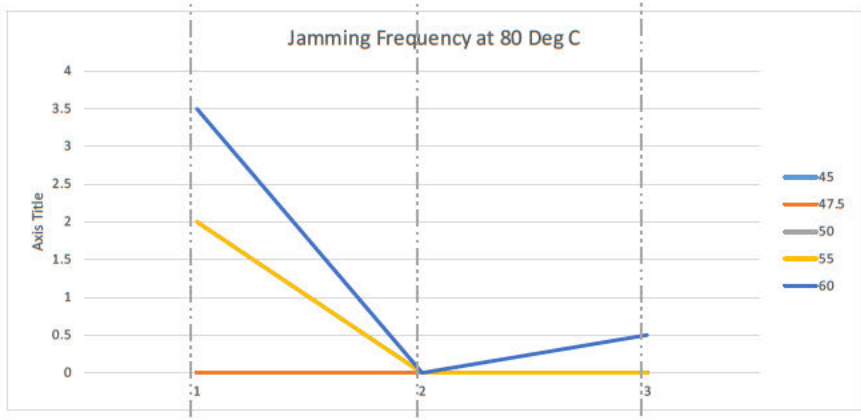
0 Cycles 21k Cycles 42k Cycles

Root Cause Analysis
KLT Results - 80°c





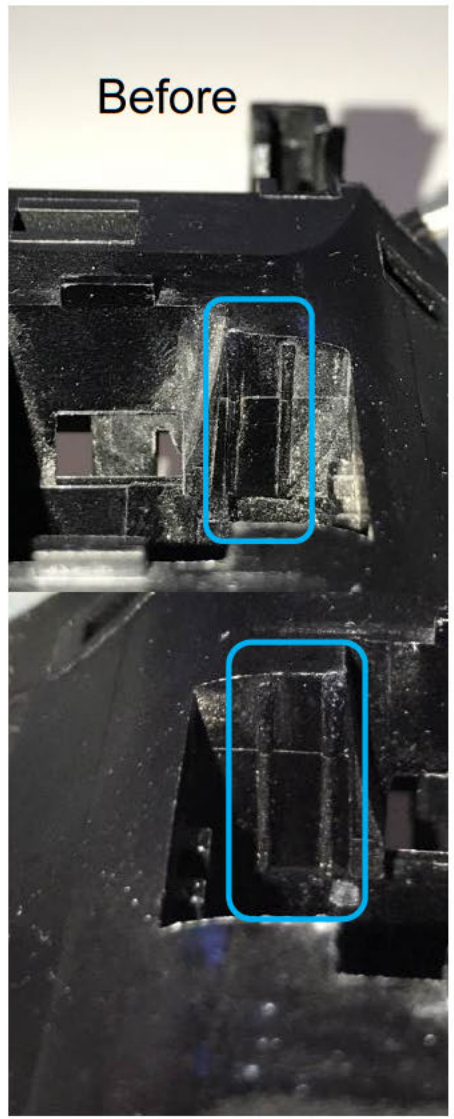




0 Cycles 21k Cycles 42k Cycles

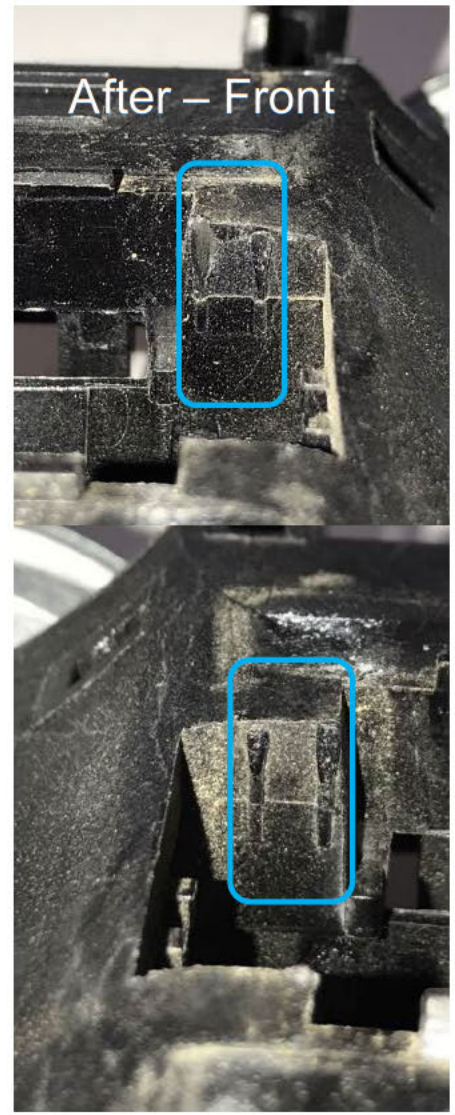
0 Cycles 21k Cycles 42k Cycles

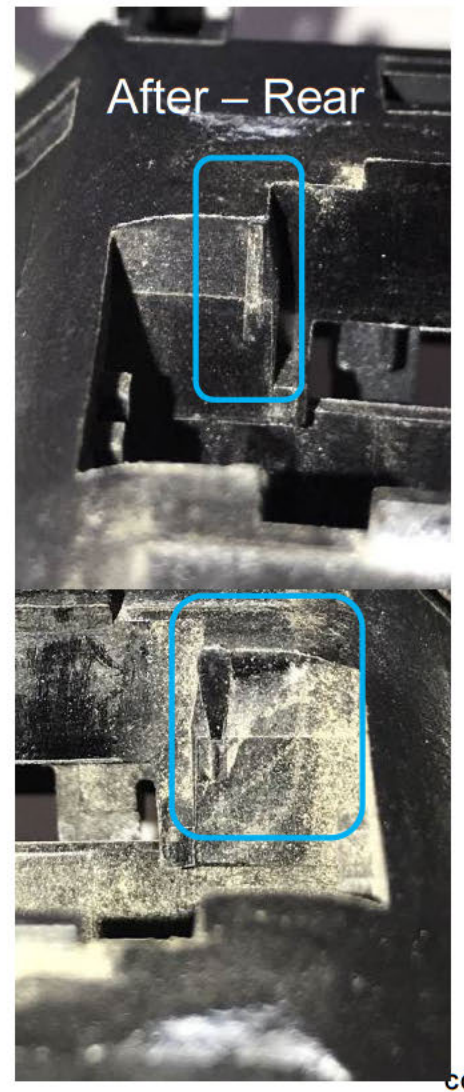
Root Cause Analysis
KLT Results – Part Comparison



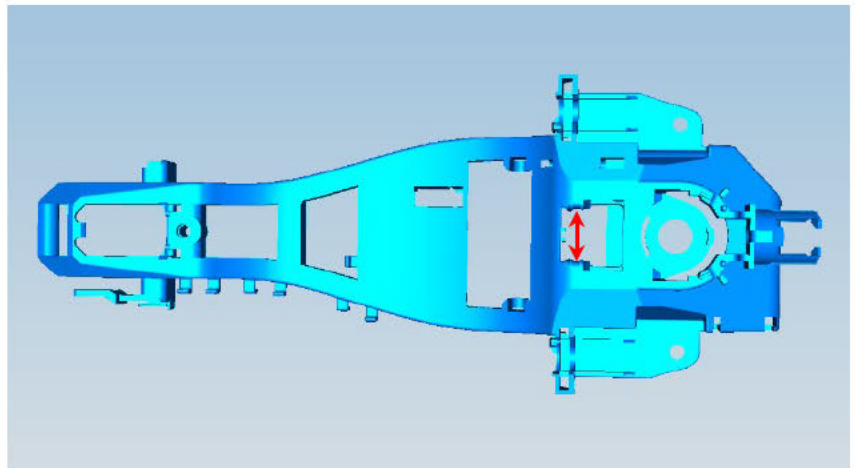
Upper Face

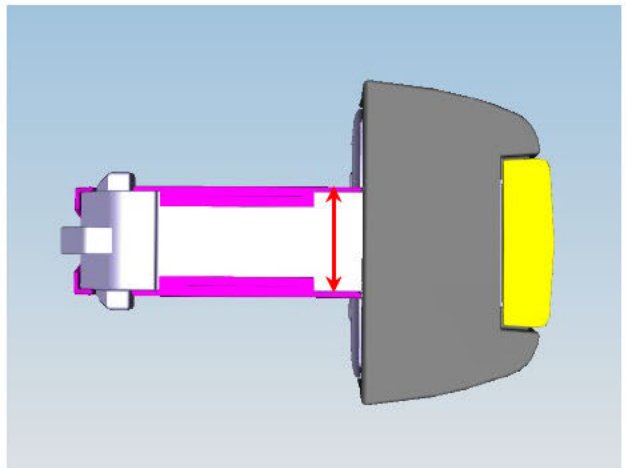
Lower Face





Root Cause Analysis
Material Behaviour Characteristics





PA66 GF30 is hygroscopic. In taking water on the part swells. Coupled with thermal expansion / contraction this may give rise to significant dimensional differences.

Study commissioned on various temperature and humidity levels with measurements being taken across the run channel in the handle chassis, and across the POM runner on the handle strap inner

Root Cause Analysis
Material Behaviour Characteristics

Initial conditions									
	l1	l2	l3	w		l1	l2	l3	w
A1	17.79	16.30	19.85	140.90	C1	18.55	17.48	16.82	271.60
	17.71	16.25	19.88	141.10		18.41	17.50	16.81	271.60
	17.81	16.33	19.84	140.80		18.49	17.49	16.84	271.50
	17.76	16.30	19.84	140.80		18.49	17.50	16.83	271.60
	17.70	16.28	19.82	140.90		18.43	17.50	16.81	271.60
Average	17.75	16.29	19.85	140.90	Average	18.47	17.49	16.82	271.58
A2	17.69	16.30	19.94	123.90	C2	18.46	17.44	16.79	264.60
	17.72	16.30	19.95	124.10		18.49	17.45	16.85	264.60
	17.69	16.31	19.94	124.00		18.47	17.46	16.84	264.70
	17.73	16.29	19.94	124.10		18.47	17.47	16.80	264.70
	17.71	16.28	19.96	123.80		18.46	17.47	16.80	264.70
Average	17.71	16.30	19.95	123.98	Average	18.47	17.46	16.82	264.66
A3	17.65	16.31	19.95	123.50	C3	18.53	17.50	16.85	264.80
	17.64	16.27	19.86	123.30		18.47	17.48	16.82	264.80
	17.66	16.28	19.88	123.30		18.46	17.50	16.85	265.20
	17.68	16.28	19.89	123.50		18.51	17.50	16.84	264.90
	17.65	16.26	19.86	123.60		18.48	17.49	16.81	264.90
Average	17.66	16.28	19.89	123.44	Average	18.49	17.49	16.83	264.92

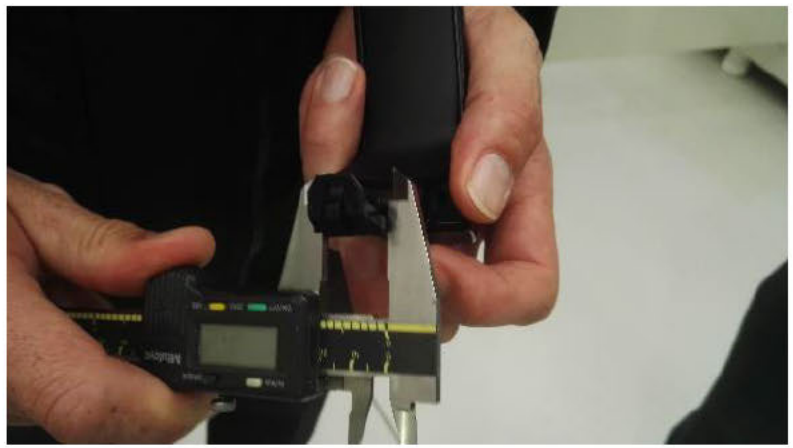
A baseline series of measurements was taken and this is used as the “control” sample. The parts were then stored at various temperatures and humidity, then measured.

The maximum deviation from the control sample was 0.57% growth

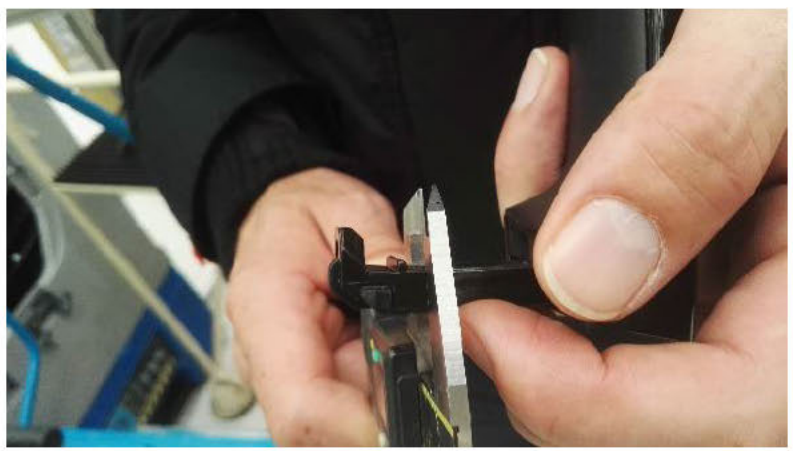
	l1	l2	l3	w		l1	l2	l3	w	Time Checked
A1	50 deg - 12% humidity				C1	50 deg - 12% humidity				09/08/2017 15:40
	17.74	16.33	19.96	140.80		18.56	17.51	16.81	271.30	
%	99.92	100.23	100.57	99.93	%	100.47	100.09	99.93	99.90	
A1	50 deg - 100% humidity				C1	50 deg - 100% humidity				10/08/2017 07:30
	17.81	16.38	19.91	141.50		18.58	17.51	16.86	272.60	
%	100.32	100.54	100.32	100.43	%	100.57	100.09	100.23	100.38	
A2	50 deg - 100% humidity									10/08/2017 07:30
	17.69	16.26	19.92							
%	99.90	99.78	99.87							

Root Cause Analysis
Material Behaviour Characteristics

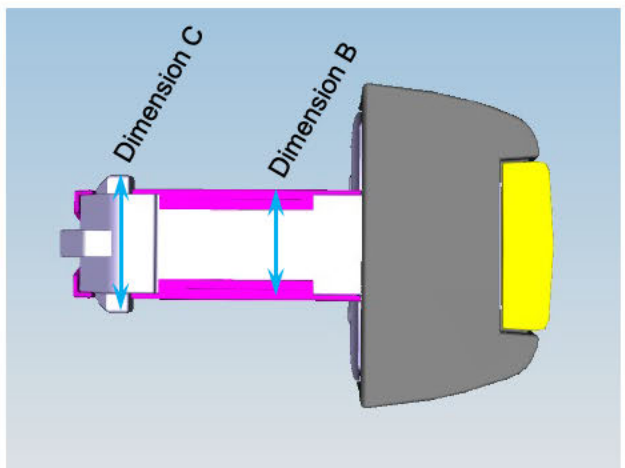
A Length 1



A Length 3

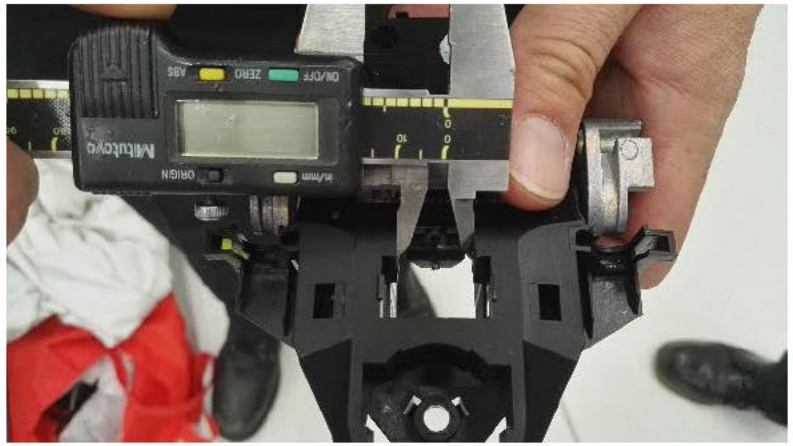


A Length 2



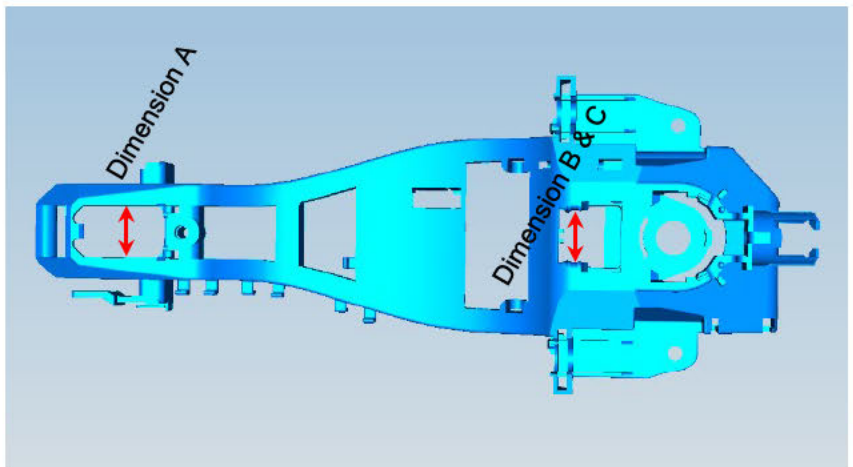
Root Cause Analysis
Material Behaviour Characteristics

C Length 1

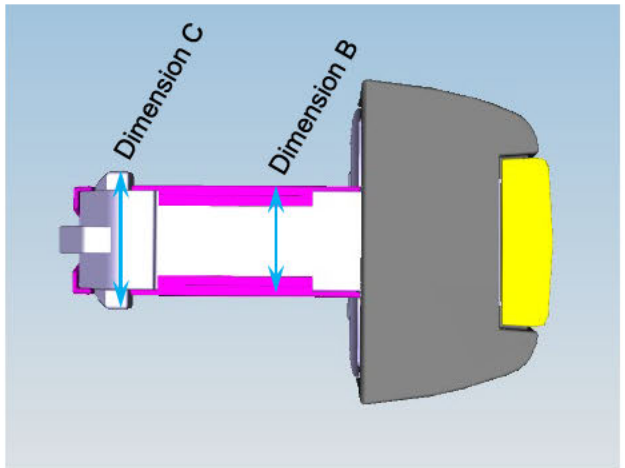


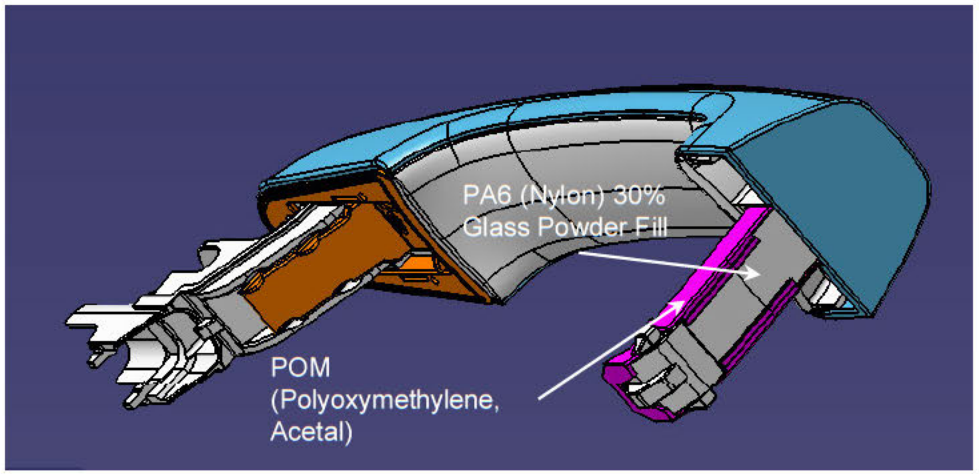
C Length 3

C Length 2

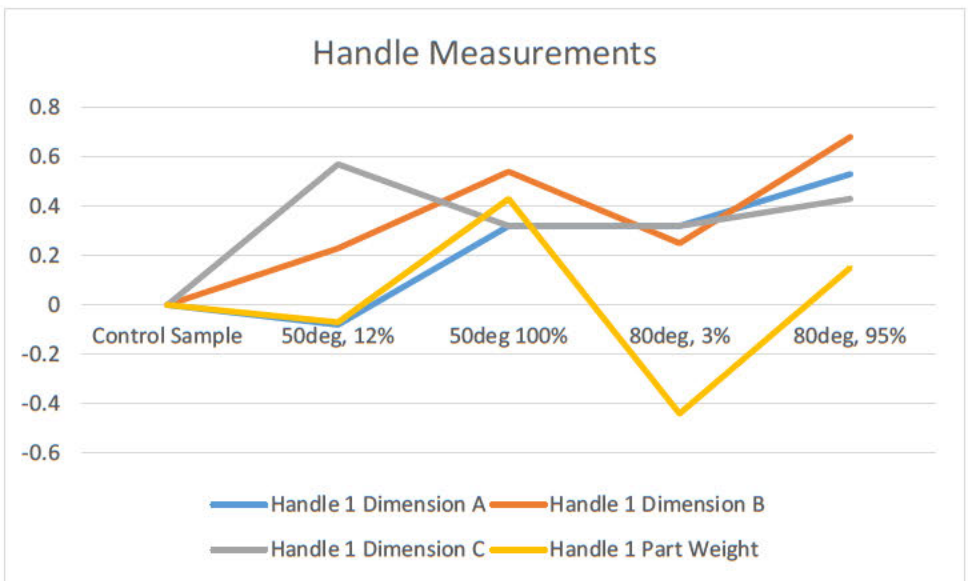


Handle Measurement
Effect of Heat and Humidity

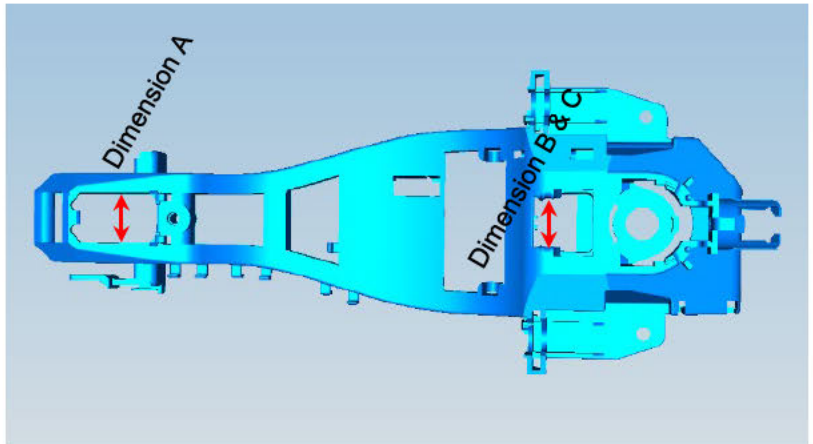


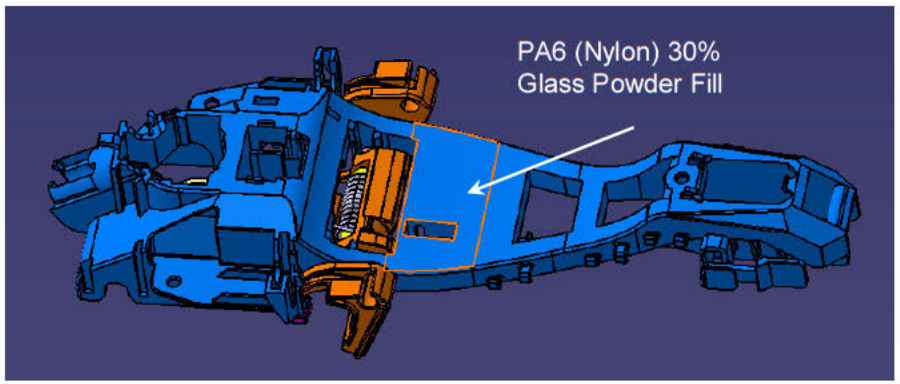


PA6 is hygroscopic, Acetal is not
Control sample is reference (0)
Graph is % deviation from control
All dimensions are external
Maximum deviation is 0.7%
Part has tendency to grow with both heat and humidity

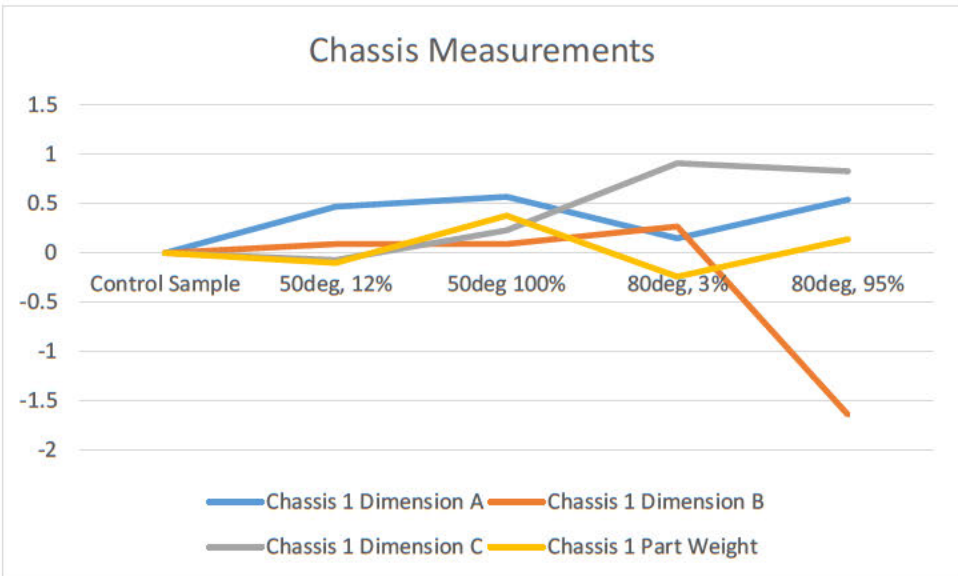


Chassis Measurement
Effect of Heat and Humidity





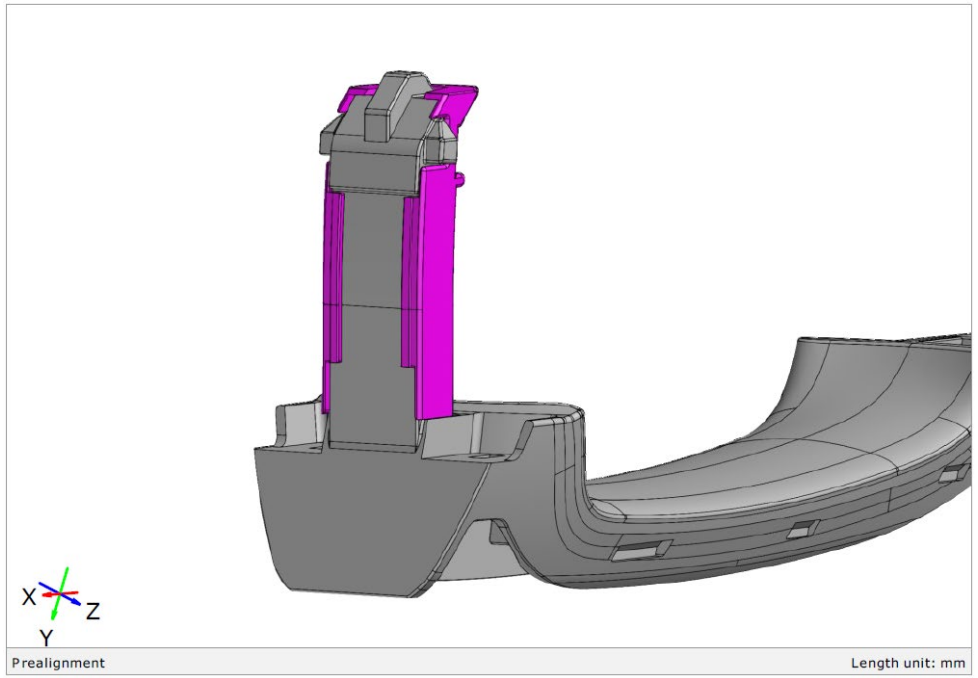
PA6 is hygroscopic
Control sample is reference (0)
Graph is % deviation from control
All dimensions are internal
Maximum deviation is 1.64% - possible outlier. Next max 0.91%
Despite measures being internal, data indicates that the dimensions also grow with heat and humidity

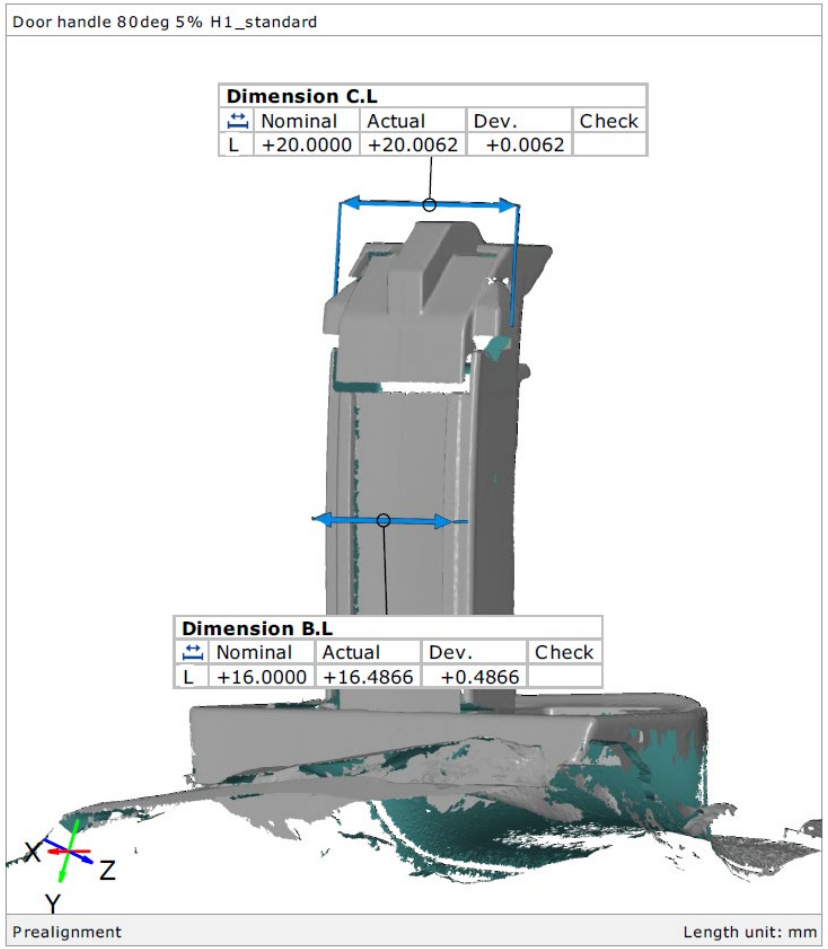


Measurement Study 2
Effect of Heat and Humidity

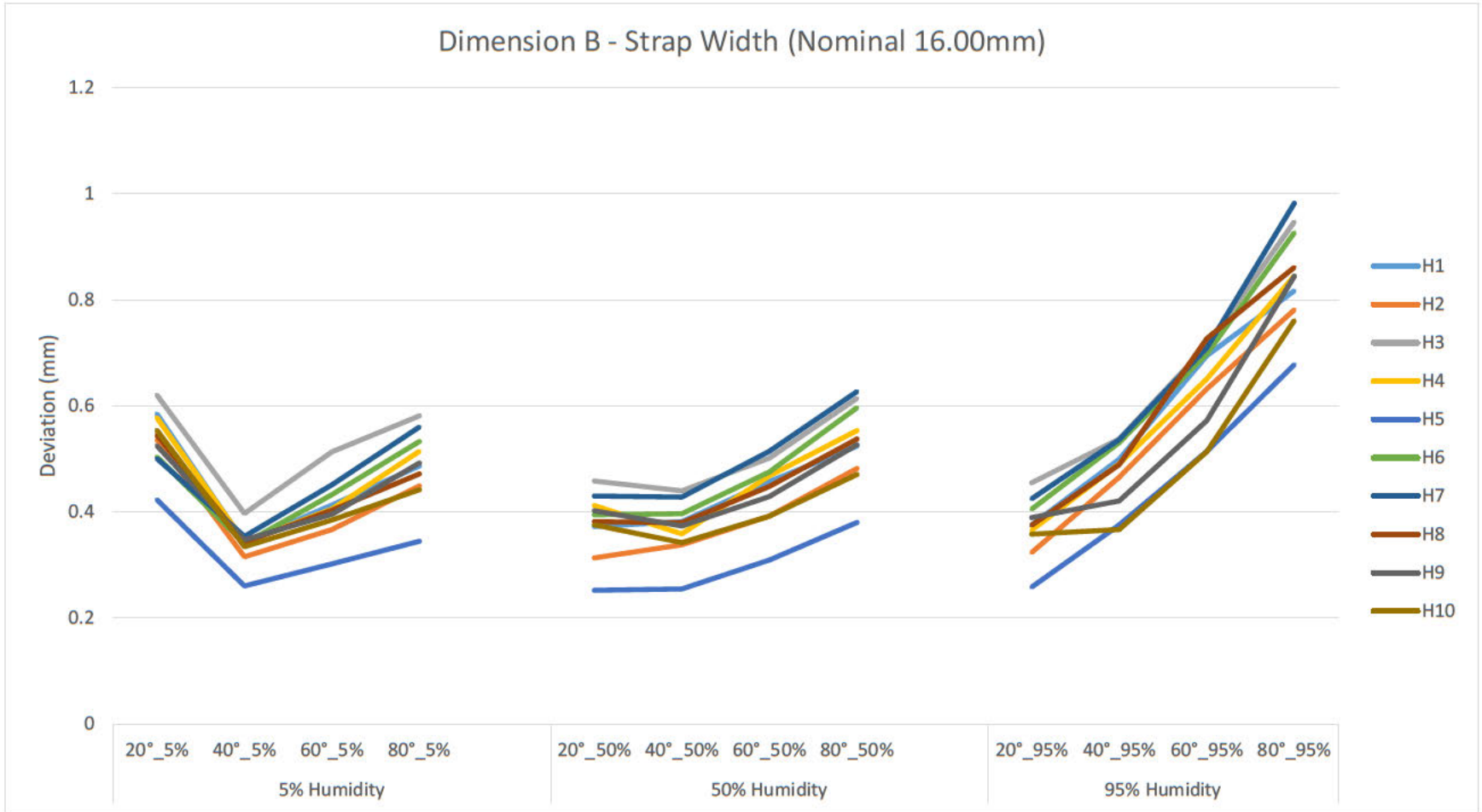
- Previous study did not have the “resolution” required
- Study also had some outliers that were considered to be skewing the data
- New study commissioned using optical scanning equipment
- 10-off handles and 10-off chassis tested
- Test process as follows:
- 5% relative humidity, soak for 6 hours at 20°c, measure, then repeat at 40°c, 60°c, and 80°c
- 50% relative humidity, soak for 6 hours at 20°c, measure, then repeat at 40°c, 60°c, and 80°c
- 95% relative humidity, soak for 6 hours at 20°c, measure, then repeat at 40°c, 60°c, and 80°c

Handle Measurement
Effect of Heat and Humidity

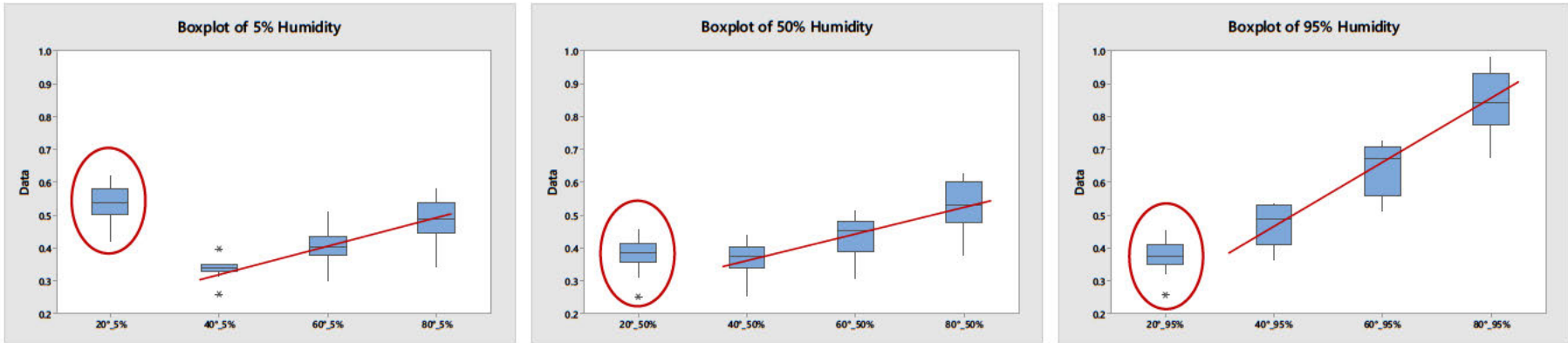




Handle Measurement
Effect of Heat and Humidity



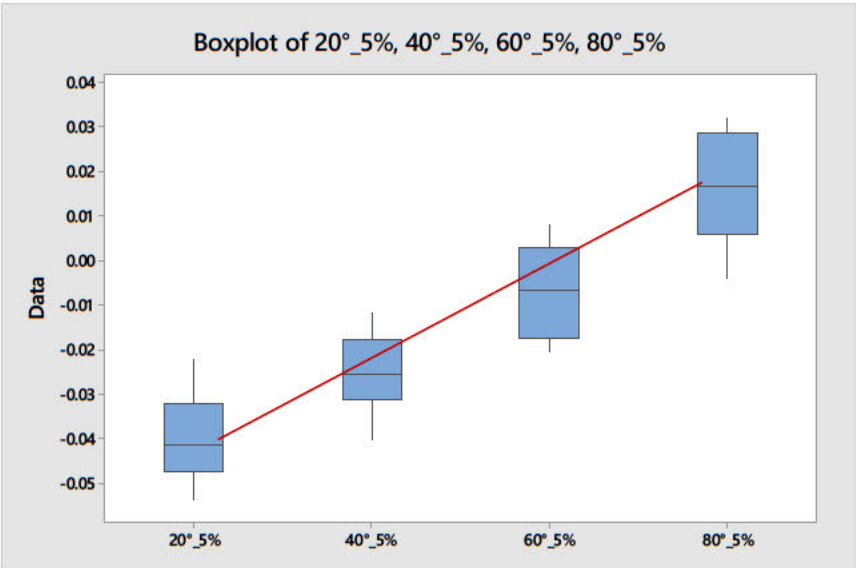
Handle Measurement
Effect of Heat and Humidity

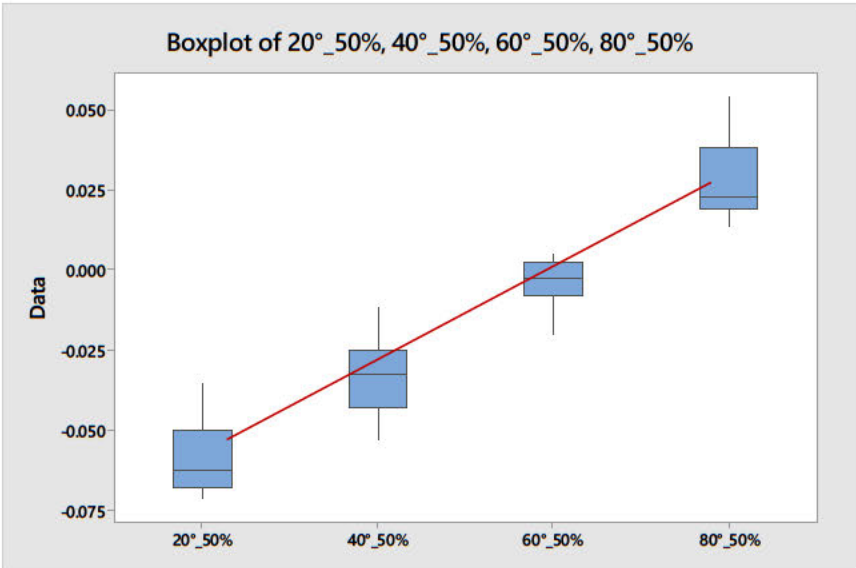


- Boxplots indicate that there is a trend for the handle to grow with temperature
- First boxplot (20 degrees) in both charts doesn't fit with the pattern
- From 40 degrees there is a steady and consistent growth
- The fact that 20 degrees doesn't fit is most likely because the POM sleeve has a minimum size – PA6 isn't being directly measured

Handle Measurement
Effect of Heat and Humidity

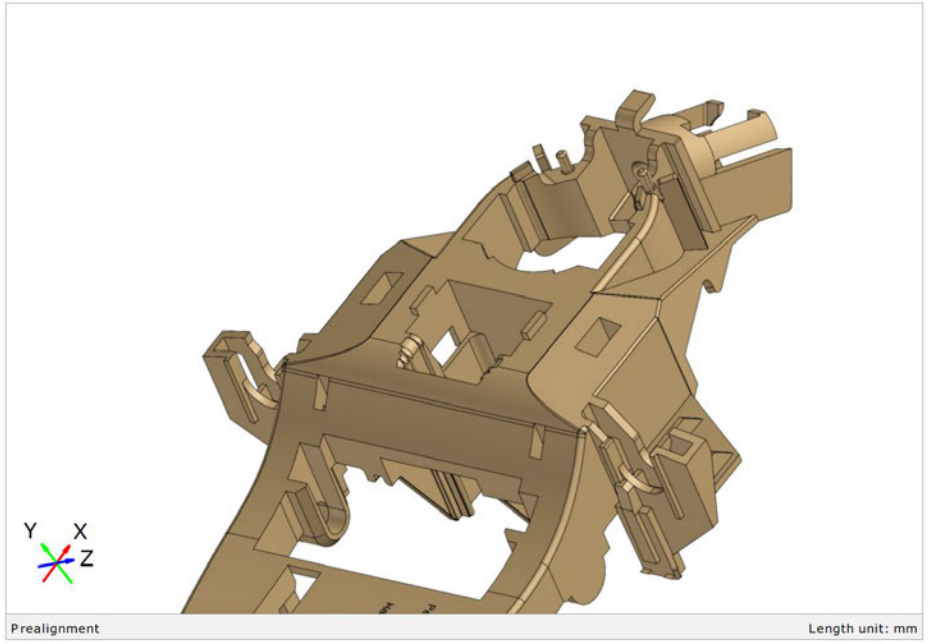
Handle Measurement
Effect of Heat and Humidity

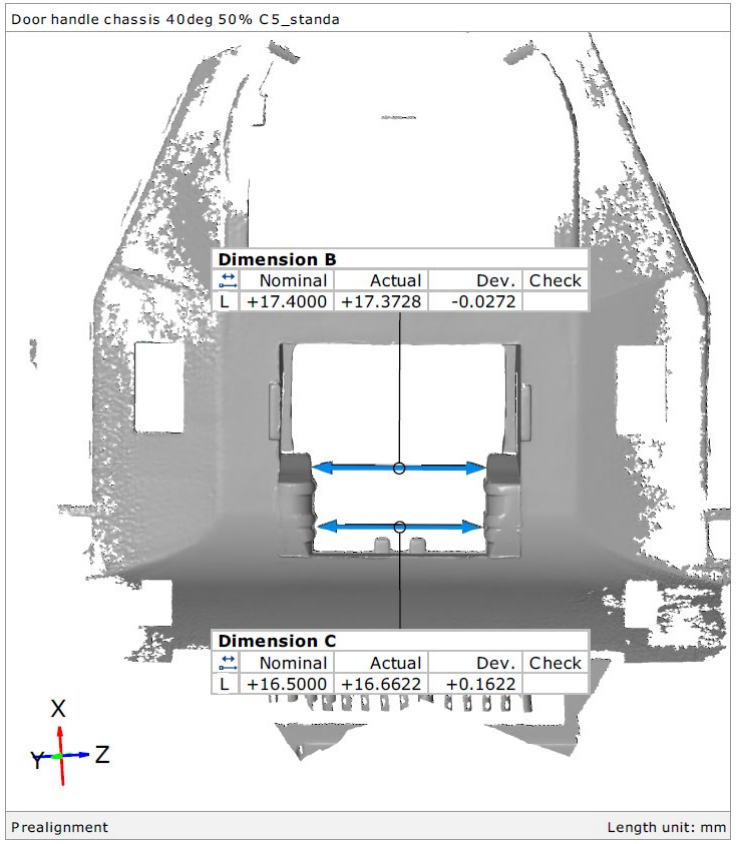




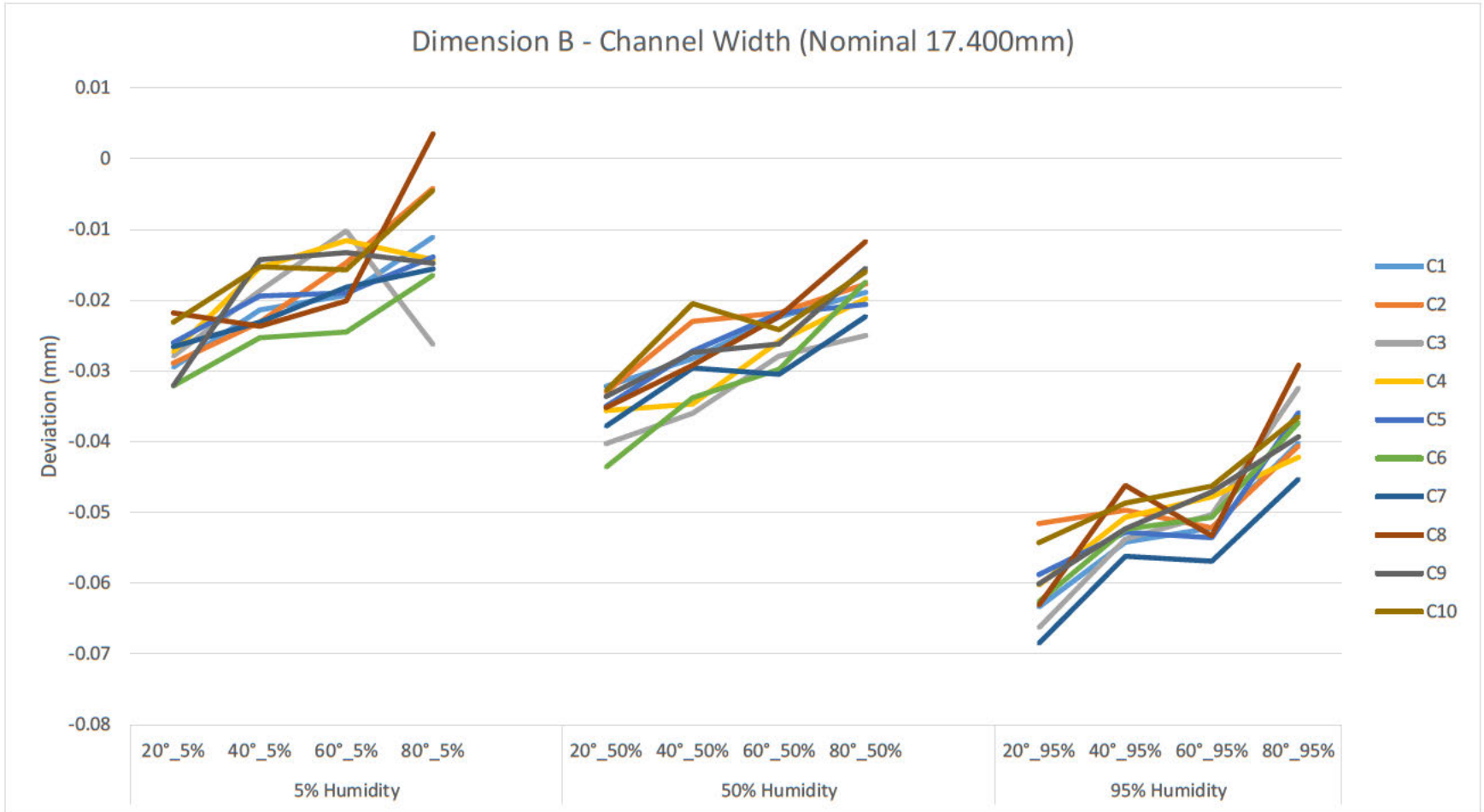
- As previous smooth rate of change observed, steady increase in size with temperature
- PA6 being directly measured, no POM sleeve
- Material behaves as expected

Chassis Measurement
Effect of Heat and Humidity

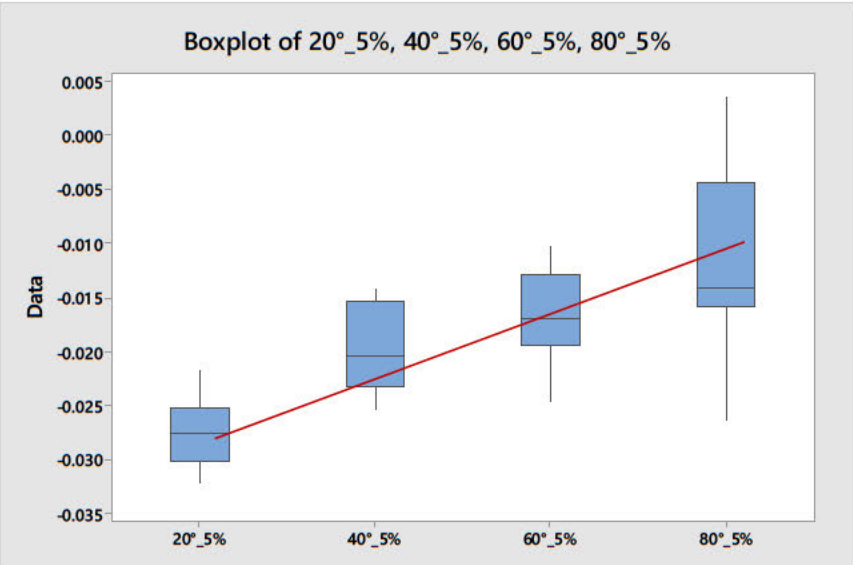


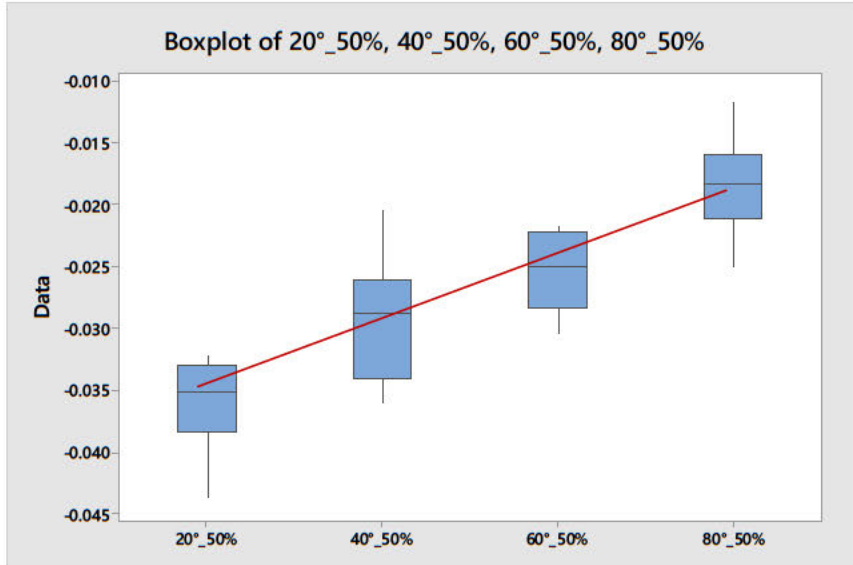


Chassis Measurement
Effect of Heat and Humidity



Chassis Measurement
Effect of Heat and Humidity

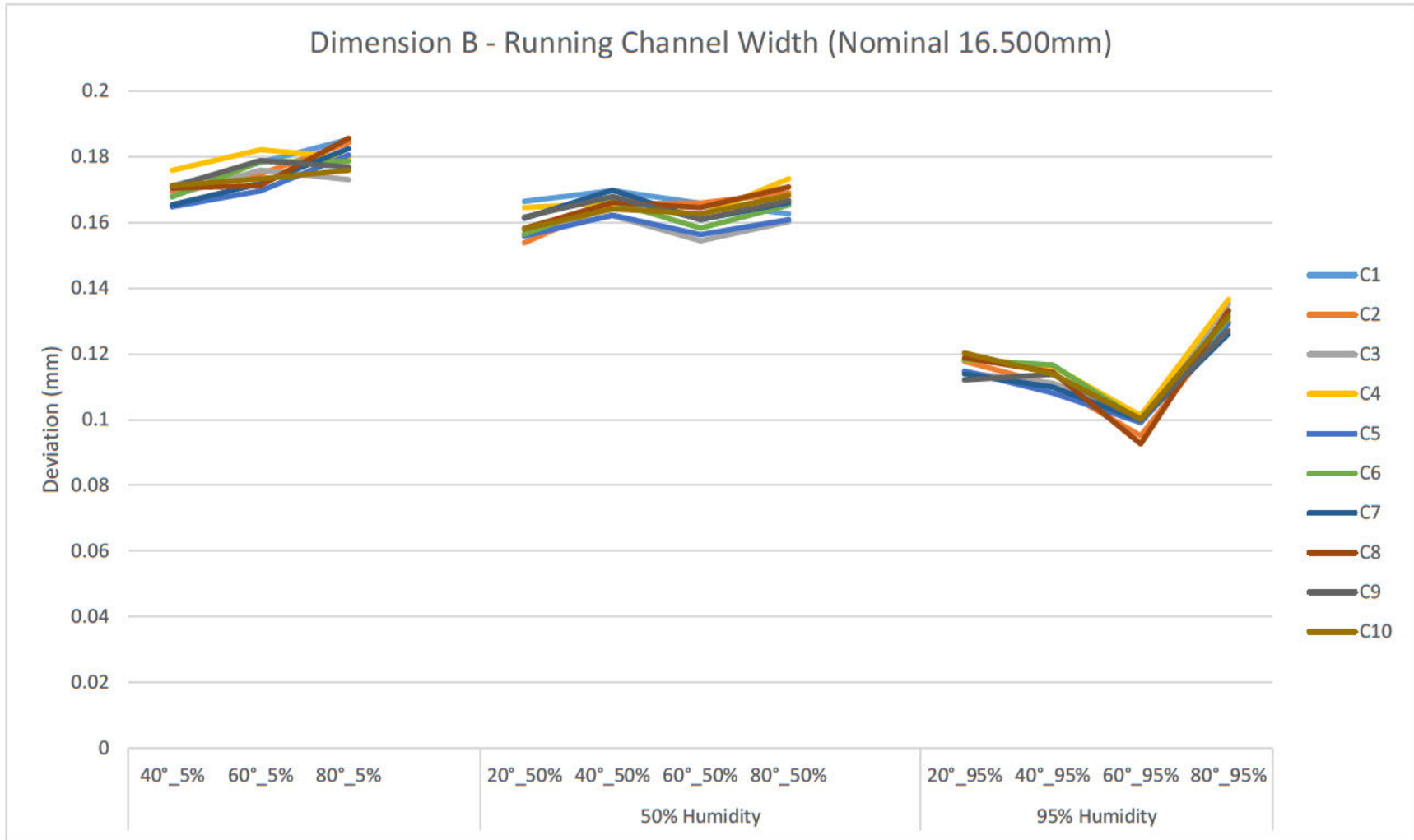




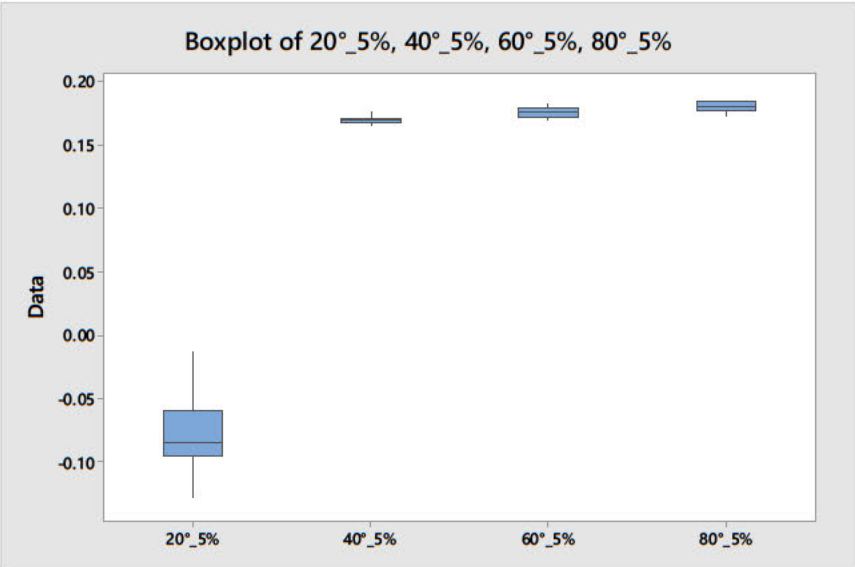
- As previous smooth rate of change observed, steady increase in size with temperature
- PA6 being directly measured, no POM sleeve
- Material behaves as expected
- → As handle strap width increases, so does aperture in chassis in which it sits

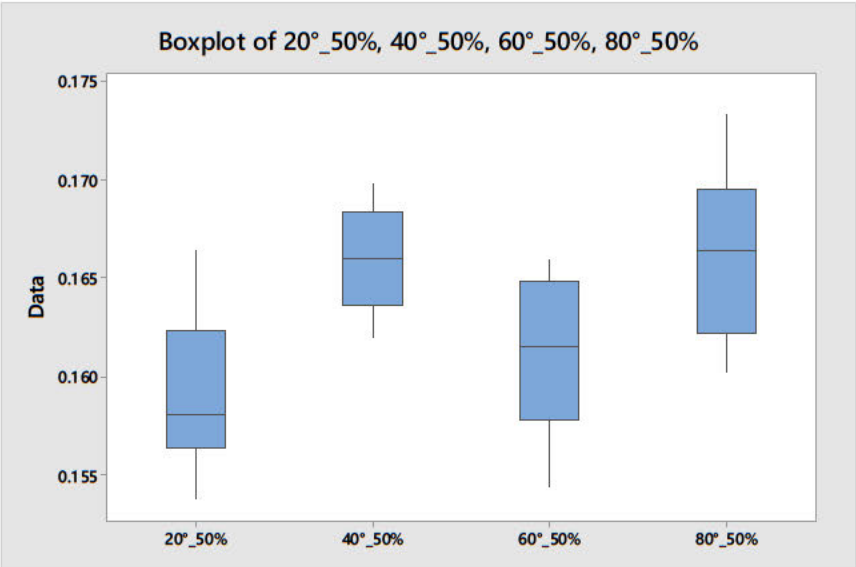
Chassis Measurement
Effect of Heat and Humidity

Chassis Measurement
Effect of Heat and Humidity



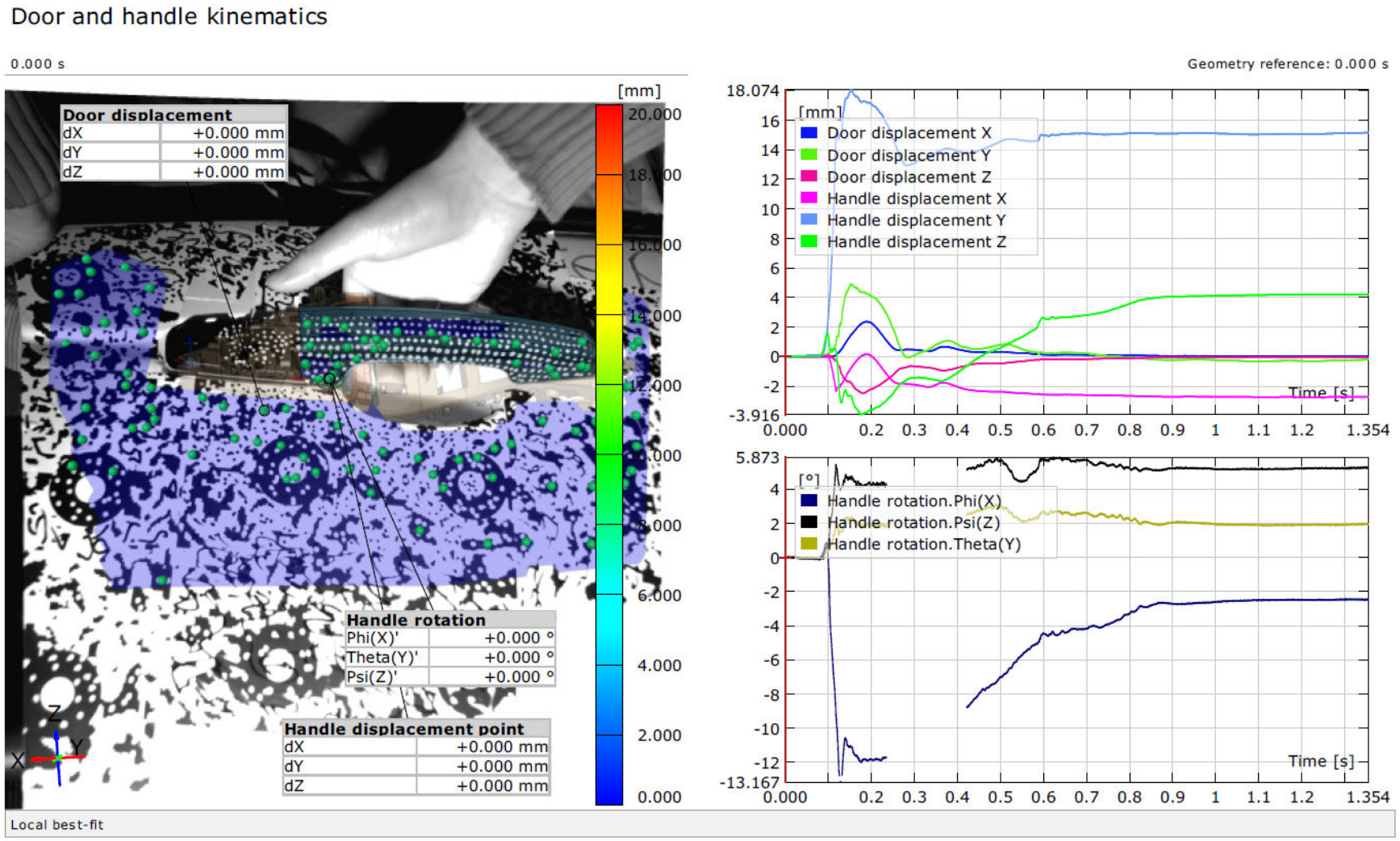
Chassis Measurement
Effect of Heat and Humidity





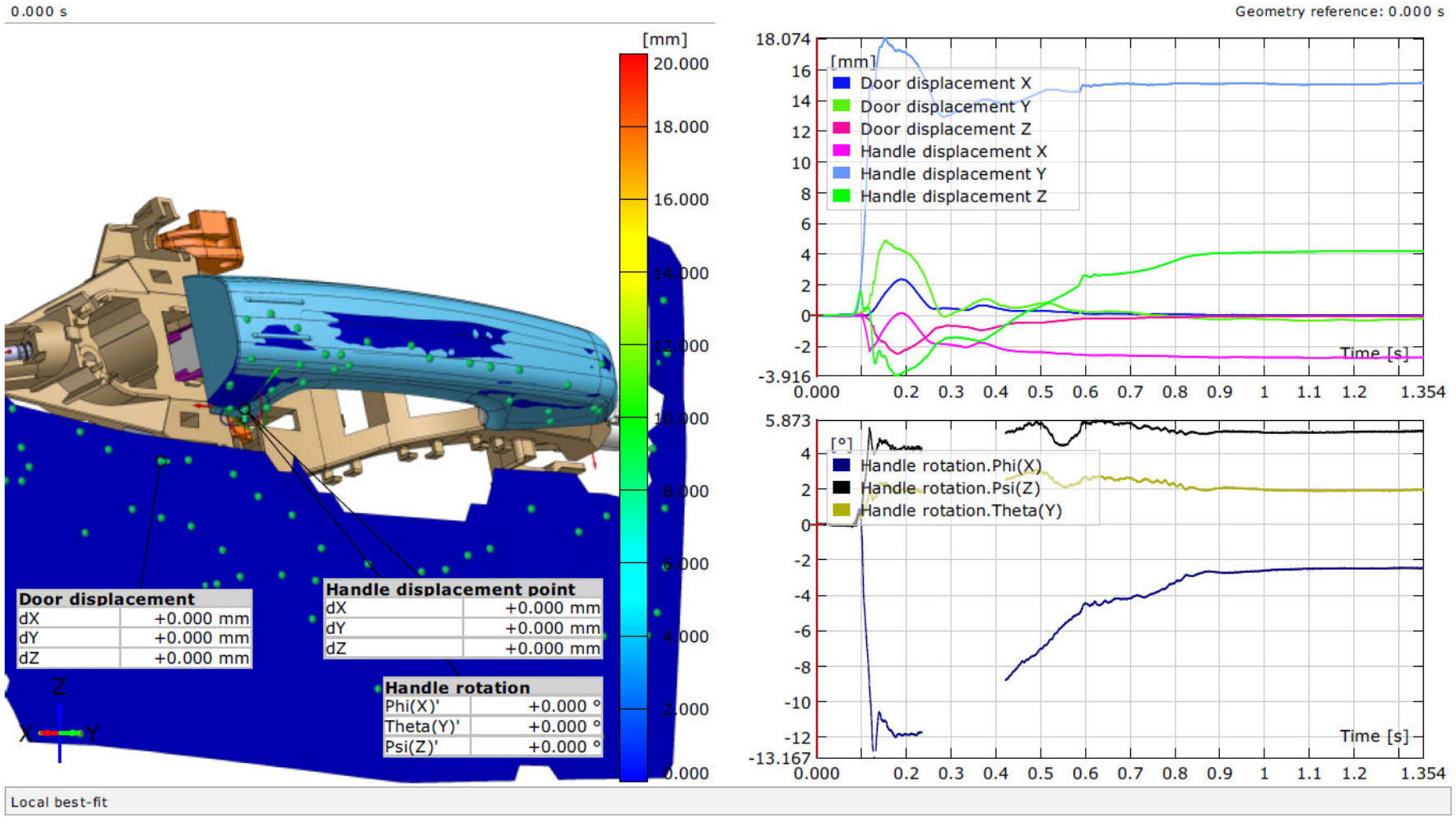
- Very unusual data set at 20 degrees 5% - lack of equilibrium in the plastic before measurements were taken
- 6 hours initial soak not long enough to stabilise
- Soak time after humidity changes increased to compensate (24-48 hours)
- Not much movement in running channel width despite temperature and humidity changes
- → Running channel is stable through testing to date

Optical Measurements
Displacement and Rotation



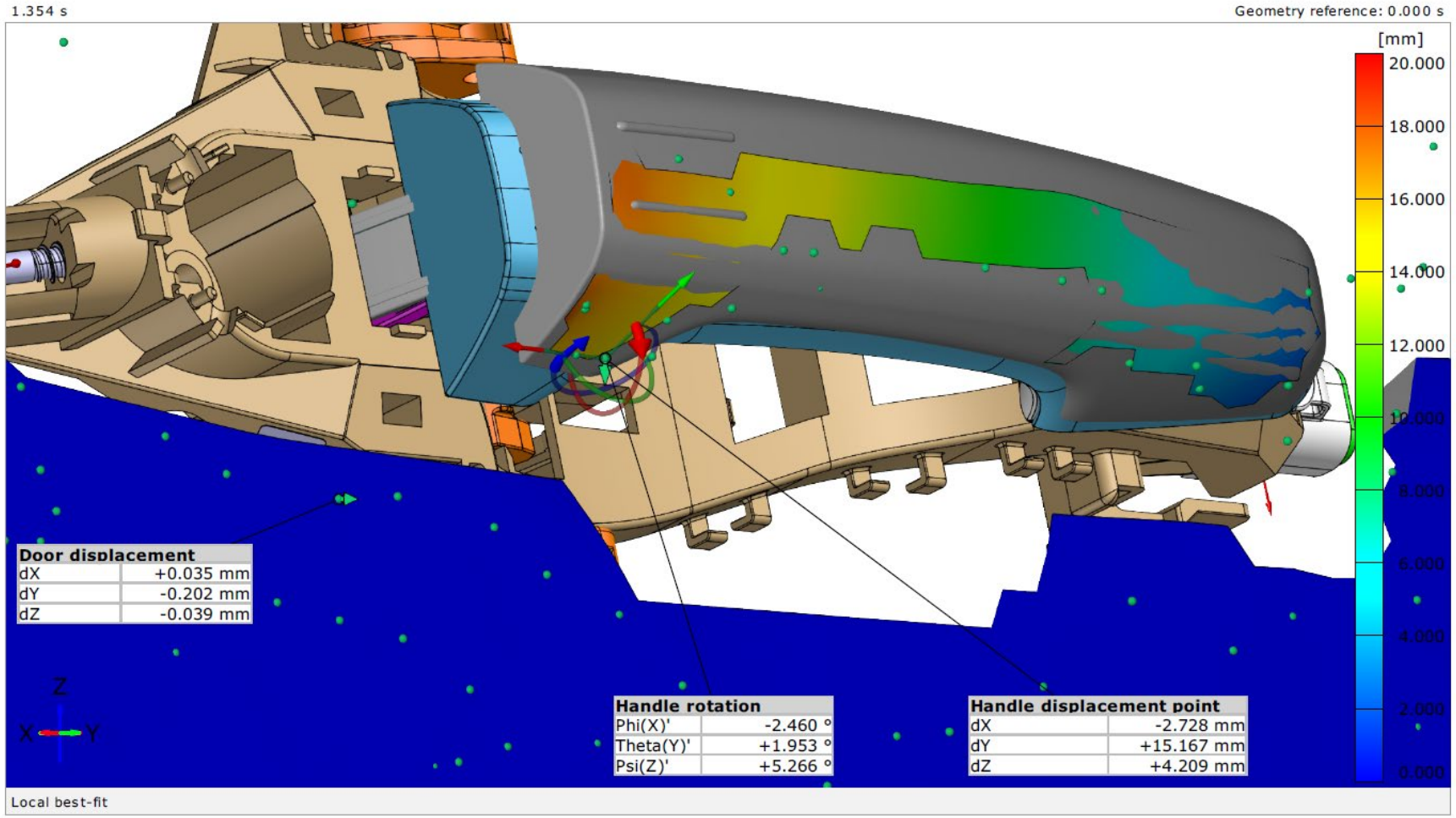
Optical Measurements
Displacement and Rotation

High speed Image surface tracking

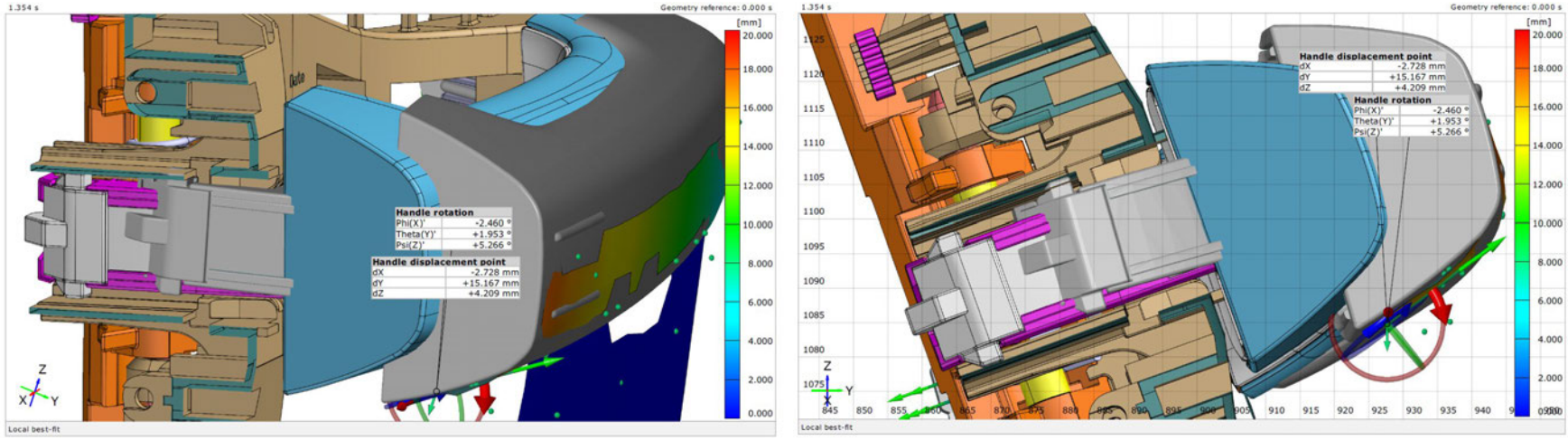


Optical Measurements
Displacement and Rotation

Handle stick position



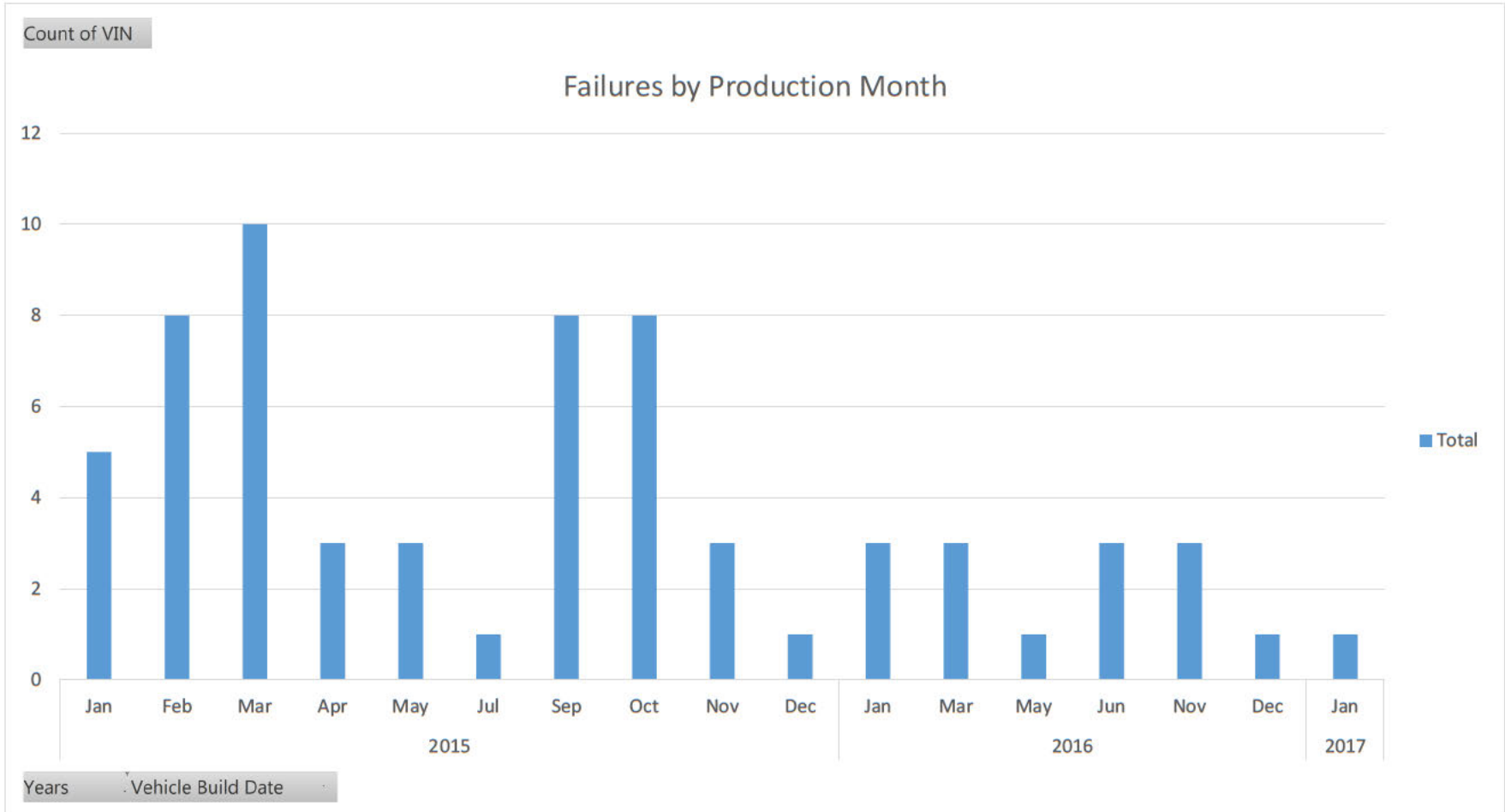
Optical Measurements
Displacement and Rotation



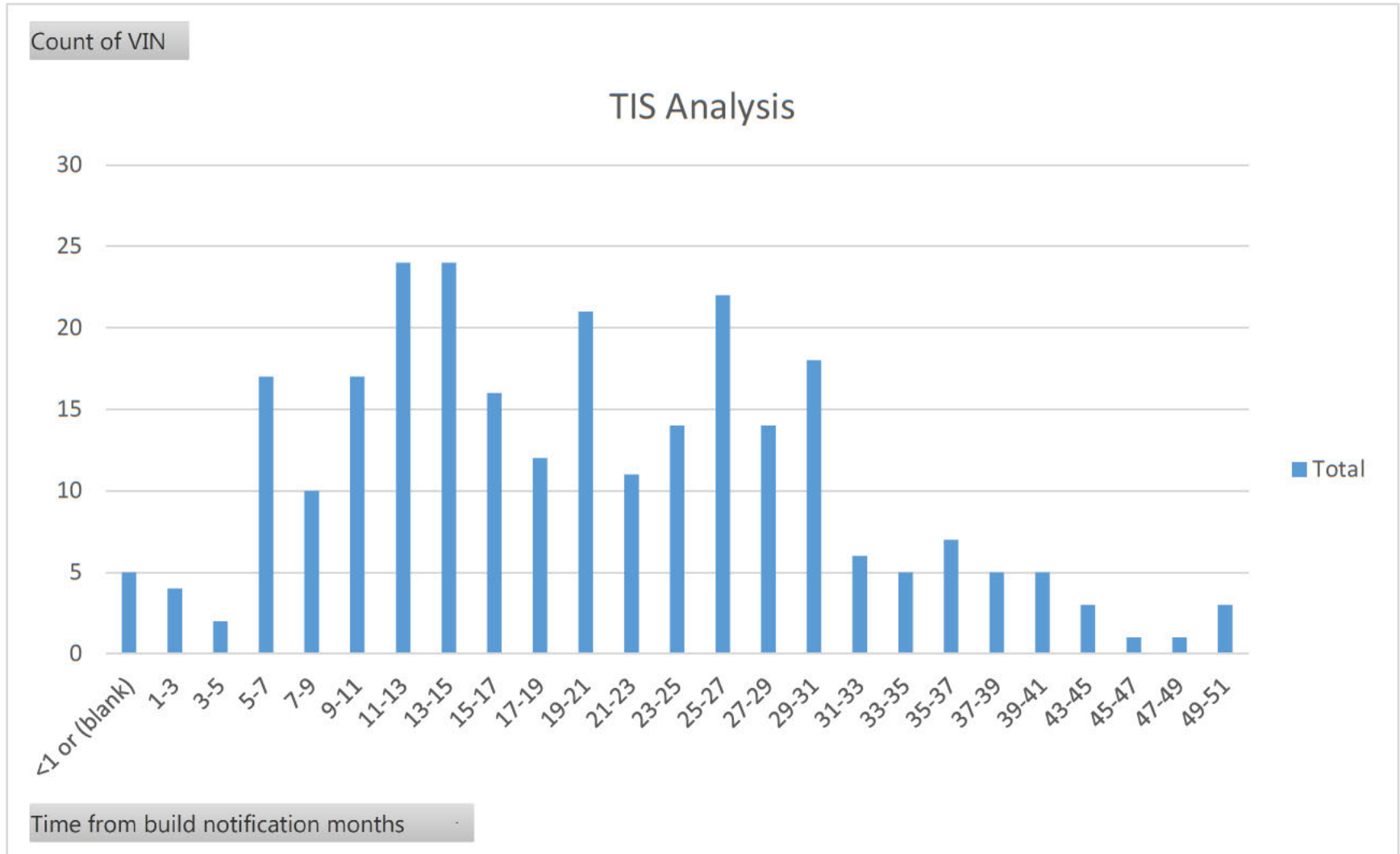
- Optical measurement techniques and high speed camera work give more insight
- Using latest CAD models there is clearly no jam where the handle used to stick on the leading edge of the chassis
- The jam at the rear is mitigated by the additional rib running backwards through the chassis
- Using the latest level parts we are unable to recreate the jam

- UNABLE TO DEVELOP RELIABLE MEASUREMENT SYSTEM

Failures by Month
Efficacy of Handle Mod Feb 2017



Failures by Month
Efficacy of Handle Mod Feb 2017



MSA Update
Testing performed CW37

- Multiple regression (DOE with existing data) has been done based on 273 existing tests. The following factors have been included:
- Operator applying load (2 operators)
- Angle of load application (45, 47.5, 50, 55 and 60 degrees to horizontal)
- Temperature (20, 40 and 80 degrees C)
- Cycles performed in key life test (0, 21000 and 42000)
- 2 handles
- This enables us to analyse sensitivity of load to jam the handle to these factors and also make an assessment of the existing measurement system.

MSA Update
Testing performed CW37

- Additional factors not included in original runs:

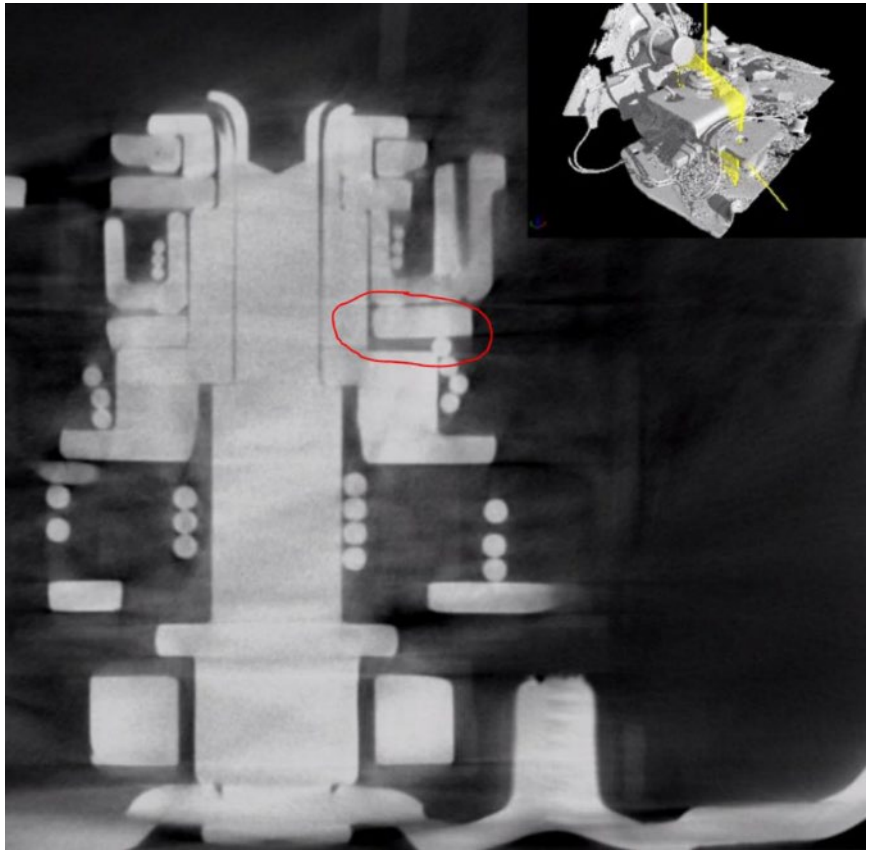
- Effect of heat and humidity in combination not included in main experiment. A separate experiment measuring a part at ambient, in dry heat and humid heat shows weight gain in humid heat and weight loss in dry heat compared to ambient. This indicates water absorption should be investigated further in subsequent experiments.

- Dust not included in original experiment. Need to do a small experiment to determine if this is significant and review customer data to apply right type of dust.

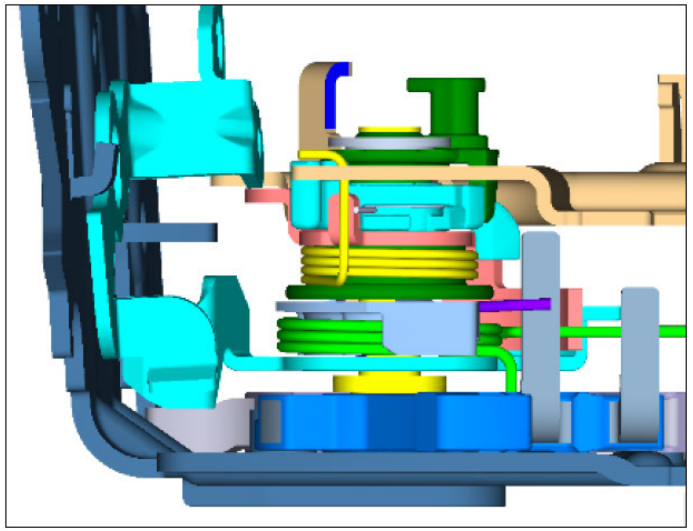
- No direct consideration of design variables (except using 2 different latches) – only external noise factors included in existing experiments.

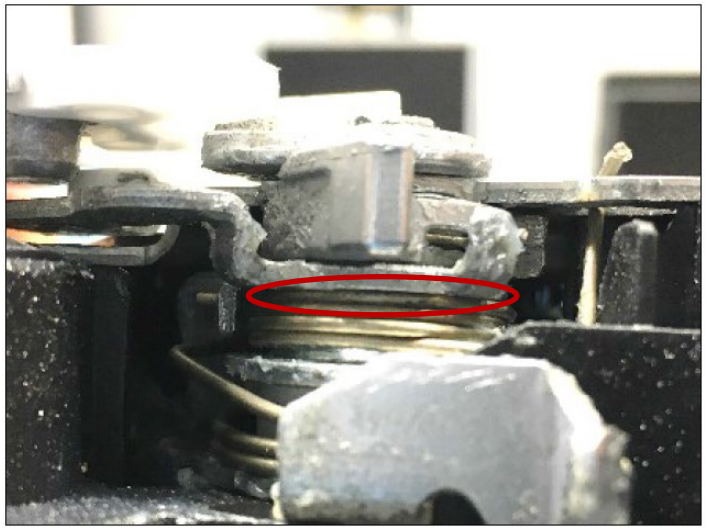
Clutch Mechanism
KV Transmission Lever Jam

- Chinese complaint of door unable to close
- Latch received at Brose
- KV lever in home position with no winds on the motor spindle
- KV transmission lever out of home position
- Pawl unable to lock claw and latch unable to be closed
- CT scan shows jammed spring on main rotational bush



Clutch Mechanism
KV Transmission Lever Jam



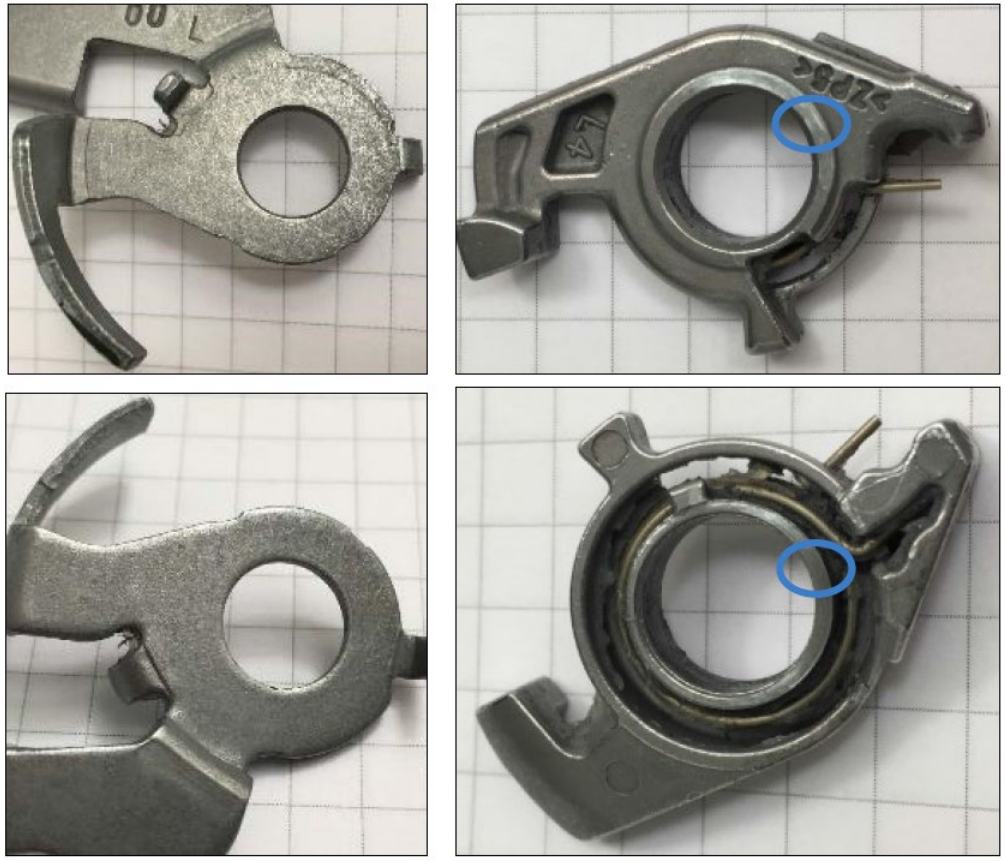


CAD image showing joint stack and how it should look
Careful teardown of the clutch left the jammed condition present until the pawl pin was removed
Error state present in the image above – spring clearly jammed between main bush and outside release chain transmission lever

Clutch Mechanism
KV Transmission Lever Jam

Tearing down the clutch mechanism revealed significant abrasion
The abrasion has left residues over the outside release chain transmission lever and the KV transmission lever
The KV transmission lever is the part that has suffered from this abrasive contact

Clutch Mechanism
KV Transmission Lever Jam



Abrasion area clearly visible on the KV transmission lever

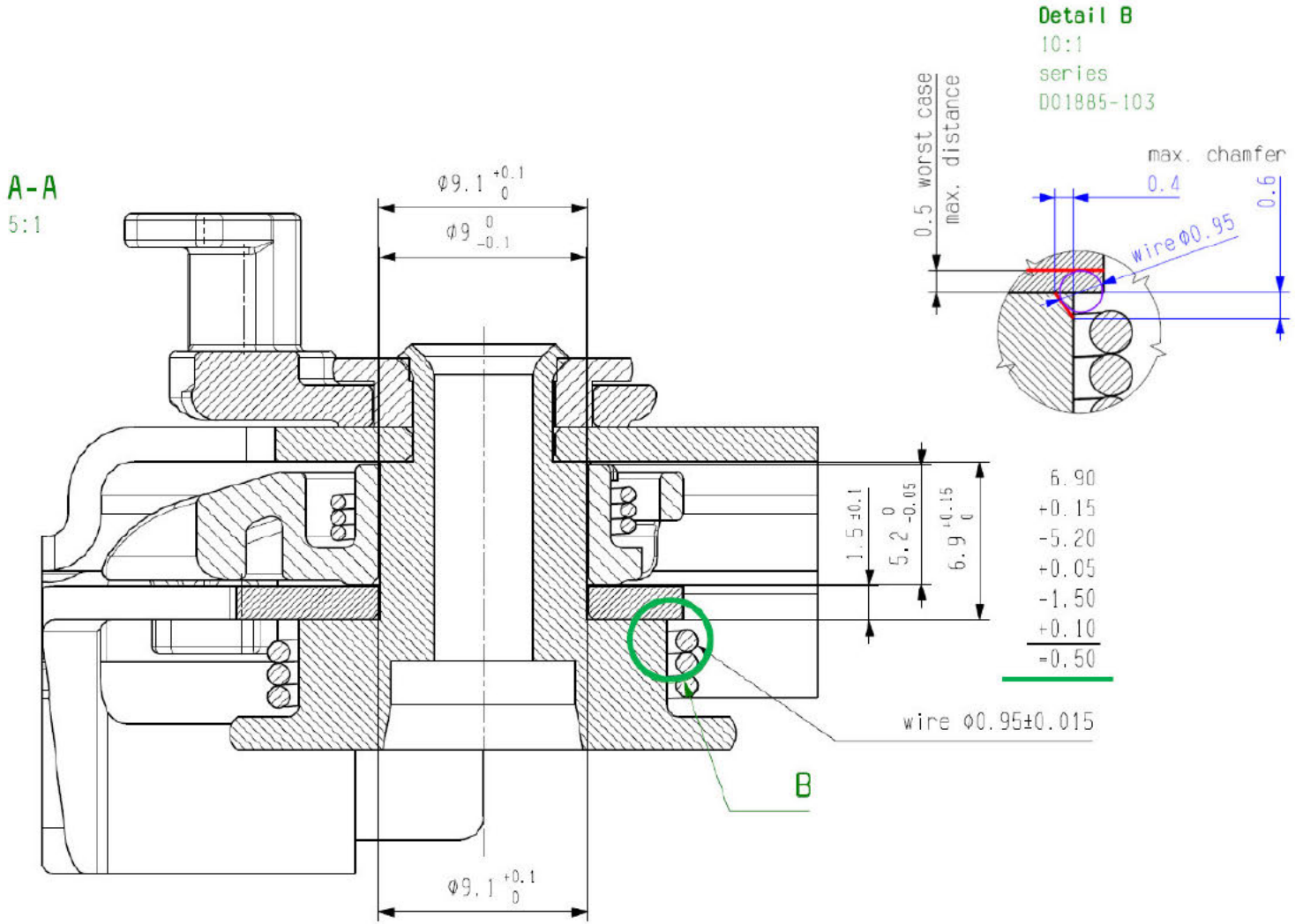
Part measured after cleaning all residue and grease

Height returned 4.92mm

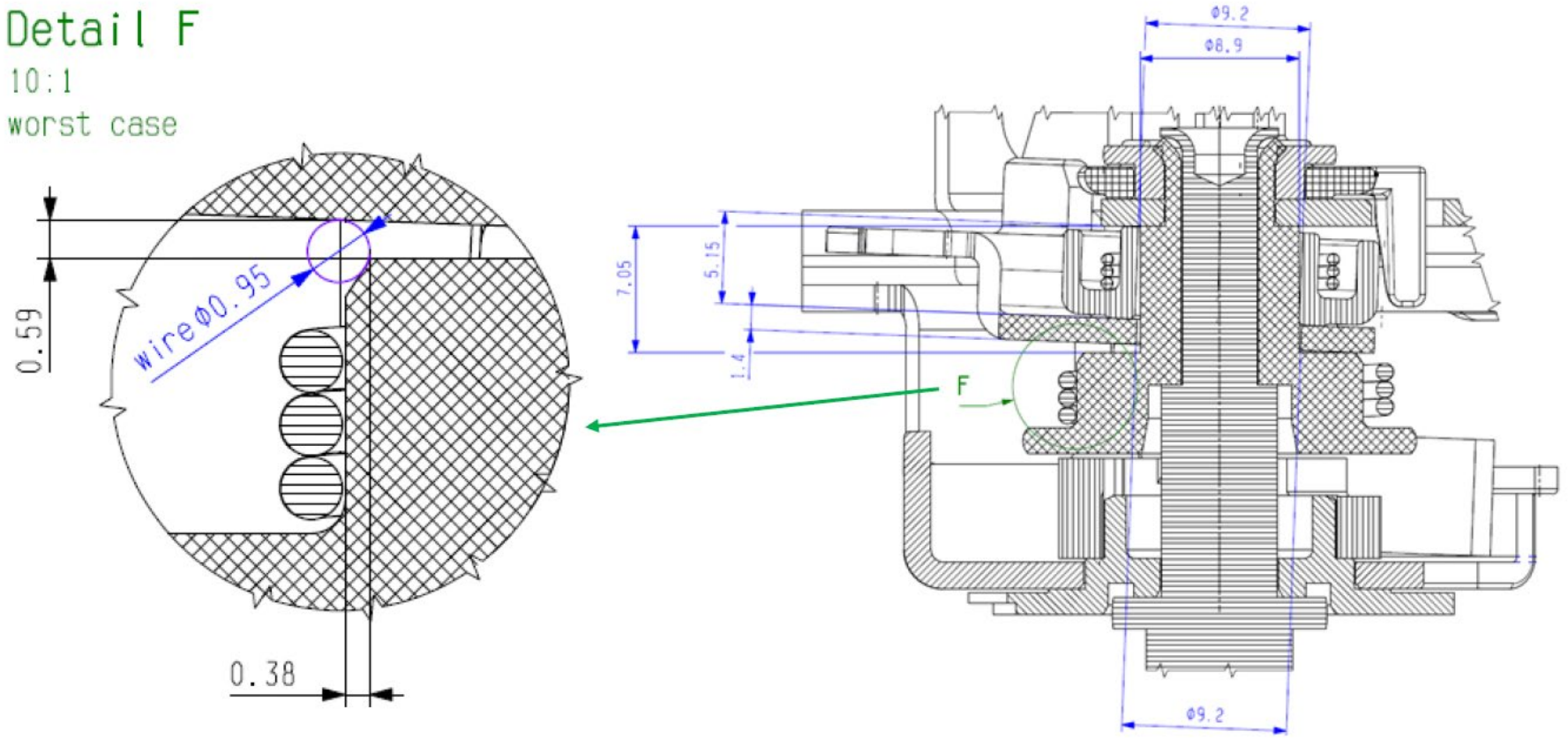
Specification 5.20 +/- 0.05mm

Part is considerably undersized in this area following use

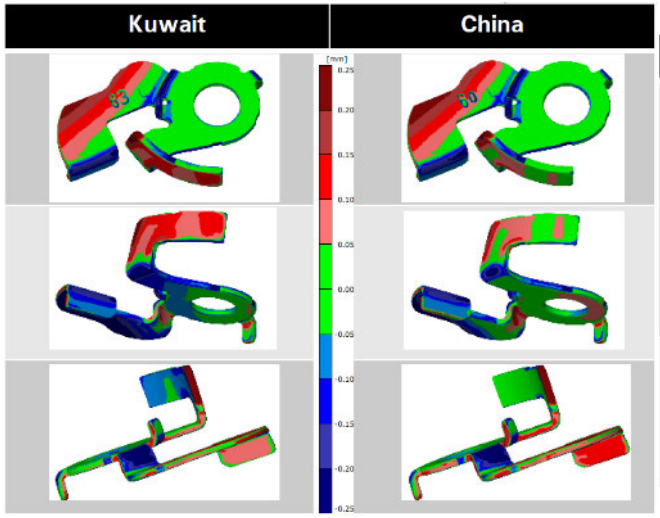
Clutch Mechanism
KV Transmission Lever Jam

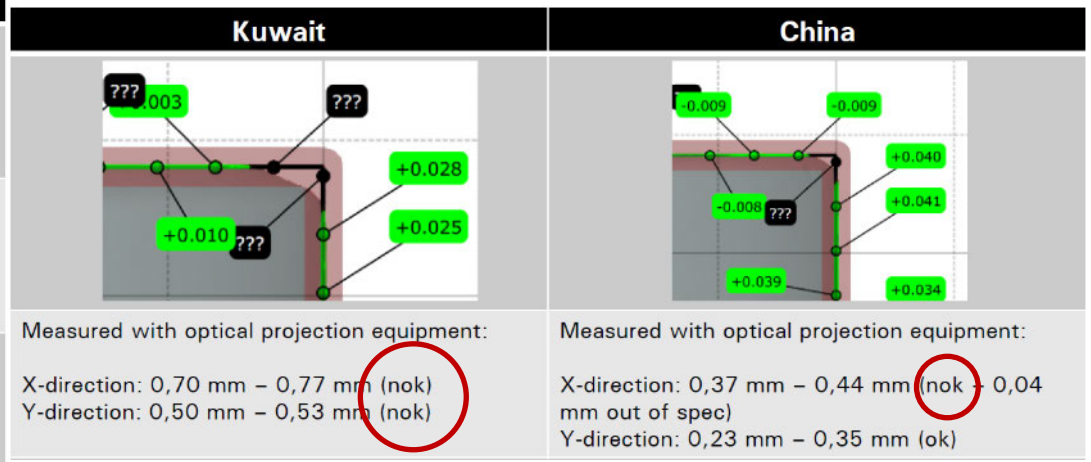


Clutch Mechanism
KV Transmission Lever Jam



Clutch Mechanism
KV Transmission Lever Jam



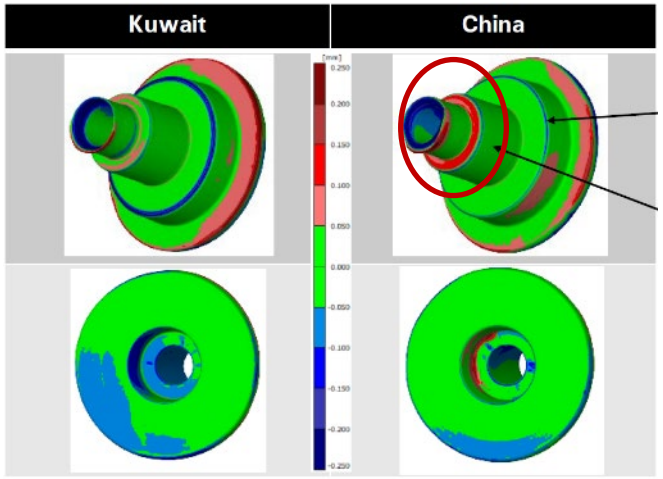


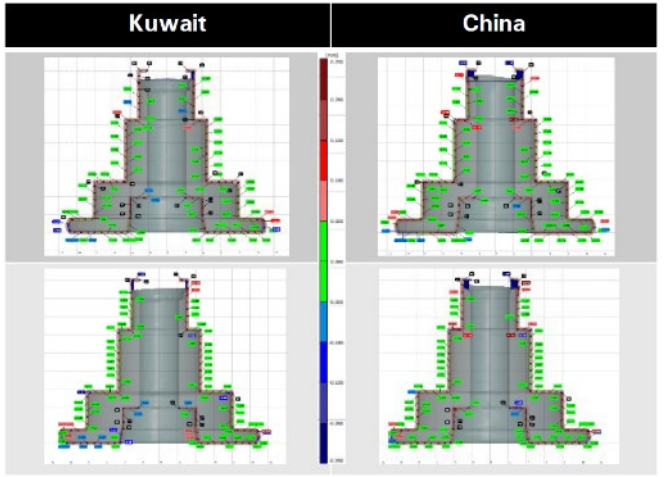
Measured with optical projection equipment:

X-direction: 0,70 mm – 0,77 mm (nok)
Y-direction: 0,50 mm – 0,53 mm (nok)

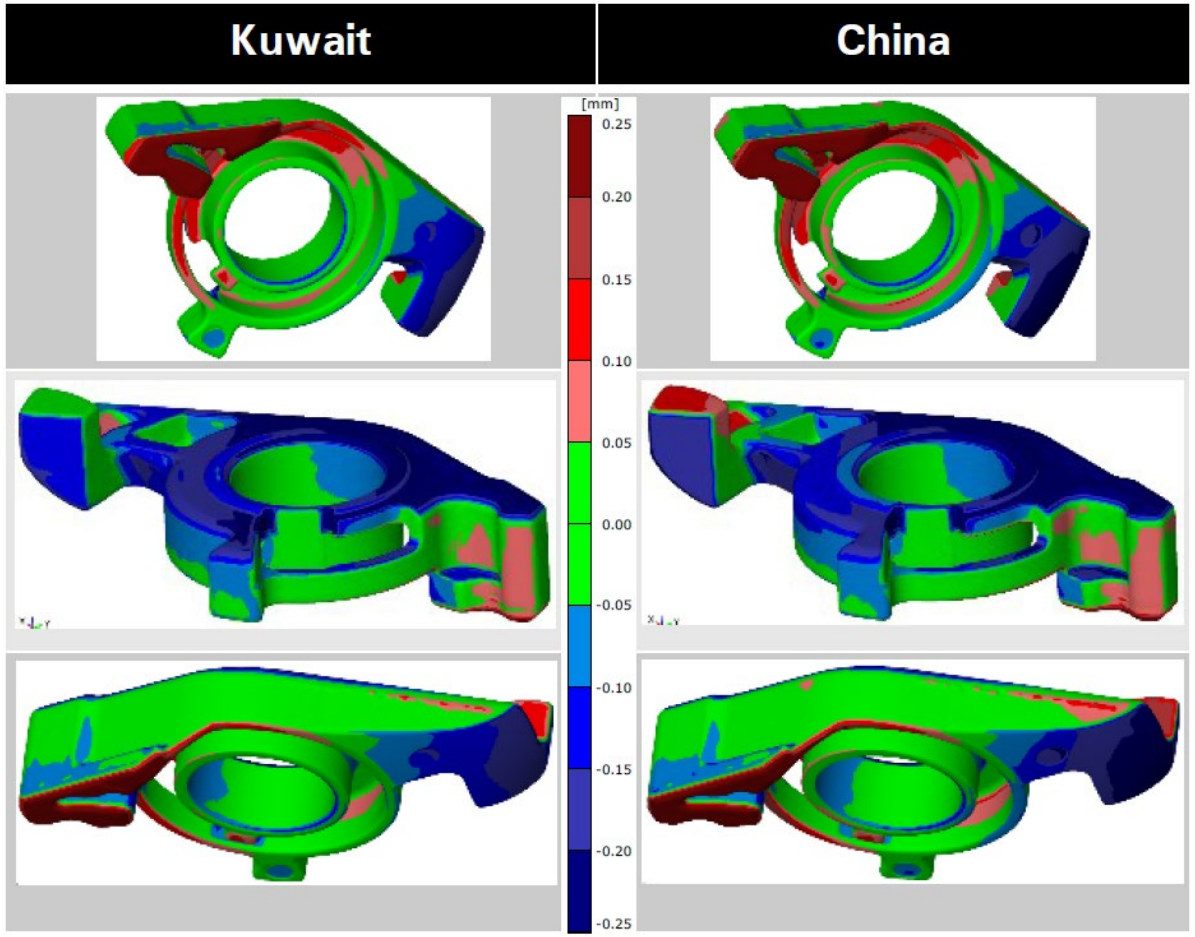
Measured with optical projection equipment:

X-direction: 0,37 mm – 0,44 mm (nok – 0,04 mm out of spec)
Y-direction: 0,23 mm – 0,35 mm (ok)





Clutch Mechanism
KV Transmission Lever Jam



KV Transmission Lever

Abraded, worn area of the lever is out of spec at 4.92mm

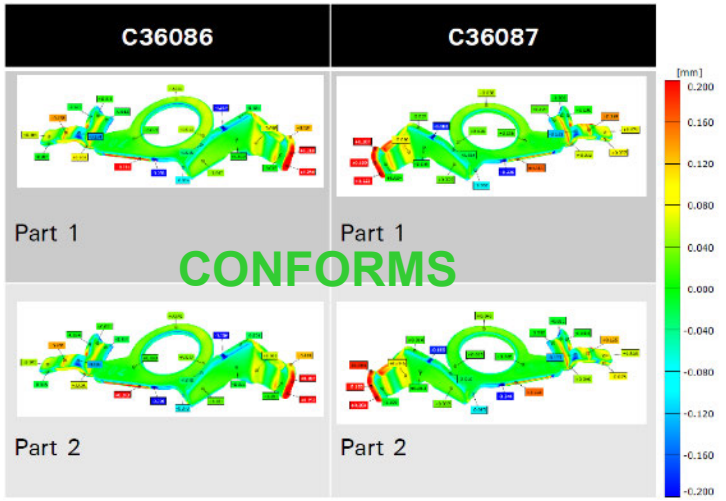
Other areas of the lever are also out of spec at 5.06mm

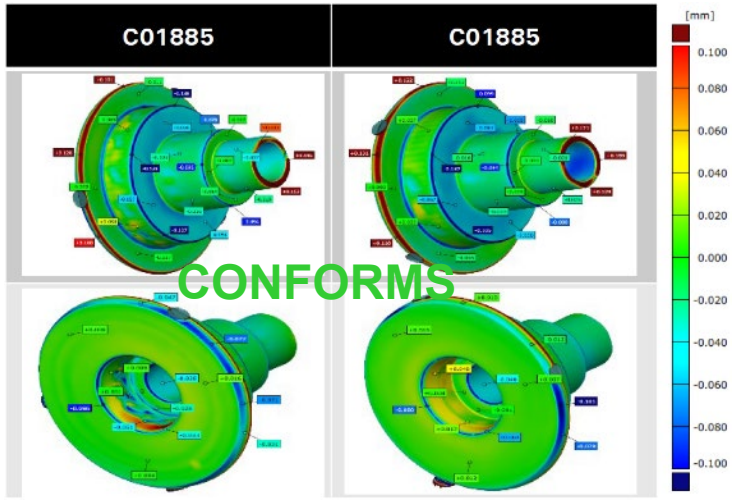
Supplier is engaged to resolve OOS conditions

Clutch Mechanism
KV Transmission Lever Jam

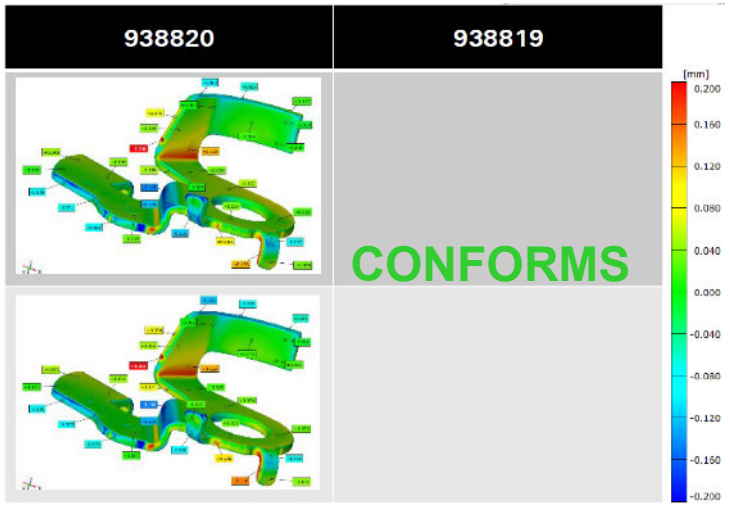
Durability test from comparable production period (beginning of 2016)	Durability test from beginning of 2017
LHF 	LHF 
	RHR 
- Test result ok – no function failure - High measurement result done today → 4,93 mm on wear out area	- Test result ok – no function failure - No wear out area

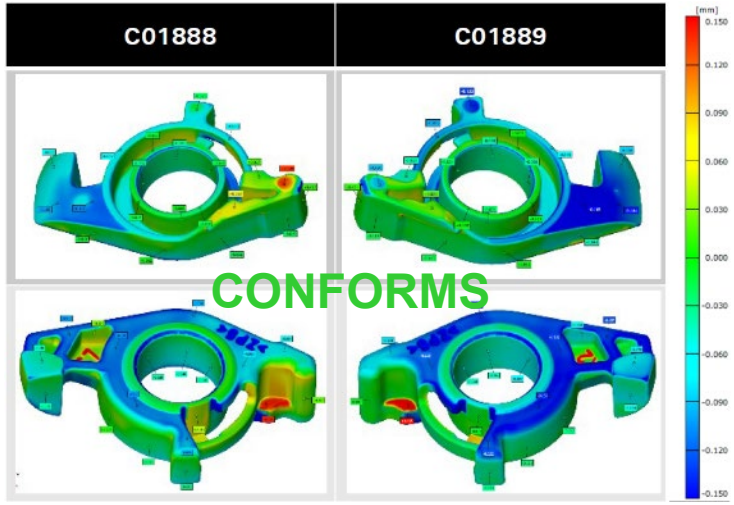
Clutch Mechanism
KV Transmission Lever Jam





Current Production Conformance





Clutch Mechanism
KV Transmission Lever Jam

No	5,2-0,05 Max	5,2-0,05 Min	Picture
1 LH	5,15	5,14	
2 LH	5,15	5,14	
3 LH	5,15	5,04	
4 RH	5,19	5,18	
5 RH	5,16	5,15	
6 RH	5,16	5,15	
7 RH	5,19	5,18	
8 RH	5,19	5,18	
9 RH	5,16	5,15	
Average LH	5,15	5,11	
Average RH	5,17	5,17	

Parts returned where the customer alleges the door opened were investigated

Parts that have exhibited no failure on the bench have been stripped down

No observable deterioration of the KV transmission lever is evident

All parts conform to specification

Clutch Mechanism
KV Transmission Lever Jam

Test:	Reproduce failure mode "sticky KV-transmission lever"					
Latches with:	KV-Transmission lever from field parts approx 5mm (Spec. 5,2 -0,05)					
	Bush with champfer similar to field part - 0,5 (Spec. -0.4) and -0,7 (Spec. -0.6)					
	Rest: current series components					
Variant:	LH latches					
Amount:	2					
	2	total series parts for comarison				
Procedure:						
	Testing within specification limit did not lead to any failed function in validation/requalification test					
	Test procedure needs to be definded with conditions out of specification					
Potential criteria:						
	Number of needed cycles according MTF of field parts = 10% of spec. cycles					
	Wet-Dust application directly to critical KV-lever area to provoke abrasion					
	Salt spray application earlier in test sequence					
	Temperature / humidity					
	We need extra storage time simulate real conditions in usage					
Timing						
	Procedure	22.09.2017				
	Test duration	approx. 30% of total life cycle testing (approx 3 weeks)				
	Test start	tbd				

Reproduce failure mode;

Specification for test currently being written (due 22/09/2017)

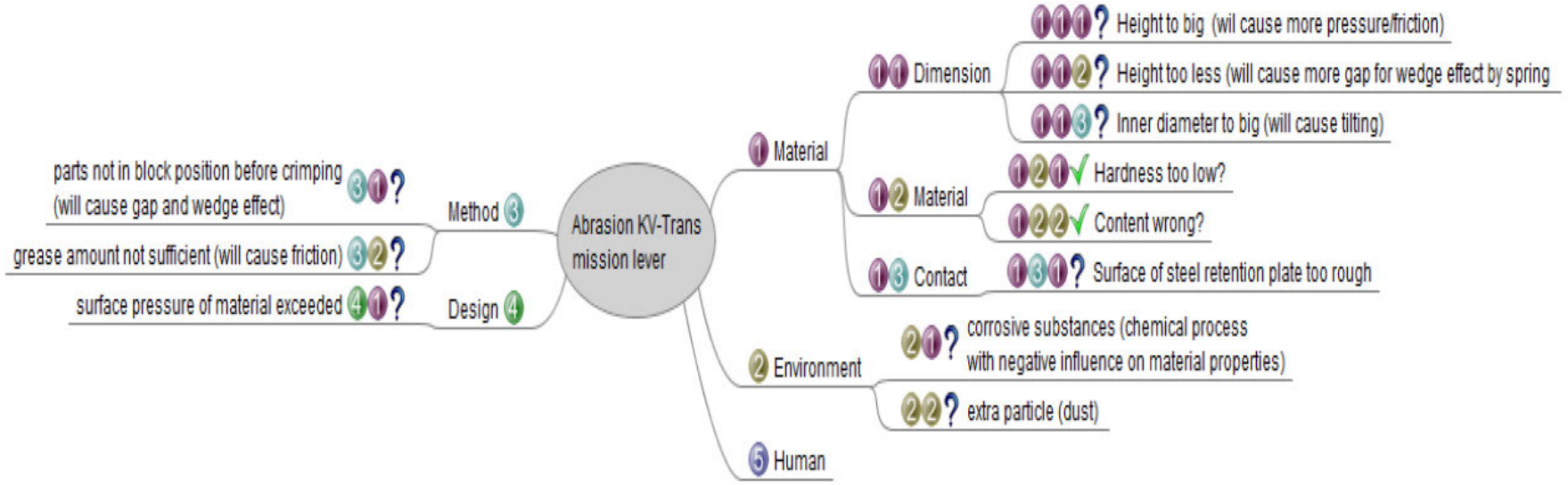
Addition of wet dust to provoke abrasion

Salt spray conditioning

Test anticipated start date 29/09/2017

Test termination 20/10/2017

Clutch Mechanism
KV Transmission Lever Jam



Abrasion was never evident during DV / KLT testing

Ishikawa under development to understand why the abrasion occurs

Ishikawa will form a direct input into the test method being developed and also sample selection for testing subjects

Clutch Mechanism
KV Transmission Lever Jam

Spec.	Current CZ 8/2017	Durability V10.627 No 6 LH	Durability V10.627 No 7 RH	Reference part PD as field part
Cavity	L1/L3/R2/R3	L2	R3	L1/L2/R3/R4
GD ZN Al 4 Cu1	Ok	Ok	Ok	Ok
Hardness HV1: 97	114-118	112-114	108-113	108-112
Density Min 6,4 g/cm3	6,419-6,447	6,445	6,451	6,412-6,437
Porosity (no spec.)	Ok	Ok	Ok	Ok
Microstructure	homogeneous	homogeneous	homogeneous	homogeneous
Summary	Ok	Ok	Ok	Ok

Conclusion:

- Material is ok. (COB Lab Report 5806)
- The abrasion is not based on a material failure

Clutch Mechanism
KV Transmission Lever Jam

	Component	What to change?	Expected Effect	pot. Negative effect	Status	Process
1	Bush	Reduce champfer	Axial force of spring (wedge effect) will be reduced	process limits due cold-forming turned part	Request to supplier (cold-forming process): - Process technically possible? - Possible amount of rejects in chamfer reduction without change in process? 05.10.2017: Still under investigation with Supplier regarding feasibility --> Timing: 20.10.2017	- increased test effort - sorting and scrapping
2	Bush	Step height -tolerance reduction	Axial force of spring (wedge effect) will be reduced	process limits due cold-forming turned part	- Process technically not possible - Request to supplier whether a smaller tolerance would be possible with increased inspection effort. 05.10.2017: Still under investigation with Supplier regarding feasibility --> Timing: 20.10.2017	
3	KV-Transmission-Lever	Material properties increase e.g. MIM / Zamak ZP2	less/no abrasion		- ZP2 has slightly better strength properties. - MIM = Prio 2 (new process, new tools, new validation) 05.10.2017: Improved material specification see next page feasibility and dimensional behavior has to be evaluated. --> First result expected 20.10.2017	Comparison tests with parts made of ZP5 and ZP2
4	KV-Transmission-Lever	Change bearing dimension (ring)	reduce tilting; increase contact area	higher friction due to bigger diameter	Work out a concept: -> what is possible new spring calculate, design change at lever 05.10.2017: No new update - Less priority	
5	spring	square cross-section	less/no entrance into gap	assembly problems / lifetime performance	Spring with similar torque with wire 0.85x0.85 possible. (Spring behavior can not be estimated) 05.10.2017: Will be evaluted together with design solution 6 + 8	Request to supplier: - Sample preparation Brose: - validation
6	forced resetting of outside transmission lever	connection between the o/s transmission lever and o/s release lever	to support resseting of KV-ler and o/s transmission lever		Design idea 05.10.2017: See next page. Prototype assembled. Possible Idea - reduce winding of outside transmission lever spring. Based on the investigation results of Point 8 might be considered additionaly.	Request to supplier: - Sample preparation Brose: - validation
7	spring	coating of spring	bigger diameter to avoid entrance		05.10.2017: After internal discussion with commoditiy expertes, idea rejected due to feasiblity and durability	
8	Additional part	downhold of spring	No gap entrance		Work out a concept: -> what is possible new spring calculate, design a bush 05.10.2017: Will be evaluted together with design solution 5 + 6	

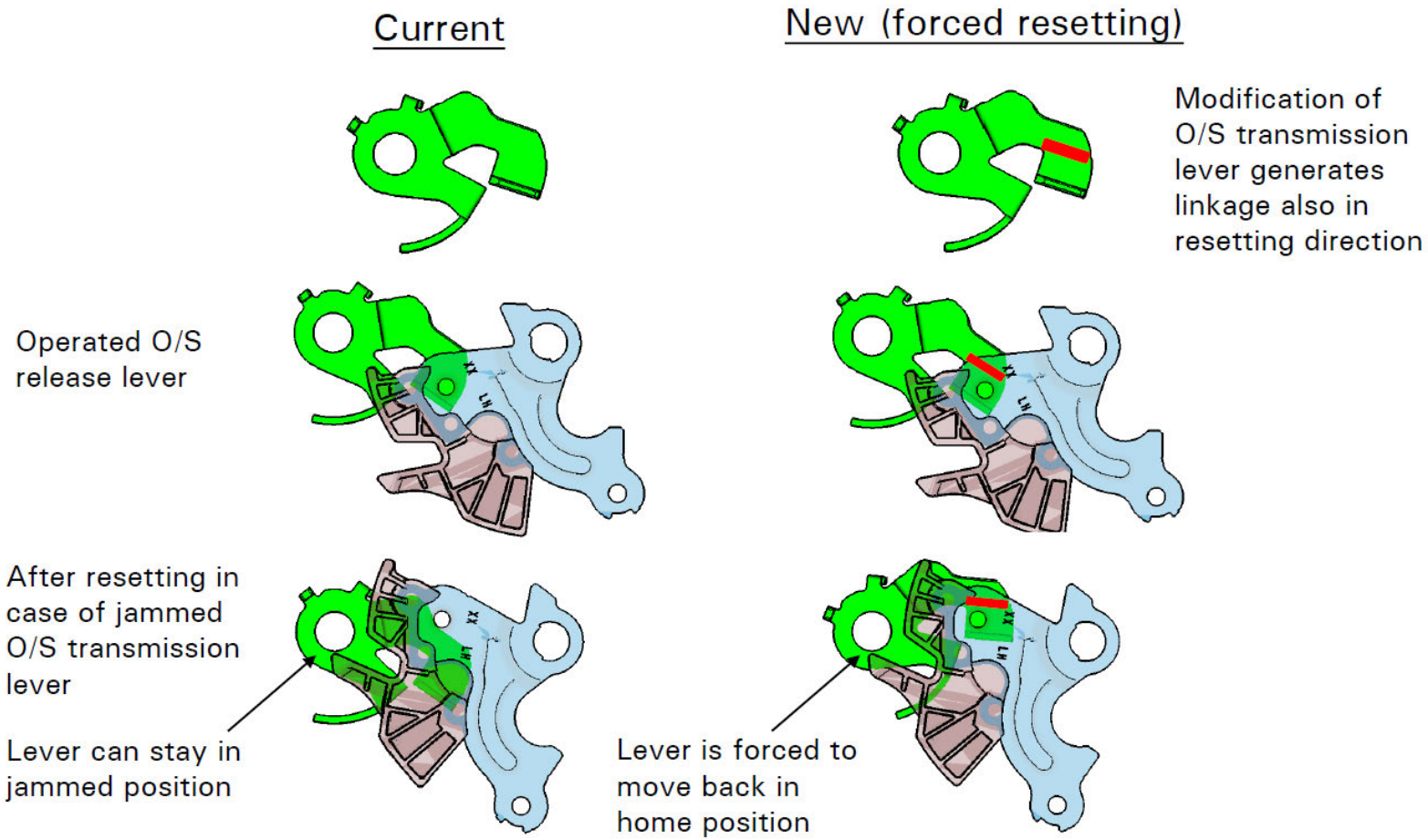
Clutch Mechanism
KV Transmission Lever Jam

Design Idea material properties Point 3

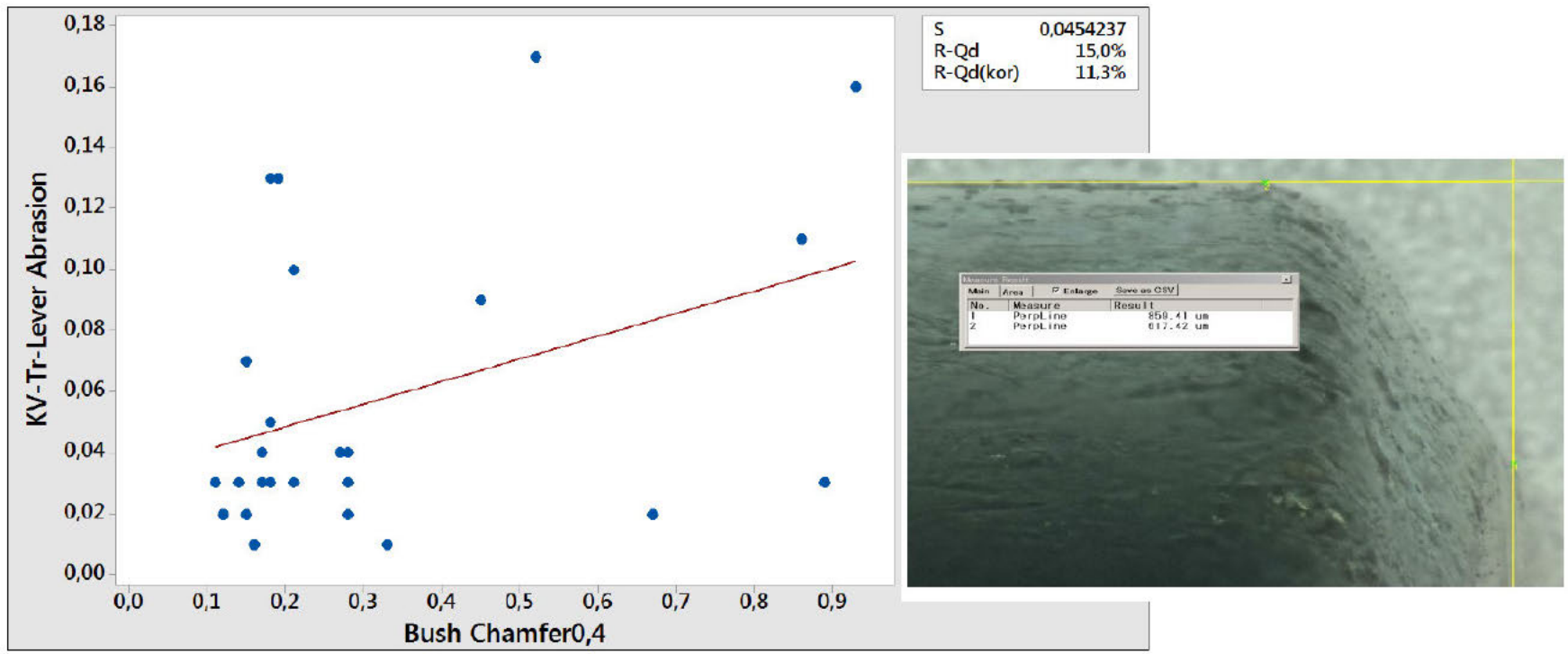
Properties	Current Material [ZP 5]	Other possible Material [ZP 2]
Tensile strength	331 MPa	397 MPa
Shear strength	262 MPa	317 MPa
Compressive strength	600 MPa	641 MPa
Hardness (Brinell)	114	130

Abrasion test for direct comparison under investigation by central laboratory

Clutch Mechanism
KV Transmission Lever Jam



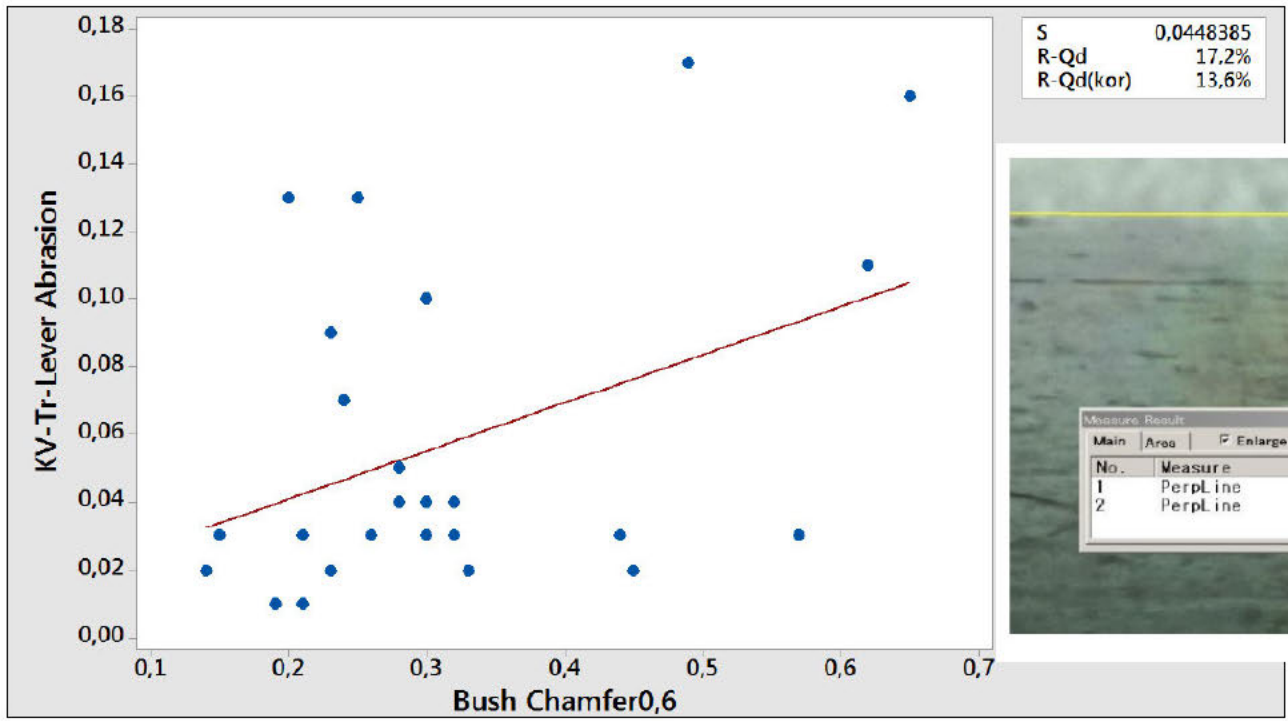
Clutch Mechanism
KV Transmission Lever Jam

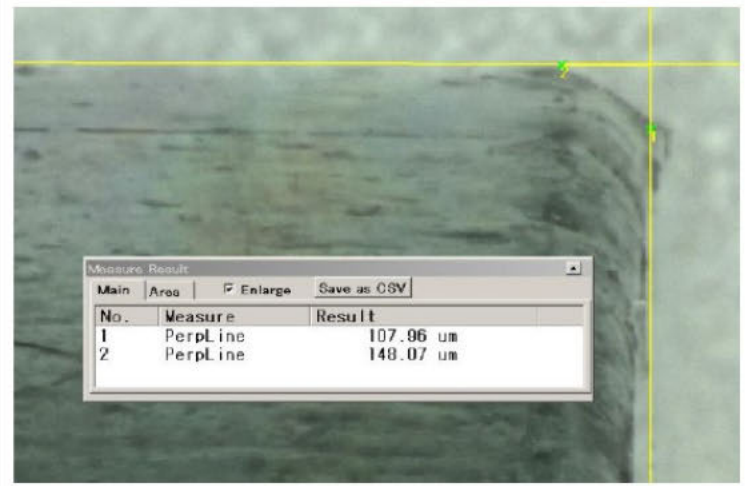


Based on few available data: bigger radial chamfer leads to more abrasion

→ This has to be confirmed with more data

Clutch Mechanism
KV Transmission Lever Jam





Based on few available data: bigger axial chamfer leads to more abrasion

→ This has to be confirmed with more data

Timeline Overlay by Country

P068 RECALL POPULATION | LATCH OK | LATCH AND RFA OK

VEHICLE BUILD DATE

Row Labels	2012 Sep	2012 Oct	2012 Nov	2012 Dec	2013 Jan	2013 Feb	2013 Mar	2013 Apr	2013 May	2013 Jun	2013 Jul	2013 Aug	2013 Sep	2013 Oct	2013 Nov	2013 Dec
AUSTRALIA(AUS)														1		1
AZERBAIJAN(AZE)																
CANADA(CAN)						1				1						1
CHINA(CHN)													1			
FINLAND(FIN)																
FRANCE(FRA)					1											
KUWAIT(KWT)							1					1	1			
LEBANON(LBN)												1				
LITHUANIA(LTU)							1									
OMAN(OMN)																
POLAND(POL)																
PORTUGAL(PRT)															1	
QATAR(QAT)																
RUSSIAN FEDERATION(RUS)			1		3	3	1	1	1	1	2	1	5	3	1	
SAUDI ARABIA(SAU)														1		
SOUTH AFRICA(ZAF)																
SPAIN(ESP)											1					
TURKEY(TUR)																
UKRAINE(UKR)													1			
UNITED ARAB EMIRATES(ARE)					1	3				4	3	5	3	7	3	1
UNITED KINGDOM(GBR)					3					1						
UNITED STATES(USA)			1		1		1		1	2	1	1	3	6	2	1
Grand Total			2		9	7	4	1	2	9	7	9	14	18	7	4

Row Labels	2014 Jan	2014 Feb	2014 Mar	2014 Apr	2014 May	2014 Jun	2014 Jul	2014 Aug	2014 Sep	2014 Oct	2014 Nov	2014 Dec
AUSTRALIA(AUS)						1						
AZERBAIJAN(AZE)									1			
CANADA(CAN)			2									
CHINA(CHN)										1		
FINLAND(FIN)				1			1		1	1		
FRANCE(FRA)											1	1
KUWAIT(KWT)												
LEBANON(LBN)						1						
LITHUANIA(LTU)												
OMAN(OMN)		2										1
POLAND(POL)									1			
PORTUGAL(PRT)												
QATAR(QAT)	1		1									1
RUSSIAN FEDERATION(RUS)	5	3		1	3	1		1	1	2		1
SAUDI ARABIA(SAU)	3											
SOUTH AFRICA(ZAF)	1											
SPAIN(ESP)												
TURKEY(TUR)	1											
UKRAINE(UKR)												
UNITED ARAB EMIRATES(ARE)	6	3	7			1	1		4	5	6	6
UNITED KINGDOM(GBR)			1	2		1						
UNITED STATES(USA)	1	1	1		1	2	1		5	2	2	2
Grand Total	18	9	12	4	4	7	3	1	13	11	9	12

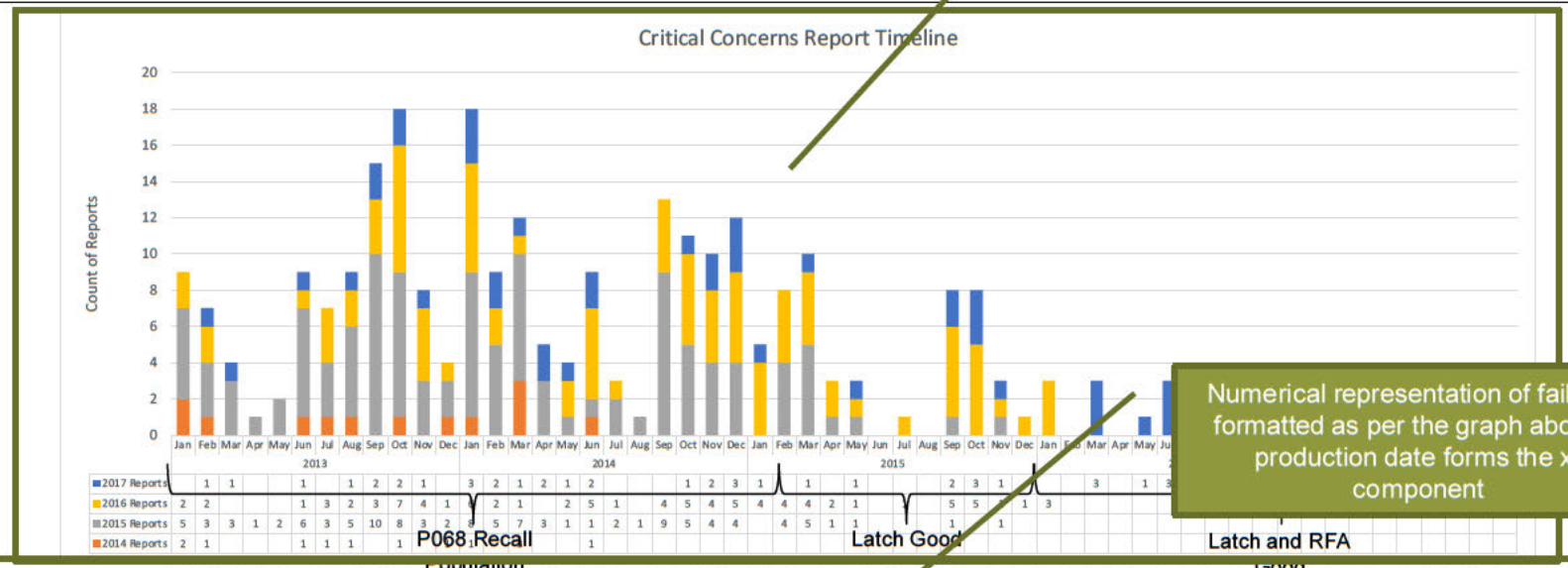
Row Labels	2015 Jan	2015 Feb	2015 Mar	2015 Apr	2015 May	2015 Jun	2015 Jul	2015 Aug	2015 Sep	2015 Oct	2015 Nov	2015 Dec
AUSTRALIA(AUS)												
AZERBAIJAN(AZE)												
CANADA(CAN)					1							
CHINA(CHN)												
FINLAND(FIN)												
FRANCE(FRA)												
KUWAIT(KWT)			1				1					
LEBANON(LBN)												
LITHUANIA(LTU)												
OMAN(OMN)												
POLAND(POL)												
PORTUGAL(PRT)												
QATAR(QAT)												
RUSSIAN FEDERATION(RUS)	1											
SAUDI ARABIA(SAU)												
SOUTH AFRICA(ZAF)												
SPAIN(ESP)												
TURKEY(TUR)												
UKRAINE(UKR)												
UNITED ARAB EMIRATES(ARE)	3	5	6	3	2				6	6	1	1
UNITED KINGDOM(GBR)									1		1	
UNITED STATES(USA)	1	3	3									
Grand Total	5	8	10	3	3		1		7	6	2	1

Row Labels	2016 Jan	2016 Feb	2016 Mar	2016 Apr	2016 May	2016 Jun	2016 Jul	2016 Aug	2016 Sep	2016 Oct	2016 Nov	2016 Dec	2017 Jan	2017 Feb	2017 Mar	2017 Apr	2017 May	Grand Total
AUSTRALIA(AUS)																		3
AZERBAIJAN(AZE)																		1
CANADA(CAN)					1													7
CHINA(CHN)			1								1	1						5
FINLAND(FIN)																		4
FRANCE(FRA)																		3
KUWAIT(KWT)													1					6
LEBANON(LBN)																		2
LITHUANIA(LTU)																		1
OMAN(OMN)																		3
POLAND(POL)																		1
PORTUGAL(PRT)																		1
QATAR(QAT)																		3
RUSSIAN FEDERATION(RUS)																		42
SAUDI ARABIA(SAU)																		4
SOUTH AFRICA(ZAF)																		1
SPAIN(ESP)																		1
TURKEY(TUR)																		1
UKRAINE(UKR)																		1
UNITED ARAB EMIRATES(ARE)	3					3												109
UNITED KINGDOM(GBR)											2							12
UNITED STATES(USA)																		45
Grand Total	3		1		1	3					3	1	1					258

Amalgamated Timeline (Explained)

Failures, Fixes, and Populations

Graphical representation of failures, x-axis is production month and legend represents the month is was reported



Numerical representation of failures, formatted as per the graph above – production date forms the x-component

	2013												2014												2015												2016												2017								
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
2014 Reports	2	1				1	1	1		1		1	1		3			1																																						13
2015 Reports	5	3	3	1	2	6	3	5	10	8	3	2	8	5	7	3	1	1	2	1	9	5	4	4		4	5	1	1				1		1																					116
2016 Reports	2	2				1	3	2	3	7	4	1	6	2	1		2	5	1		4	5	4	5	4	4	4	2	1		1		5	5	1	1	3																	
2017 Reports		1	1			1		1	2	2	1		3	2	1	2	1	2				1	2	3	1		1		1				2	3	1				3		1	3												
Grand Total	9	7	4	1	2	9	7	9	15	18	8	4	18	9	12	5	4	9	3	1	13	11	10	12	5	8	10	3	3	1			8	8	3	1	3		3		1	3												

All modifications performed to date aligned to timeline above, with reason for the modification on the right and issue it was / is addressing

"Old" pedigree latch	
Handle ears modified	First release intended
Stronger KV return spring	Reduce the risk of the cord binding
Greased sinter bearing	To prevent corrosion of the KV motor, P068 issue
Leak path into latch closed	To eliminate corrosion of the KV motor, P068 issue
New software in RFA (production)	Production fix for short circuit, P068 issue
Modified handle chassis	Eliminate handle jam entirely
Modified OS transmission lever	Fix under development, sticking KV clutch mech due to jammed spring (undersize KV transmission lever) ?
P068 Recall Population	
Latch good	
Latch and RFA Good (production)	
Handle Binding small abuse load	
Handle Binding large abuse load	
Handle no longer binds (production)	
Sticking KV Clutch	

Populations of the three major issues: short circuit, handle binding and sticking KV clutch, displayed by risk level and aligned to timeline

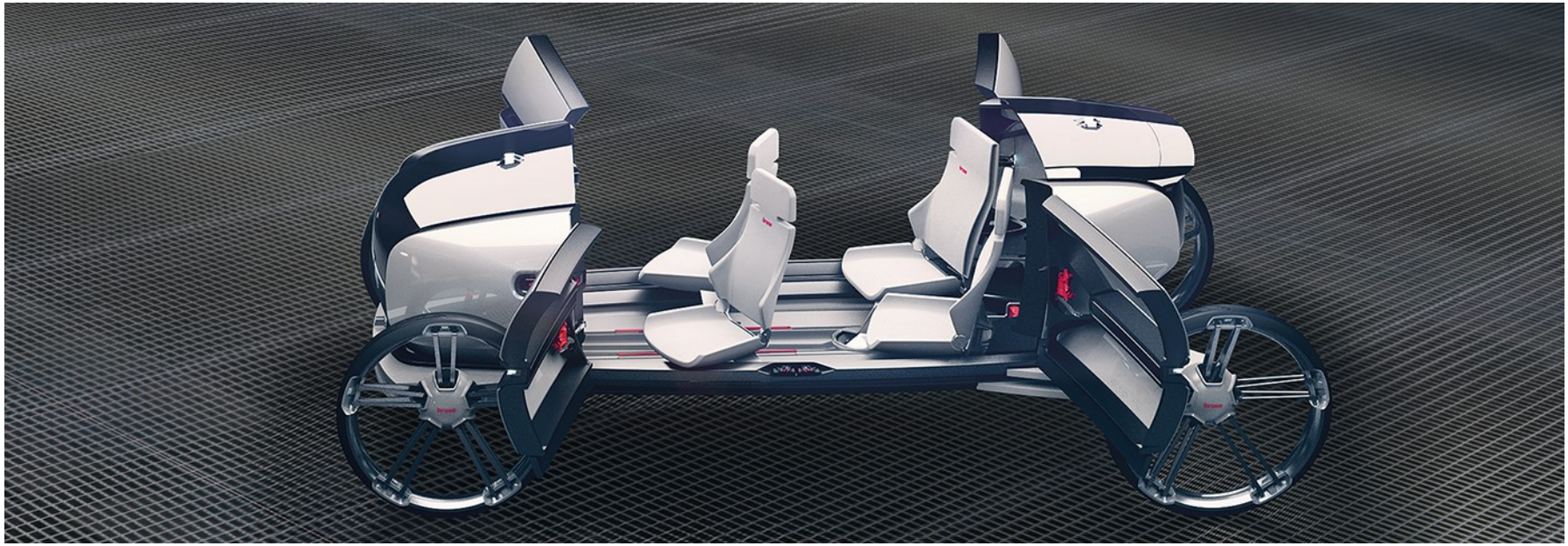
Next Steps in Investigation

- From PSCC
  > Brose (supplier) DFMEA deep dive for any other possible failure modes not yet revealed
  > Investigate key characteristics on parts which affect KV Transmission Lever Jam condition
  > Brose Supplier parts quality over time – assurances all parts are delivered to spec. – dimensions and critical characteristics, material etc.
  > Tier 2 (to Brose) manufacturing change history including controls and reasons for changes.

- To be reviewed with Brose and JLR PSCC on 28 November 2017

PSCC 23.01.2018

Unilatch KV-Transmission Lever



JLR Whitley, 23.01.2018

PSCC 23.01.2018
Risk evaluation – Timing presented to PSCC 12.12.2017

No	Chapter	Task	Start	End
1	**Abrasion test**	Target: Abrasion rate on KV-Transmission lever	**30.11.2017**	**15.12.2017**
2	**Disassembly of field parts**	Target: Bush and KV-Transmission lever from PD before 5/2016 Re-use of components to build test samples	**11.12.2017**	**15.12.2017**
3	**Field latch components**	Target: Dimension results from Bush and KV Transmission lever from PD before 5/2016 Availability of components for (old) design index before 5/2017	**15.12.2017**	**05.01.2018**
4	**DOE components**	Target: Prepare samples acc. DOE Plan	**05.12.2017**	**12.01.2018**
5	**DOE samples build**	Target: Latches acc. design Index before Mai 2016	**15.01.2018**	**18.01.2018**
6	**Pre-Testing**	Target: Procedure for DOE is feasible to detect the failure mode (3 times) Most critical (No5) and uncritical (No16) combination from DOE-Plan.	**19.01.2018**	**31.01.2018**
7	**DOE**	Target: Evidence for contribution of nok chamfer/height	**31.01.2018**	**23.02.2018**
8	**Result**	Target: Interpretation of DOE output	**01.02.2018**	**24.02.2018**

PSCC 23.01.2018
Risk evaluation – Timing update

No	Chapter	Task	Start	End	
1	**Abrasion test**	Target: Abrasion rate on KV-Transmission lever	**30.11.2017**	**26.01.2018**	80% Done
2	**Disassembly of field parts**	Target: Bush and KV-Transmission lever from PD before 5/2016 Re-use of components to build test samples	**11.12.2017**	**17.01.2018**	Done
3	**Field latch components**	Target: Dimension results from Bush and KV Transmission lever from PD before 5/2016 Availability of components for (old) design index before 5/2017	**15.12.2017**	**19.01.2018**	Done
4	**DOE components**	Target: Prepare samples acc. DOE Plan	**05.12.2017**	**18.01.2018**	Done
5	**DOE samples build**	Target: Latches acc. design Index before Mai 2016	**19.01.2018**	**19.01.2018**	Done
6	**Pre-Testing**	Target: Procedure for DOE is feasible to detect the failure mode (3 times) Most critical (No5) and uncritical (No16) combination from DOE-Plan.	**22.01.2018**	**31.01.2018**	
7	**DOE**	Target: Evidence for contribution of nok chamfer/height	**31.01.2018**	**23.02.2018**	
8	**Result**	Target: Interpretation of DOE output	**01.02.2018**	**24.02.2018**	

PSCC 23.01.2018
Next Steps from PSCC 28.11.2017 - Update

▪ Finalise D-FMEA review regarding bearing areas	cw50/2017 -> done
▪ Evaluate CC and SC characteristics on further single parts	cw50/2017 -> done
▪ Defined characteristics of bushing and KV transmission lever to be implemented in supplier process (Change management)	cw04/2018 -> done Process at supplier under control PPAP target cw12/2018

Brose will focus on investigation of robustness increase of latch design, as follows:

▪ Forced resetting of O/S transmission lever detailed planning to be done	Q3-2018
▪ Investigate feasibility of smaller chamfer on bushing	cw04/2018
▪ Investigate feasibility of more wear-resistant material of KV-transmission lever. ZP2 ordered. Next step: abrasion test to compare with ZP5 (serial)	cw7/2018 cw10/2018

Backup

- Presentation shown to PSCC at 28.11.2017 and 12.12.2017

PSCC 12.12.2017
Questions raised by PSCC on 28.11.2017

1. What evidence can Brose present, that the failure mode will not occur on latches built before Jan 2016 and after Mai 2016?
   - batch issue
   - Nio parts + conditions
   - Design issue

2. Brose to present timing plan regarding risk assessment

3. For how long will abrasion occur? Does it stop at some point of time?
   Team should perform a DoE to judge/identify influence factors.

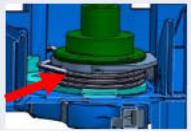
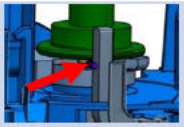
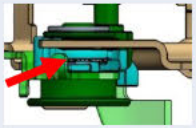
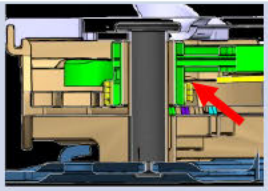
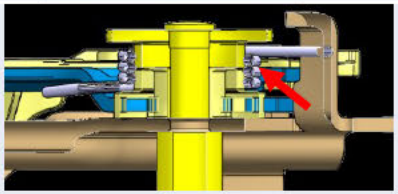
4. Are there relevant minor deviations during supplier audits for bushing and KV transmission lever?

5. KV-Function disabled in RFA – explain technical effect

PSCC 12.12.2017

Potential further failure modes relating to wear out

Investigation lever bearings

Investigated design	picture	Investigation result
Spring outside transmission lever		- currently discussed failure mode - If parts are nok (chamfer too big, lever too thin) spring can be forced in the area of chamfer
CL clutch spring		Evaluated → no risk of jamming
Spring pawl		Evaluated → no risk of jamming
Spring KV transmission lever		Evaluated → no risk of jamming
KV lever (plastic)		Evaluated → no risk of jamming
o/s release lever		Evaluated → no risk of jamming

PSCC 12.12.2017
Risk evaluation - Timing

No	Chapter	Task	Start	End
1	**Abrasion test**	Target: Abrasion rate on KV-Transmission lever	**30.11.2017**	**15.12.2017**
2	**Disassembly of field parts**	Target: Bush and KV-Transmission lever from PD before 5/2016 Re-use of components to build test samples	**11.12.2017**	**15.12.2017**
3	**Field latch components**	Target: Dimension results from Bush and KV Transmission lever from PD before 5/2016 Availability of components for (old) design index before 5/2017	**15.12.2017**	**05.01.2018**
4	**DOE components**	Target: Prepare samples acc. DOE Plan	**05.12.2017**	**12.01.2018**
5	**DOE samples build**	Target: Latches acc. design Index before Mai 2016	**15.01.2018**	**18.01.2018**
6	**Pre-Testing**	Target: Procedure for DOE is feasible to detect the failure mode (3 times) Most critical (No5) and uncritical (No16) combination from DOE-Plan.	**19.01.2018**	**31.01.2018**
7	**DOE**	Target: Evidence for contribution of nok chamfer/height	**31.01.2018**	**23.02.2018**
8	**Result**	Target: Interpretation of DOE output	**01.02.2018**	**24.02.2018**

PSCC 12.12.2017
Risk evaluation overview

Target: Identify the risk of jamming for latch status before 5/2016

Input:

DOE:

Factor: 1) Height of KV-Transmission Lever 2) chamfer of bush

Effect/Interaction of factors -> What ?

Data:

Measured components from field return parts (approx. 200)

Process capability / probability -> How many ?

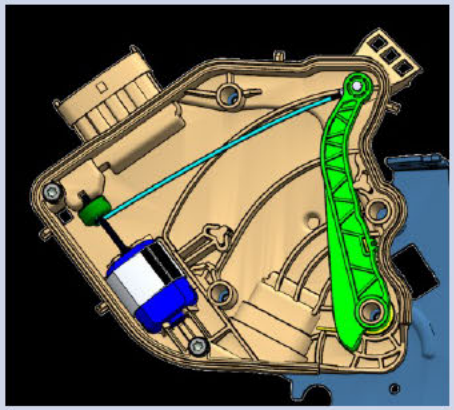
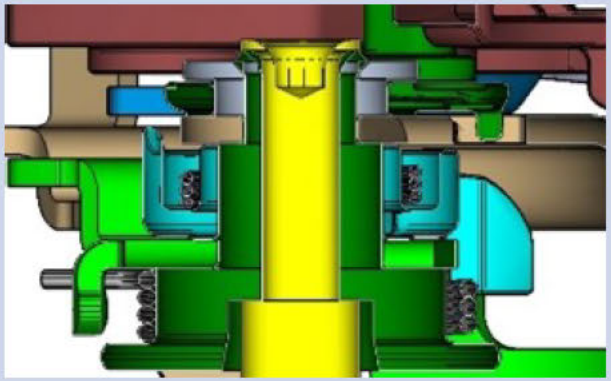
Output:

Are the factors causing the jammed status?

What is the probability of the identified critical factor?

What is the pobability for jamming?

PSCC 12.12.2017
KV-Function disabled in RFA – explain technical effect to latch „jammed“

Failure mode	„cord will not unwind“ (P068)	Spring jams KV mechanism
Technical influence of disabled KV function in RFA	 - green KV lever will stay in home position – KV mechanism can not jam in activated position	 - overall rotation angle of KV transmission lever (light blue) is reduced - Less tilting of KV transmission lever under load - different abrasion behavior expected
Will disabling the KV Function in the RFA solve the issue?	yes	no, spring could still move into the gap

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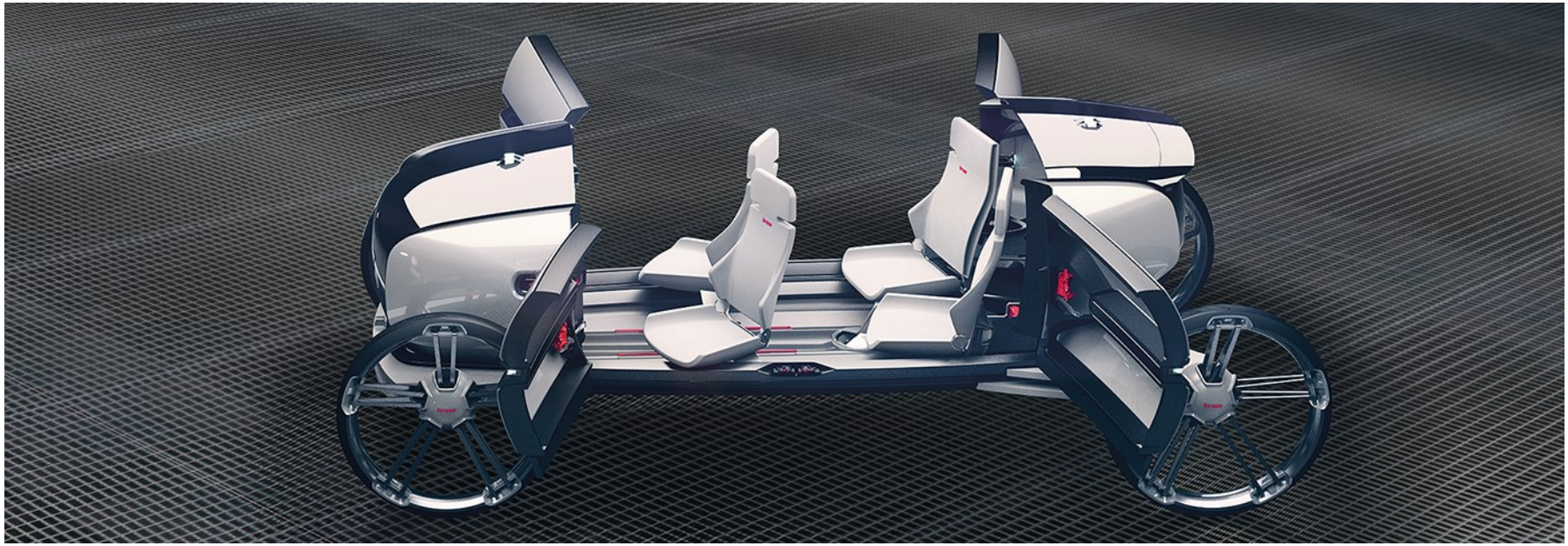


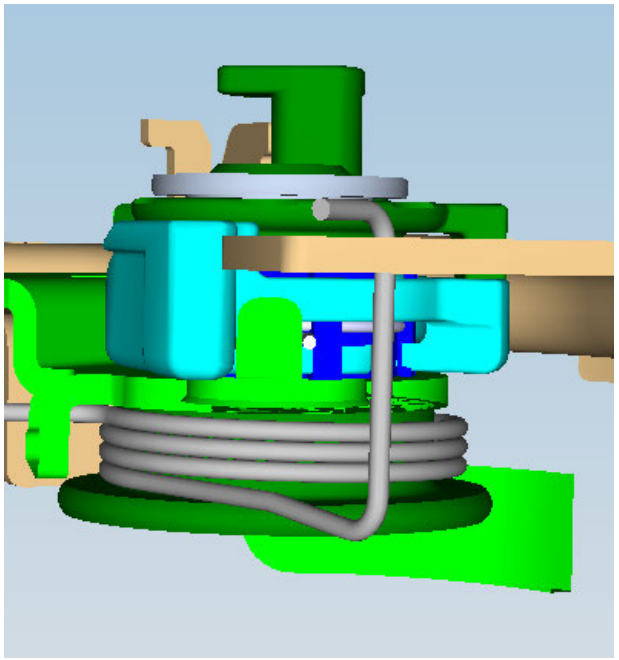
Questions from Mail Matt Newman

Key questions that were asked and require responding to are as follows;

-
- Current Production;
- 1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers (Tier 2, Tier 3 etc)?
- 2. What controls are in place at Brose Roznov to ensure supplier parts meet specification before being assembled into the latch?
- 3. How are we able to confidently say that the issue with the KV lever being out of specification and the bush chamfer being out of specification was resolved in May 2015?
- Future Production;
- 4. Complete DFMEA review
- 5. Assurance that all potential failure modes on the latch have been considered and mitigated, including any abrasion or wear and tear conditions that could reasonably be expected
- 6. What can Brose do, from a specification perspective, to ensure that parts supplied from Tier 2 and Tier 3 suppliers meet specification on function-critical parts

Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

Focus: KV-Subassy



Components

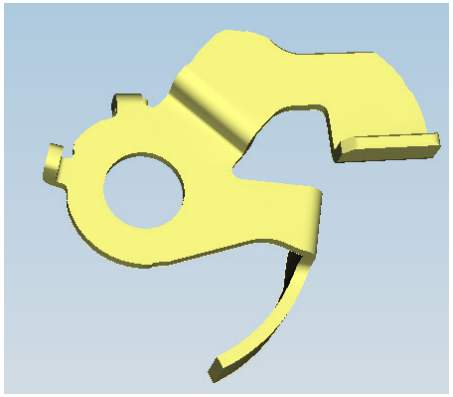
HEBEL (ABH-innen) LEVER
HEBEL (Kupplungshebel) LEVER
HEBEL (Uebertragungshebel) LEVER
FEDER (Schenkelfeder ABH-innen) SPRING
HUELSE (ABH-innen) BUSH
FEDER (Schenkelfeder Uebertragungshebel) SPRING
HUELSE (Kupplungshebel OBW) BUSH

Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

Component	Drawing SC´s	Feasebility	PPAP	CP check Incl. SC´s	Current cpk
Lever ORL 738819	3	confirmed	released	confirmed	capable
Lever D01886	2	confirmed	released	confirmed	capable
Lever D01888	0	confirmed	released	confirmed	n/a
Spring D02491	3	confirmed	released	confirmed	capable
Bush D01885	2	confirmed	released	confirmed	capable
Spring D01826	1	confirmed	released	confirmed	capable
Bush D01891	0	confirmed	released	confirmed	n/a

Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

Component	Drawing SC´s	Feasebility	PPAP	CP check Incl. SC´s	Current cpk
Lever ORL 738819	3	confirmed	released	confirmed	capable



LH

Dimension	Cpk
Profil 0,4	1,36
Profil 0,35 at M1	2,7
Profil 0,35 at M2	3,19
Dim 4,5 at P7	1,57
Dim 4,5 at P8	1,85

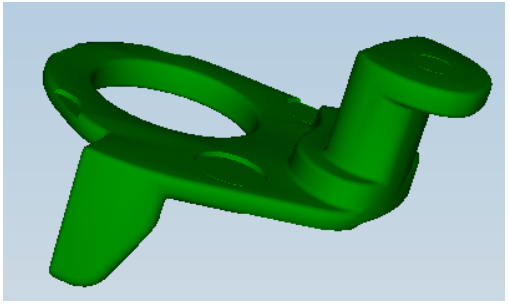
RH

Dimension	Cpk
Profil 0,4	1,34
Profil 0,35 at M1	3,72
Profil 0,35 at M2	7,45
Dim 4,5 at P7	1,33
Dim 4,5 at P8	1,62

Remark: SC´s not linked to KV jammed issue
Conclusion: Part is ok and under control

Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

Component	Drawing SC´s	Feasebility	PPAP	CP check Incl. SC´s	Current cpk
Lever D01886	2	confirmed	released	confirmed	capable



LH

Dimension	Cpk
Profil 0,1	2,21
Diam 9,6	2,56

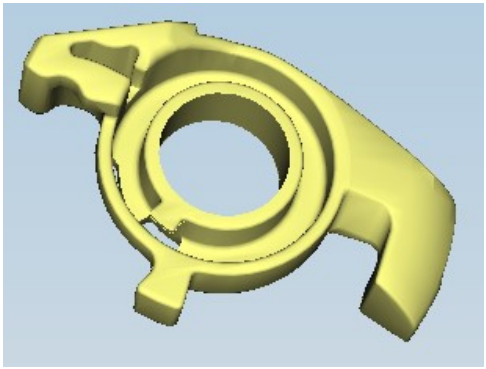
RH

Dimension	Cpk
Profil 0,1	2,04
Diam 9,6	1,93

Remark: SC´s not linked to KV jammed issue
Conclusion: Part is ok and under control

Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

Component	Drawing SC´s	Feasebility	PPAP	CP check Incl. SC´s	Current cpk
Lever D01888	0	confirmed	released	confirmed	n/a



LH

Dimension	Cpk
Diam 9,1	1,29
Height 5,2	1,57

Height 5,2-0,05

#	C01888	C01889
1	5,17	5,17
2	5,18	5,18
3	5,19	5,18
4	5,18	5,18
5	5,19	5,18
6	5,19	5,18
7	5,19	5,18
8	5,18	5,18
9	5,18	5,18
10	5,17	5,18
Min	5,17	5,17
Max	5,19	5,18
Average	5,18	5,18

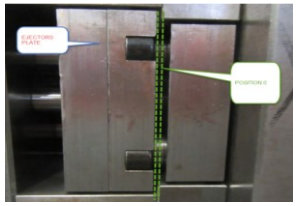
Conclusion: Part is ok and under control SC´s will be defined, see slide answer question 6

Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

C01888/9 KV-Transmission Lever actions since Mai 2016

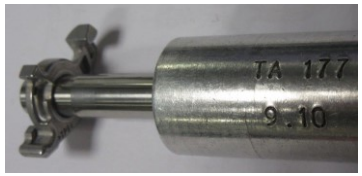
Problem: Height less than 5,2-0,05
Against occurence:
- Tool cleaning process improved
- Maintenance updated

Diecast tool



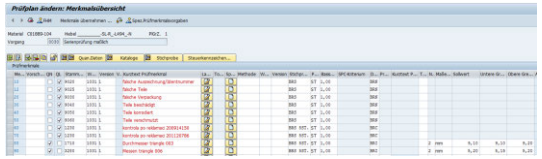
Against non detection, CP update:
- Included in 1st part release,
- Random check every 8 hours
of diameter (gauge) and height (caliper)

Diameter – Gauge TA177



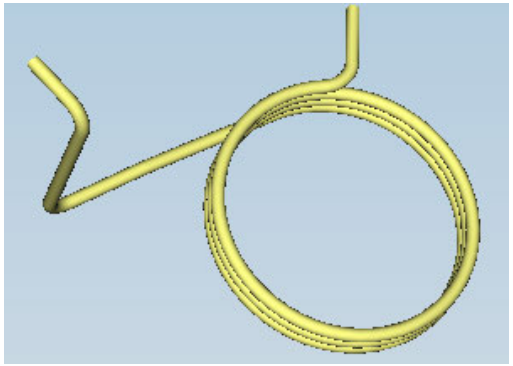
Brose since 23.11.2017
Incoming inspection of height and diameter
5 parts – each delivery

Control plan



Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

Component	Drawing SC´s	Feasebility	PPAP	CP check Incl. SC´s	Current cpk
Spring D02491	3	confirmed	released	confirmed	capable



LH Dimension	Cpk
M1	2,96
M2	3,58

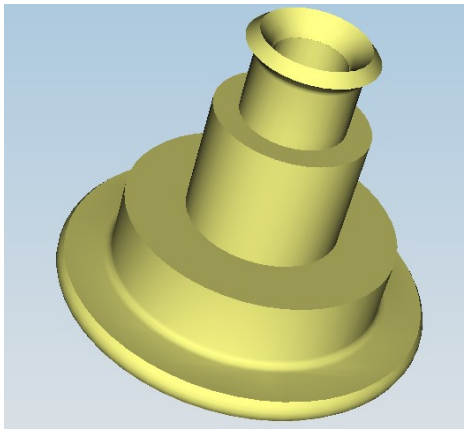
RH Dimension	Cpk
M1	3,18
M2	3,69

Third SC is regarding durability 200.000 cycles between M1 and M2

Remark: SC´s not linked to KV jammed issue
Conclusion: Part is ok and under control

Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

Component	Drawing SC´s	Feasebility	PPAP	CP check Incl. SC´s	Current cpk
Bush D01885	2	confirmed	released	confirmed	capable



Dimension Cpk

Diam 9	2,1
Dim 6,9	1,97
Chamfer -0,6	1,53
Chamfer -0,4	1,68

additional
additional

Remark: SC´s linked to KV jammed issue
Conclusion: Part is ok and under control

Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

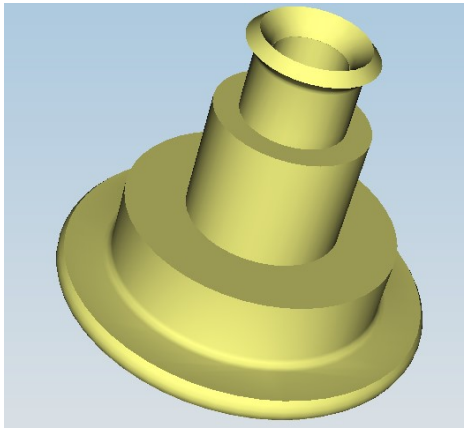
C01885 Bush actions since Mai 2016

Problem: Chamfer

Against occurence:
Improvement of tool venting

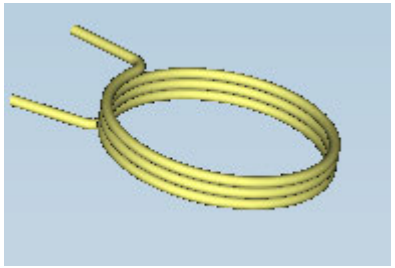
Against non detection:
New software for 100% camera chamfer detection.

Confirmed by supplier visit



Current Production;
1. What controls are currently in place that guarantee parts meet specification at Brose's suppliers

Component	Drawing SC´s	Feasebility	PPAP	CP check Incl. SC´s	Current cpk
Spring D01826	1	confirmed	released	confirmed	capable



LH Dimension	Cpk
M1	3,45
M2	3,71

RH Dimension	Cpk
M1	2,13
M2	2,44

Remark: SC´s not linked to KV jammed issue
Conclusion: Part is ok and under control

Current Production;
2. What controls are in place at Brose Roznov to ensure supplier parts meet specification before being assembled into the latch?

- Bush C01885-102
  - **Incoming inspection:**

  After claim in Mai 2016 the first two deliveries have been checked → result OK
  Standard incoming inspection (without counter measurment)

  - **Supplier audits:**

  2016 ISO 16949 → no major deviation found,
  2016 ISO 9001 → no major deviation found,
  2017 D part self assessment → result 100%

  - **Requalifications:**

  2017 Technical requalification → result OK

Current Production;
2. What controls are in place at Brose Roznov to ensure supplier parts meet specification before being assembled into the latch?

- KV Transmission Lever C01888/C01889-104
  - **Incoming inspection:**

After claim in Mai 2016 the first two deliveries have been checked → result OK
Standard incoming inspection: Height and diameter check added 23.11.2017

  - **Supplier audits:**

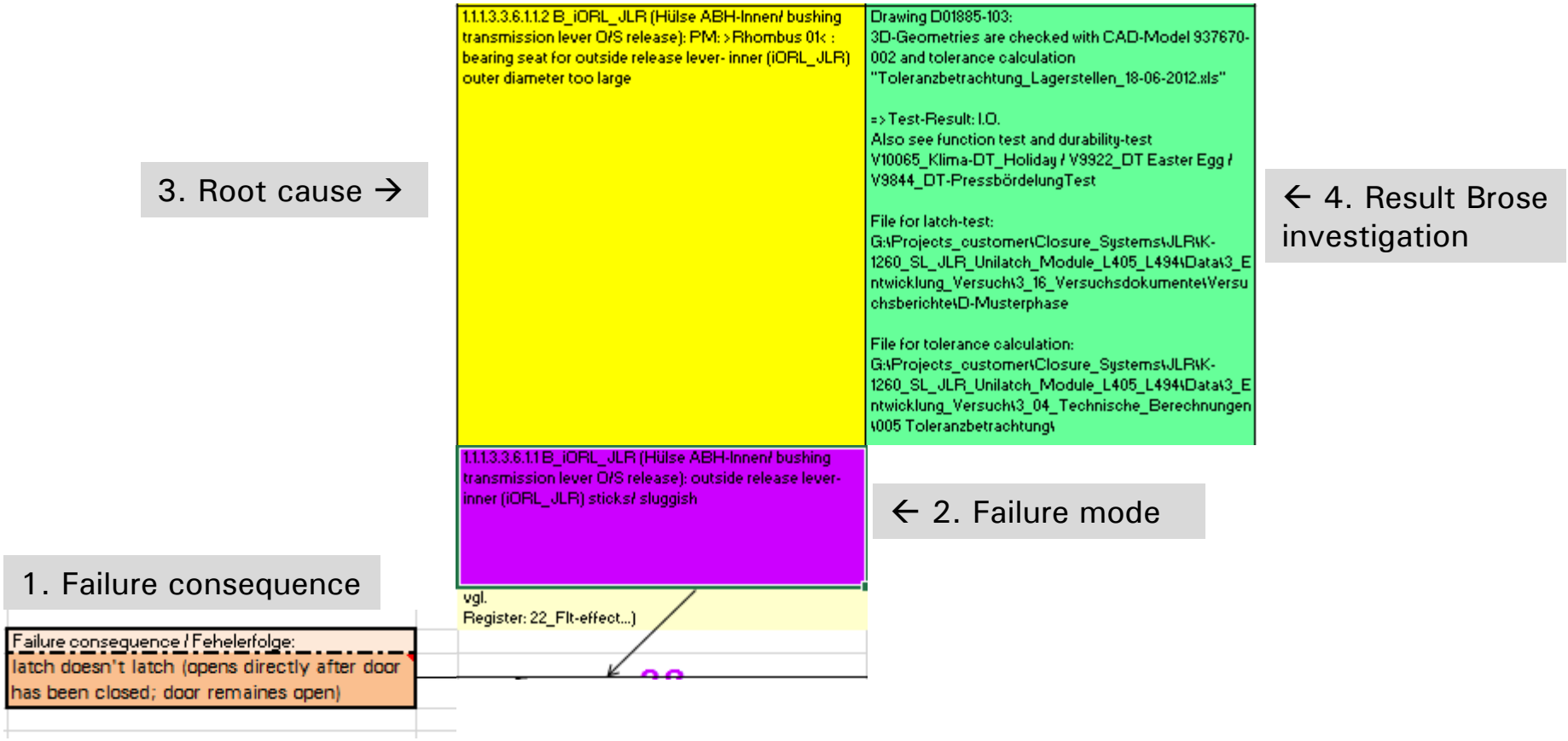
2016 ISO 16949 → no major deviation found,
2016 ISO 9001 → no major deviation found,
2017 P-Audit → result 94%
2017 D part selfassessment → result 90%

  - **Technical requalifications:**

In 2014 → result OK, no major deviation found,
In 2017 for different parts → result OK, no major deviation found.

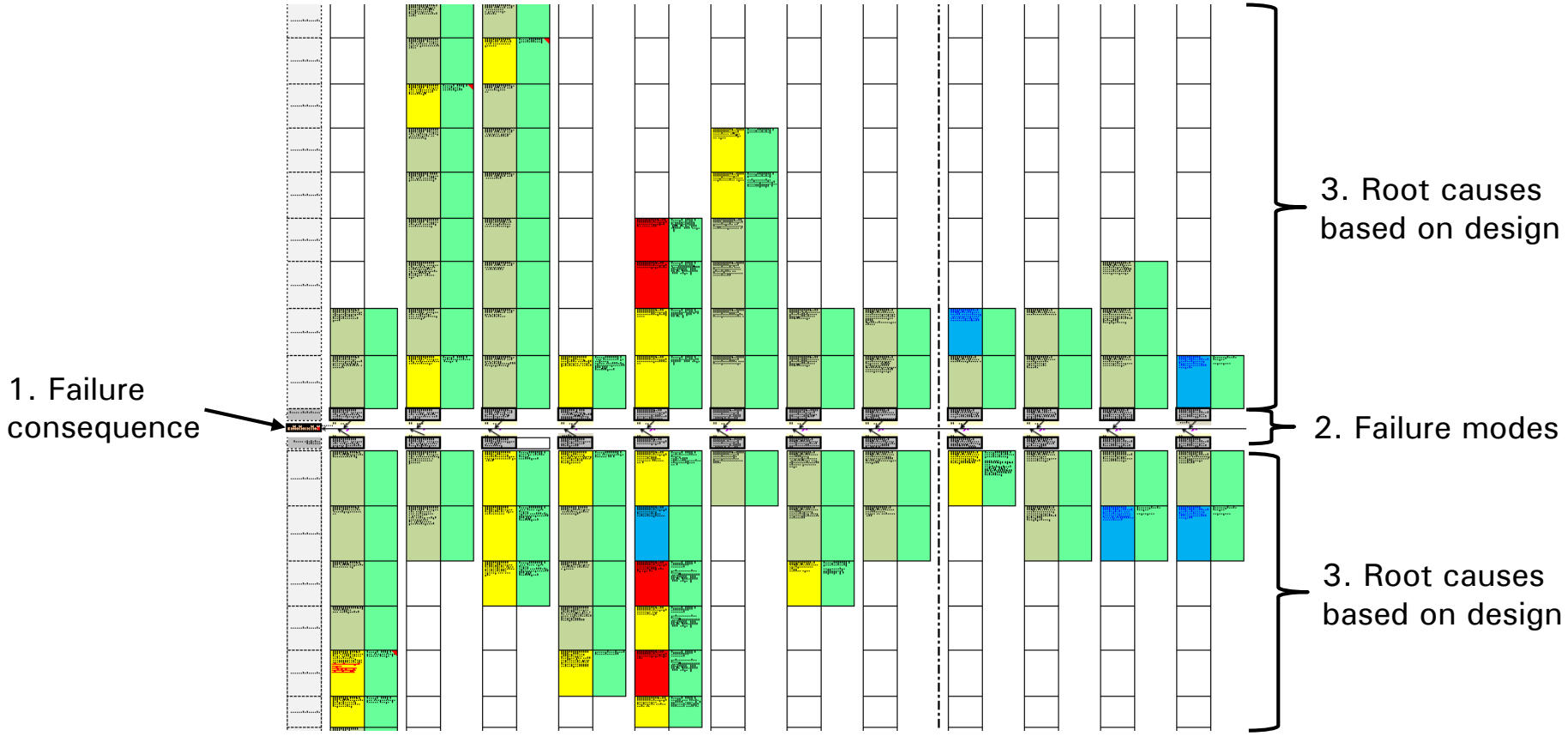
4. DFMEA review

- Logic for performed DFMEA review



4. DFMEA review

- Evaluated failures that could lead to the failure consequence „door will not latch“



5. potential further failure modes relating to wear out

- Brose uses Standard-DFMEA´s including Lessons Learned from the organisation
- Single parts will be evaluated for possible design failures and their influence regarding the latch function e.g.:
  - Part is too thick/too thin
  - Wrong material used
  - Freeplay too big/too small
  - Reset force too high / too weak

- Evaluation done in „one dimension“
  - Abrasion reduces lever height – does less height of the lever lead to functional failure?
- Seen failure mode requires more complex analysis
  - abrasion → bigger gap → spring into gap → wedging effect → jamming

→ This failure mode has been analysed in particular for other bearings in the KV release chain as well (see next slides)

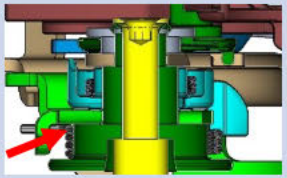
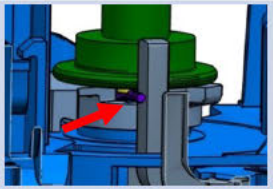
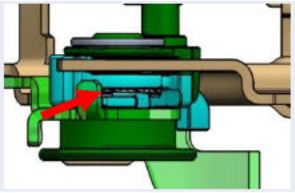
5. potential further failure modes relating to wear out

Investigation lever bearings

- Approach for evaluation of potential jamming:
  - Is spring leg positioned between moveable parts (e.g. levers)?
  - Can spring leg get between two parts (potential for jamming) in case of abrasion or too much play?

5. potential further failure modes relating to wear out

Investigation lever bearings

Investigated design	picture	Investigation result
Spring outside transmission lever		- currently discussed failure mode - If parts are nok (chamfer too big, lever too thin) spring can be forced in the area of chamfer
CL clutch spring		Evaluated → no risk of jamming
Spring pawl		Evaluated → no risk of jamming
Spring KV transmission lever		Evaluated → no risk of jamming
Further designs to be investigated	KV-Hebel + ABH aussen	

6. Single part specification on function-critical parts

bush outside transmission lever

- Link failure consequence „door will not latch“ with „chamfer bush outside transmission lever too large“

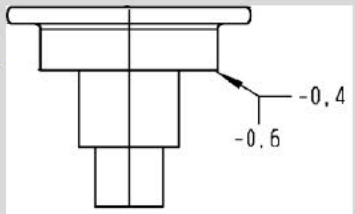
→ Failure consequence „door will not latch“ will require severity of 10 in FMEA

- Change of severity will generate an CC evaluation

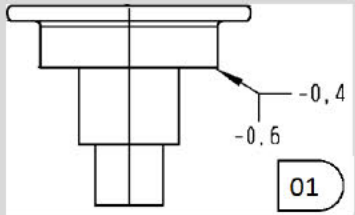
→ Bush supplier already implement 100% camera check on this characteristic

- Control of suppliers can further be improved:
  - Certified delivery

Current status - bush



Future status - bush



6. Single part specification on function-critical parts

KV transmission lever

- Link failure consequence „door will not latch“ with „KV transmission lever too thin“

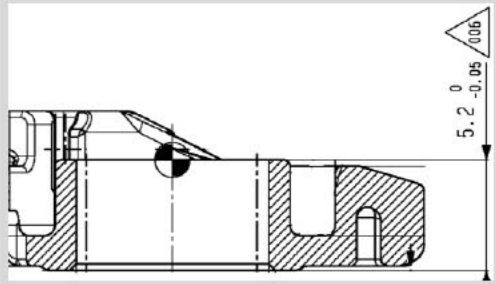
→ Failure consequence „door will not latch“ will require severity of 10 in FMEA

- Change of severity will generate an CC evaluation

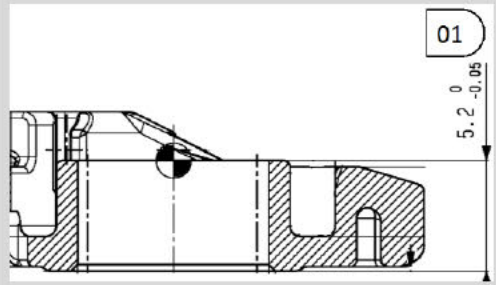
→ Supplier needs to implement ongoing process control

- Control of suppliers can further be improved:
  - Spot check of delivered parts during incoming inspection at Brose

Current status - lever



Future status - lever



Next Steps

- Finalise D-FMEA review regarding bearing areas — cw50/2017 done
- Evaluate CC and SC characteristics on further single parts Oliver — cw50/2017 open
- Defined characteristics of bushing and KV transmission lever to be implemented in supplier process (Change management) Oliver timing — cw04/2018 open

Brose will focus on investigation of robustness increase of latch design, as follows:

- Forced resetting of O/S transmission lever detailed planning to be done — Q3-2018 open Oliver
- Investigate feasibility of smaller chamfer on bushing Uwe (drawing with -0,2 to -0,3) — cw04/2018 open
- Investigate feasibility of more wear-resistant material of KV-transmission lever ordered for cw7) — tbd open (ZP2 in

brose

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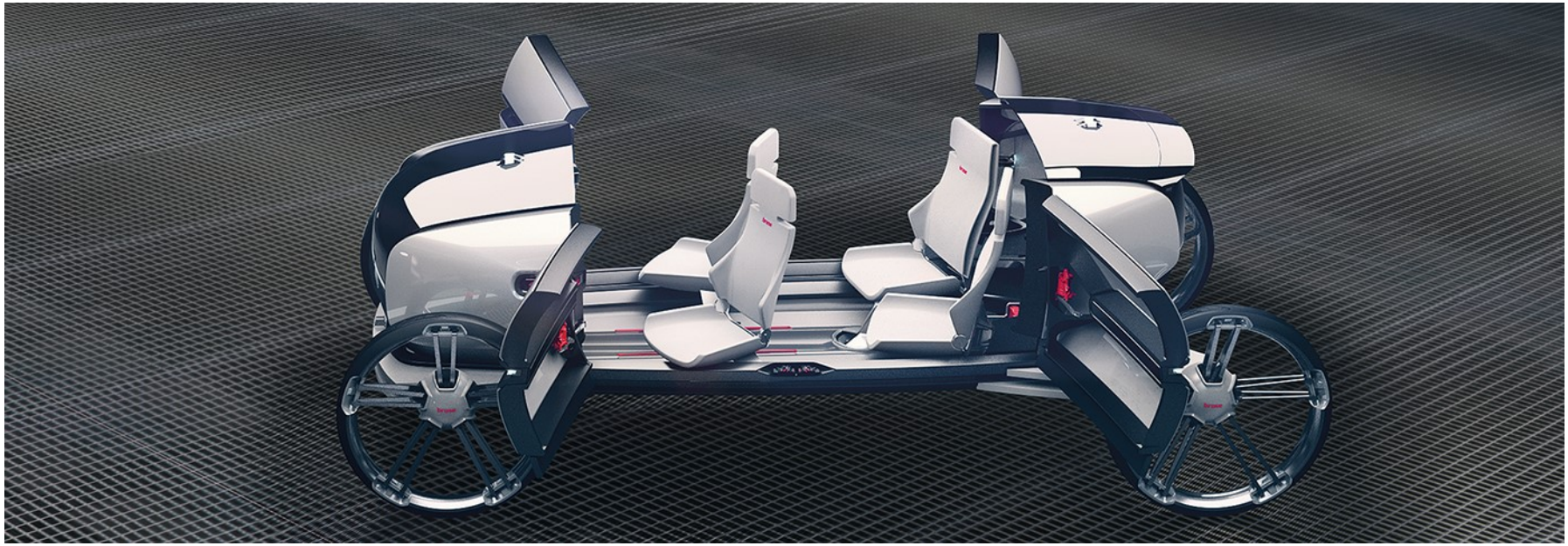
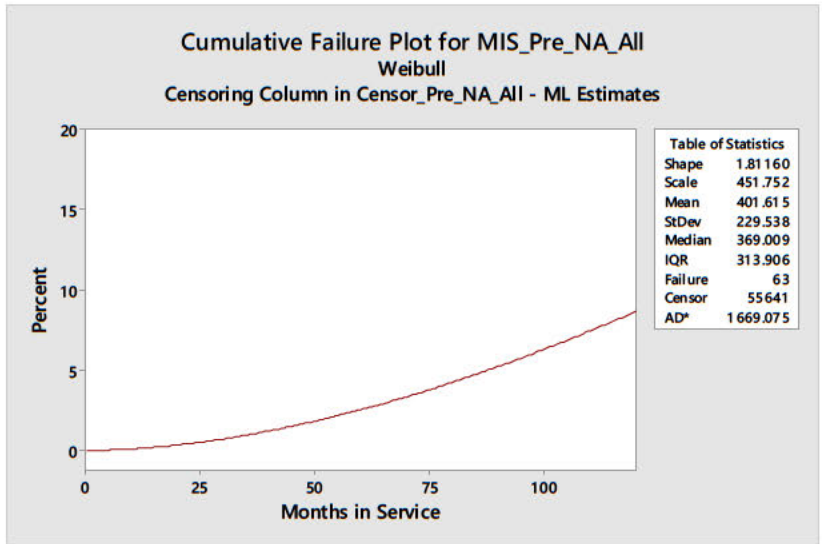


POST P068 REPORTS – NORTH AMERICAN DATA SET ONLY

PARAMETRIC PREDICITON MODELS – 10 YEARS IN SERVICE

POST-P068 REPORTS ANALYSIS

NHTSA PRE-P068 "FAILURE TO LATCH"



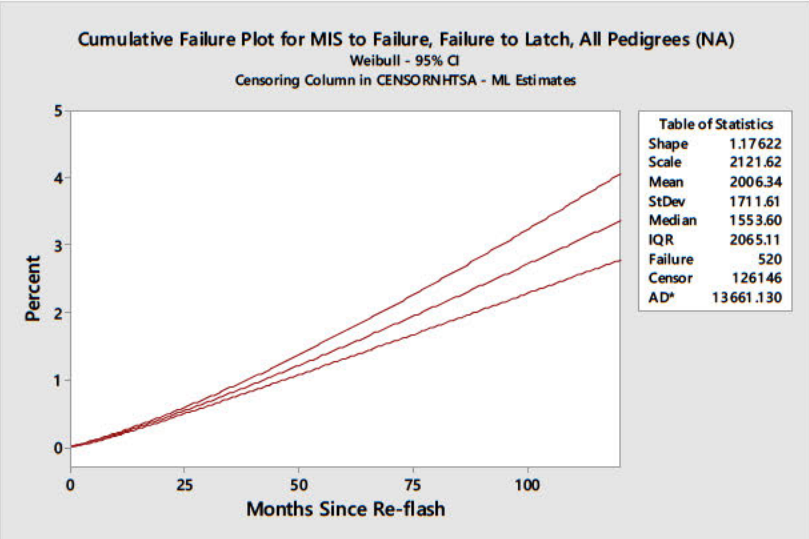
	95% CI		
MIS_Pre_NHTSA	Percent	Lower Boundary	Upper Boundary
3	0.01	0.01	0.02
9	0.08	0.06	0.11
15	0.21	0.16	0.27
21	0.38	0.29	0.52
27	0.61	0.42	0.87
33	0.87	0.58	1.31
39	1.18	0.74	1.86
45	1.52	0.92	2.52
51	1.90	1.10	3.28
57	2.32	1.30	4.14
63	2.78	1.50	5.11
69	3.27	1.72	6.18
75	3.79	1.94	7.35
81	4.35	2.17	8.62
87	4.93	2.41	9.98
93	5.55	2.65	11.43
99	6.19	2.90	12.97
105	6.86	3.16	14.59
111	7.56	3.42	16.29
117	8.29	3.69	18.07

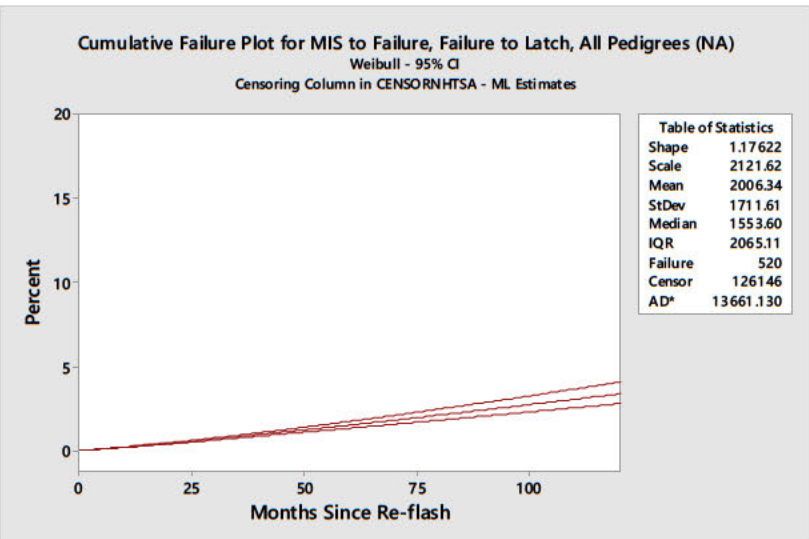
Pre-P068 action, the predicted parametric model indicates a worst case report rate of "Failure to Latch" of 180.7 R/1000 at ten years in service, covering all known failure modes. The global prediction for the same error state is 253.4 R/1000. Nominally the predicted failure rate is 82.9 R/1000.

Note the y-axis has been locked at 20%

POST-P068 REPORTS ANALYSIS

NHTSA POST P068 “FAILURE TO LATCH”





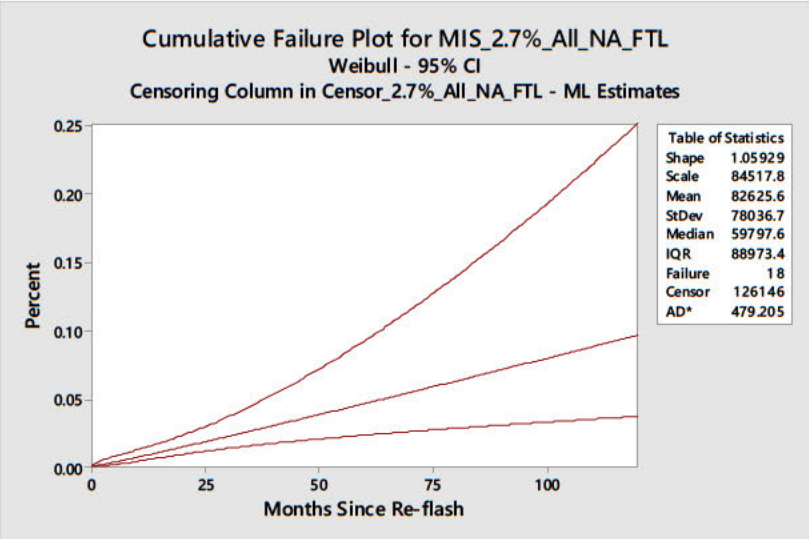
y-axis locked at 20% (direct comparison with pre-P068 failure rate

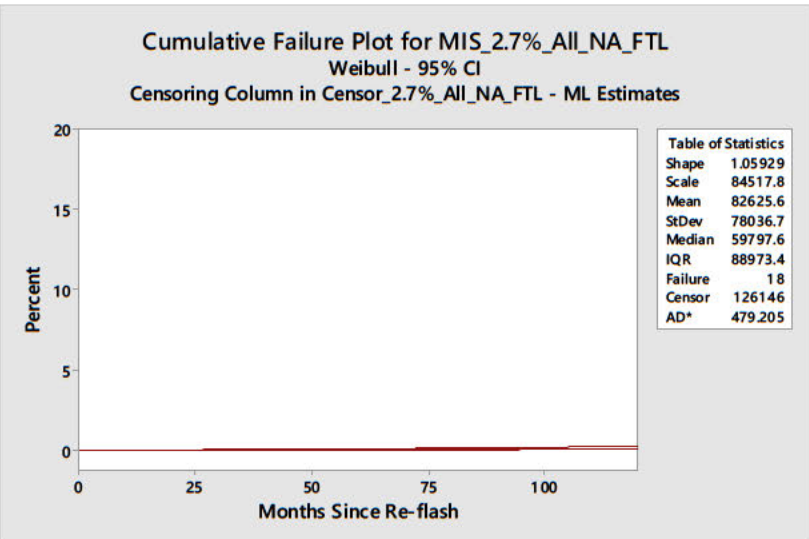
		95% CI		
MIS	Percent	R/1000	Lower Boundary	Upper Boundary
3	0.044484	0.444841	0.036141	0.0547528
9	0.161864	1.61864	0.143813	0.182179
15	0.294988	2.94988	0.269245	0.323188
21	0.437897	4.37897	0.401897	0.477114
27	0.588061	5.88061	0.53762	0.64322
33	0.744029	7.44029	0.675104	0.819962
39	0.904845	9.04845	0.813967	1.00582
45	1.06982	10.6982	0.954044	1.19957
51	1.23845	12.3845	1.09521	1.40029
57	1.41032	14.1032	1.23738	1.60725
63	1.58511	15.8511	1.38044	1.81985
69	1.76254	17.6254	1.52432	2.03761
75	1.94239	19.4239	1.66895	2.26012
81	2.12446	21.2446	1.81425	2.48703
87	2.30858	23.0858	1.96018	2.71804
93	2.49459	24.9459	2.10667	2.95286
99	2.68238	26.8238	2.25369	3.19128
105	2.87181	28.7181	2.40119	3.43305
111	3.06279	30.6279	2.54912	3.678
117	3.25522	32.5522	2.69747	3.92595

Post P068 action, the predicted parametric model indicates a worst case report rate of “Failure to Latch” of 39.25 R/1000 at ten years in service, covering all known failure modes. Nominally the prediction is 32.5 R/1000

POST-P068 REPORTS ANALYSIS

NHTSA POST P068 “FAILURE TO LATCH” – 2.7% MODIFIER





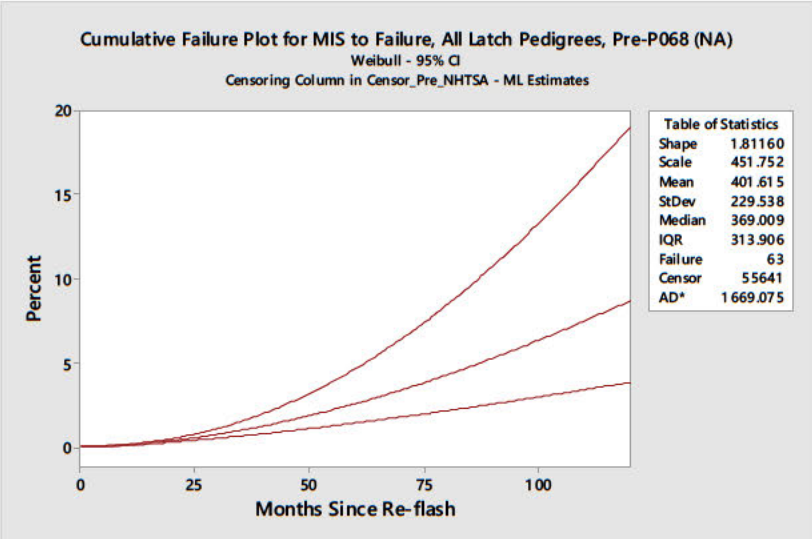
y-axis locked at 20% (direct comparison with pre-P068 failure rate

	95% CI	
MIS_2.7%_All_NA_FTL	Percent	Lower Boundary	Upper Boundary
3	0.00	0.00	0.01
9	0.01	0.00	0.01
15	0.01	0.01	0.02
21	0.02	0.01	0.02
27	0.02	0.01	0.03
33	0.02	0.01	0.04
39	0.03	0.02	0.05
45	0.03	0.02	0.06
51	0.04	0.02	0.07
57	0.04	0.02	0.09
63	0.05	0.02	0.10
69	0.05	0.03	0.11
75	0.06	0.03	0.13
81	0.06	0.03	0.14
87	0.07	0.03	0.16
93	0.07	0.03	0.17
99	0.08	0.03	0.19
105	0.08	0.03	0.21
111	0.09	0.04	0.22
117	0.09	0.04	0.24

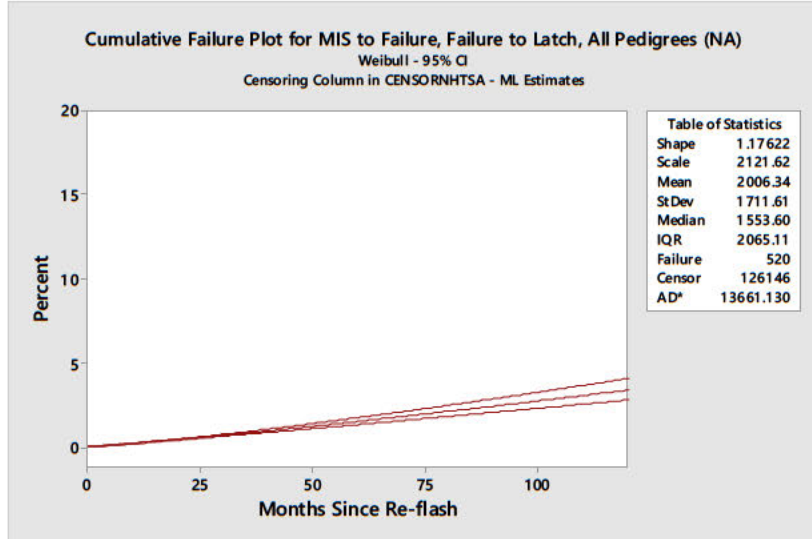
Post P068 action, using a modifier of 2.7% and applying this pre-processing to the quantity of reports, the model indicates a worst case report rate of “Failure to Latch” of 2.4 R/1000 at ten years in service, *covering specifically corroded KV actuators*. Nominally the prediction is 0.9R/1000

POST-P068 REPORTS ANALYSIS

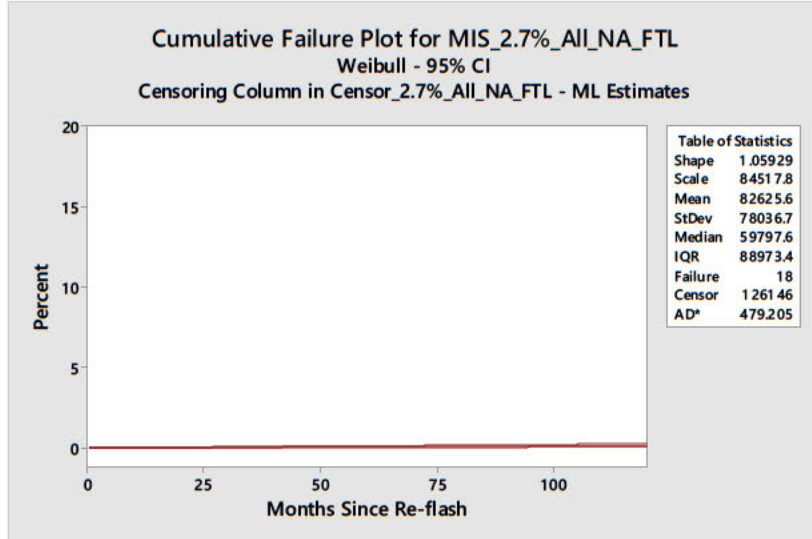
NHTSA POST P068 “FAILURE TO LATCH” COMPARISON



Pre-P068 Predicted Failure Rate at 10 years in service, all failure modes



Post-P068 Predicted Failure Rate at 10 years in service, all failure modes



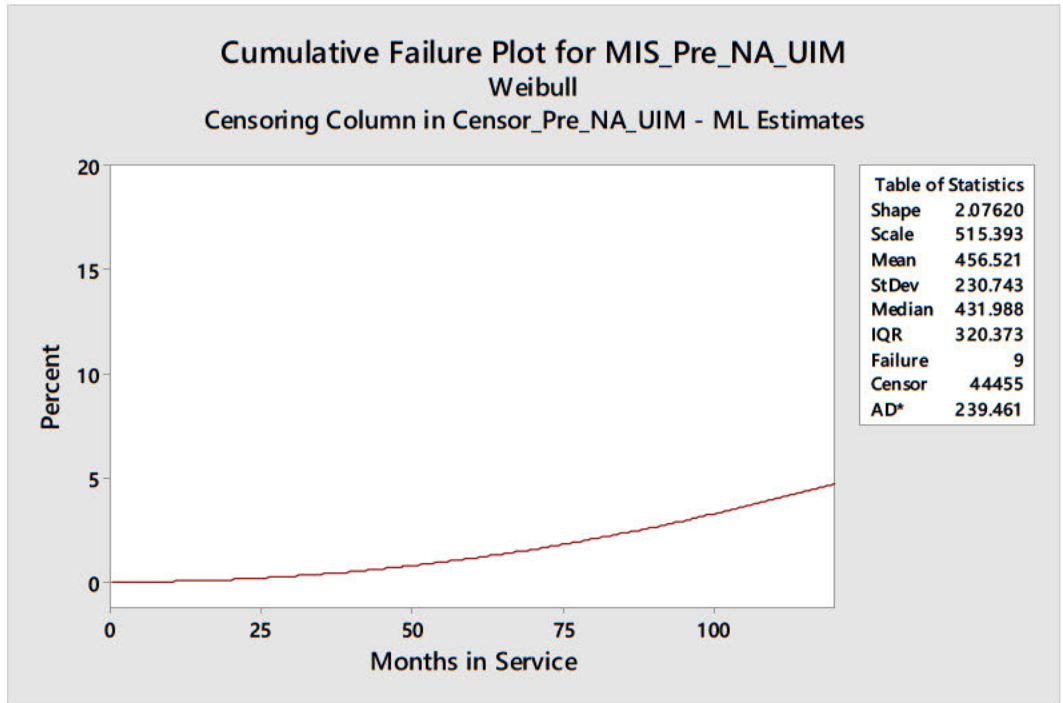
Post-P068 Predicted Failure Rate at 10 years in service, corroded KV actuator specific

We know from returned latches that 2.7% of them are confirmed as failing due to a corrode KV actuator. Using 2.7% as a modifier for the data set before processing delivers the expected failure rate for the corrosion specific failure mode;

Pre-P068 prediction at 10 years in service is	82.9 R/1000
Post-P068 prediction at 10 years in service is	32.5 R/1000
Post-P068 prediction at 10 years in service (KV Actuator Corrosion) is	0.9 R/1000

POST-P068 REPORTS ANALYSIS

NHTSA PRE P068 “UNLATCHED IN MOTION (UIM)”



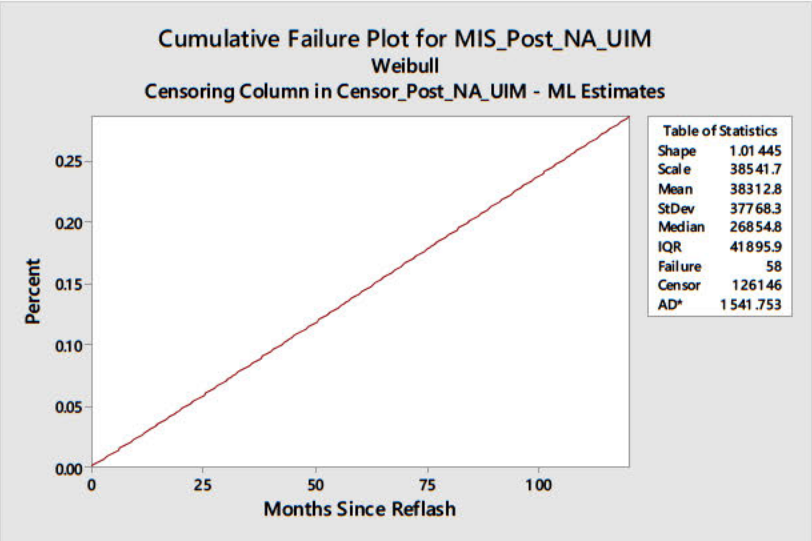
MIS_Pre_NA_UIM	Percent	R/1000
3	0.00	0.02
9	0.02	0.22
15	0.06	0.65
21	0.13	1.30
27	0.22	2.19
33	0.33	3.32
39	0.47	4.69
45	0.63	6.31
51	0.82	8.18
57	1.03	10.29
63	1.26	12.65
69	1.53	15.26
75	1.81	18.12
81	2.12	21.22
87	2.46	24.58
93	2.82	28.17
99	3.20	32.01
105	3.61	36.10
111	4.04	40.42
117	4.50	44.99

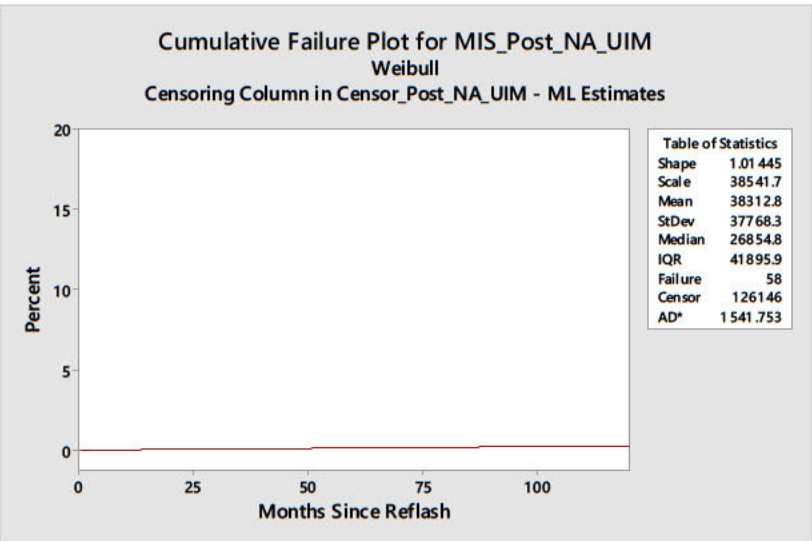
Pre-P068 action, the predicted parametric model indicates a nominal report rate of “Unlatched in Motion” of 45 R/1000 at ten years in service, covering all known failure modes

Note the y-axis has been locked at 20% as with the previous prediction (200 R/1000)

POST-P068 REPORTS ANALYSIS

NHTSA POST P068 “UNLATCHED IN MOTION (UIM)”





y-axis locked at 20% (direct comparison with pre-P068 failure rate

MIS_Post_NA_UIM	Percent	R/1000
3	0.01	0.07
9	0.02	0.21
15	0.03	0.35
21	0.05	0.49
27	0.06	0.63
33	0.08	0.77
39	0.09	0.92
45	0.11	1.06
51	0.12	1.20
57	0.13	1.35
63	0.15	1.49
69	0.16	1.63
75	0.18	1.78
81	0.19	1.92
87	0.21	2.06
93	0.22	2.21
99	0.24	2.35
105	0.25	2.50
111	0.26	2.64
117	0.28	2.79

Post P068 action, the predicted parametric model indicates a report rate of “Unlatched in Motion” at ten years in service, covering all known failure modes of 2.8 R/1000

POST-P068 REPORTS ANALYSIS

NHTSA POST P068 “UNLATCHED IN MOTION (UIM)” – 2.7%

MIS	Reports	2.7% Modifier
25	1	0
24	1	0
23	1	0
22	6	0
21	1	0
20	0	0
19	3	0
18	1	0
17	1	0
16	3	0
15	4	0
14	2	0
13	3	0
12	1	0
11	1	0
10	0	0
9	1	0
8	3	0
7	2	0
6	4	0
5	2	0
4	1	0
3	7	0
2	5	0
1	4	0

The data set, once modified to a rate of 2.7%, yields zero failures when rounded to the nearest full integer.

Parametric analysis cannot occur on this data set.

However, in summary, the forecasted failure rate would be 0 R/1000 at 10 years in service for the failure mode “Unlatched in Motion”

Pre-P068 prediction at 10 years in service is	45.0 R/1000
Post-P068 prediction at 10 years in service is	2.80 R/1000
Post-P068 prediction at 10 years in service (KV Actuator Corrosion) is	0.00 R/1000

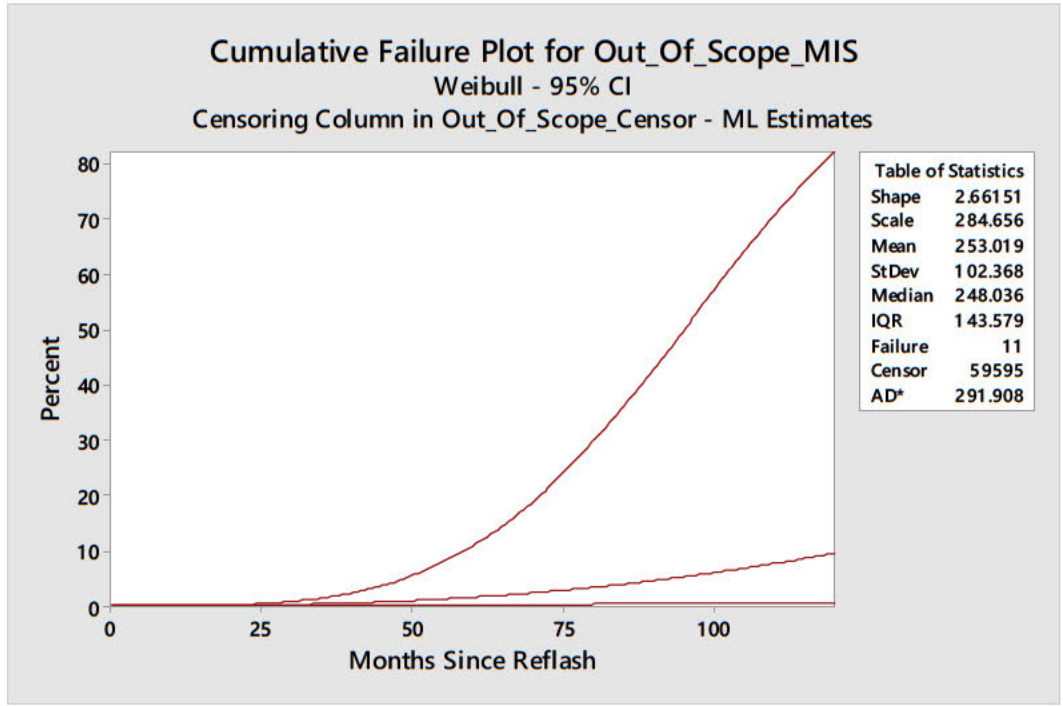
POST-P068 RETURNS
WHAT IS THE FAILURE MECHANISM?

- Latch “blind spot” issue – fixed on L405 rear doors only in July 2014. Can still occur L405 fronts and L494 all doors
- Cinch transmission lever spring location – fixed in production Oct 2015
- Exterior release handle jamming after actuation – strap modification in production May 2014
- KV motor cord wound and jammed - spring strength increase in Aug 2014
- RFA software applying short circuit to KV motor – software fixed in production Dec 2015
- KV transmission lever jammed by spring – bush and lever controls implemented Jun 2016
- Exterior release handle jamming (ii) – handle chassis modification in production Feb 2017
- Cinch motor multiwall broken – cable reversed in production Aug 2017
- Cinch motor cable disconnected from the multiwall – ongoing (QSF)
- Customer sensitive to latch issues on L405 and L494

	Ajar Warning	Physical Indicator	Hazardous
Blind Spot	N	N	N
Cinch Spring	Y	Y	N
Exterior Handle (i)	N	Y	N
KV Motor Cord	N	N	Y
Jammed KV Transmission Lever	N	N	Y
RFA Software	N	N	Y
Exterior Handle (ii)	N	Y	N
Cinch Multiwall Broken	Y	Y	N
Cinch Cable Disconnected	Y	Y	N

Definition for Hazardous; A door that can appear fully closed, without the ajar warning on the instrument pack, and with no physical indicators that are clearly visible to the customer that there is an error state present, that fails to secure in both the primary and secondary latched positions.

POST-P068 RETURNS
OUT OF SCOPE FAILURES



	95% CI		
Out_Of_Scope_MIS	Percent	Lower Boundary	Upper Boundary
3	0.00	0.00	0.00
9	0.01	0.00	0.02
15	0.04	0.02	0.07
21	0.10	0.04	0.22
27	0.19	0.07	0.54
33	0.32	0.09	1.15
39	0.50	0.12	2.15
45	0.73	0.14	3.71
51	1.02	0.17	5.94
57	1.37	0.20	8.99
63	1.79	0.23	12.98
69	2.27	0.27	17.96
75	2.83	0.30	23.97
81	3.46	0.34	30.92
87	4.17	0.37	38.67
93	4.97	0.41	46.97
99	5.84	0.45	55.50
105	6.79	0.48	63.91
111	7.83	0.52	71.82
117	8.96	0.56	78.91

The Out Of Scope reports for Unlatched in Motion (UIM) have 11 reports post recall scope.

These have been plotted against the build volumes for the months in question, NA market sold vehicles only.

The intervals are too wide to have confidence in the prediction.

POST-P068 RETURNS
OUT OF SCOPE FAILURES

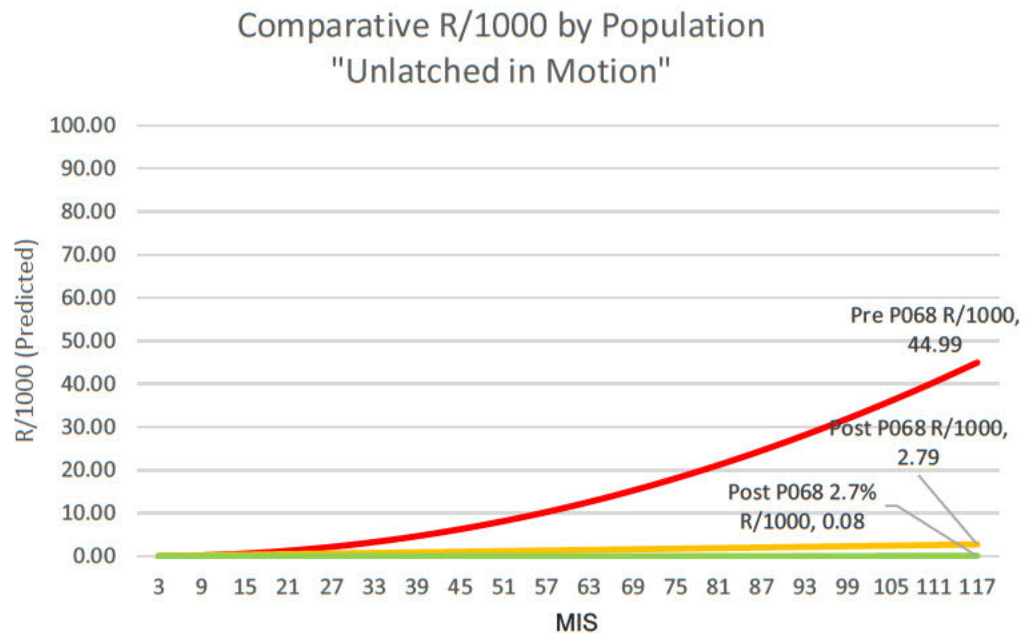
DOC_NUM	Category	Vehicle owner or fleet name (and fleet contact person) street address, email address and telephone number;	VIN_CD	Last Six	Build date	Mode
434419C	Consumer complaint		[redacted]		27/02/2015	Range Rover
523901A	Consumer complaint				08/04/2015	Range Rover Sport
611710A	Consumer complaint				09/05/2015	Range Rover
256008D	Consumer complaint				13/05/2015	Range Rover
597668A	Consumer complaint				14/08/2015	Range Rover
043636A	Consumer complaint				29/09/2015	Range Rover Sport
192885A	Consumer complaint				05/11/2015	Range Rover
011985A	Consumer complaint				16/11/2015	Range Rover Sport
112403B	Consumer complaint				25/01/2016	Range Rover Sport
265792E	Consumer complaint				04/04/2016	Range Rover
103909A	Consumer complaint				04/04/2016	Range Rover Sport

These vehicles are all built with short circuit RFA software
Common cause failure

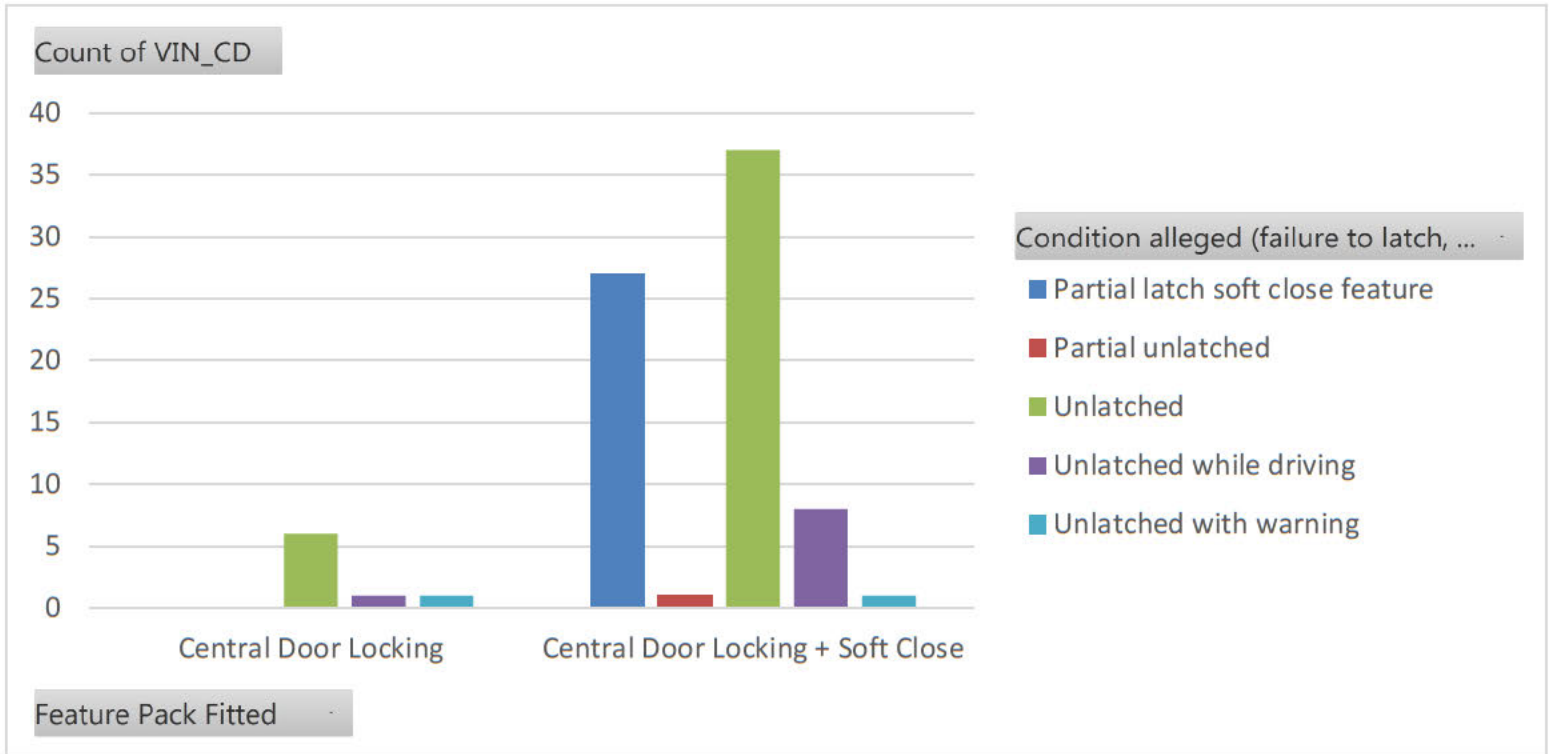
These vehicles all fall within the jammed KV clutch build window
Special cause failure

POST-P068 RETURNS

COMPARATIVE ANALYSIS BY FAILURE MODE BY POPULATION



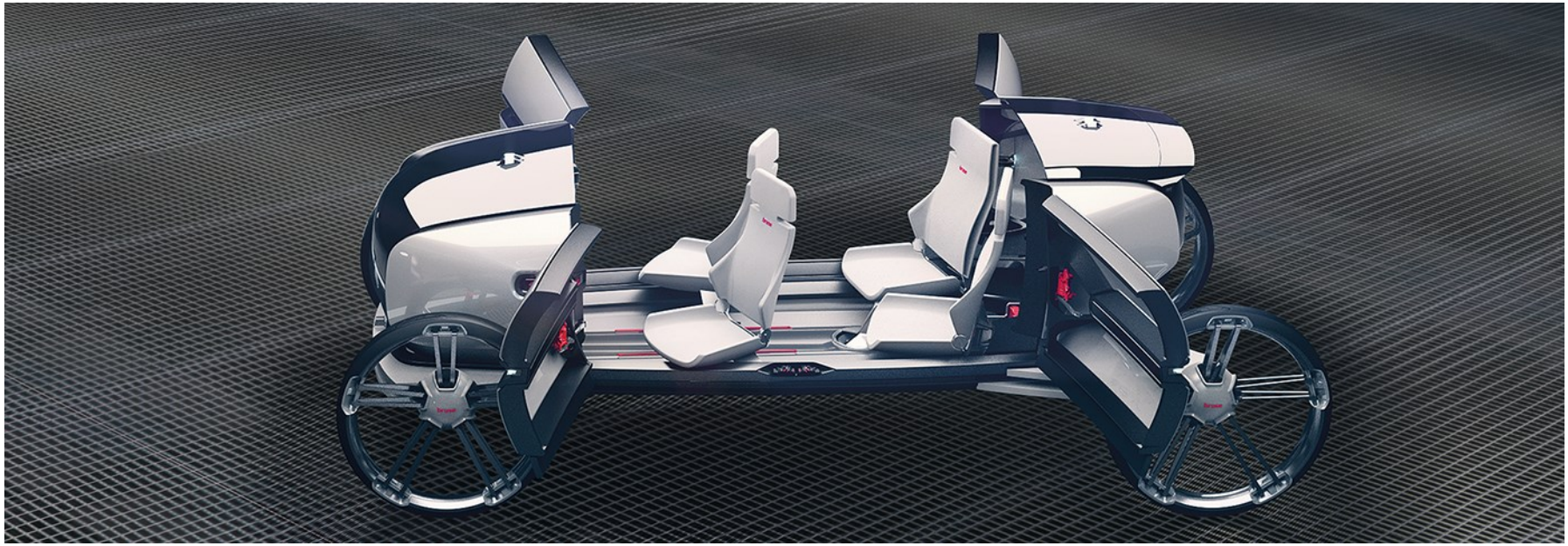
POST-P068 RETURNS
NHTSA FEATURE ANALYSIS – SOFT CLOSE



Most of the 84 originally confirmed reports come from vehicles fitted with a soft close feature

Of the 8 vehicles without soft close feature, 6 were reported as unable to latch, 1 unlatched while driving (which still does not mitigate the potential blind spot), and one unlatched with warning

JLR Uni-latch High End KV



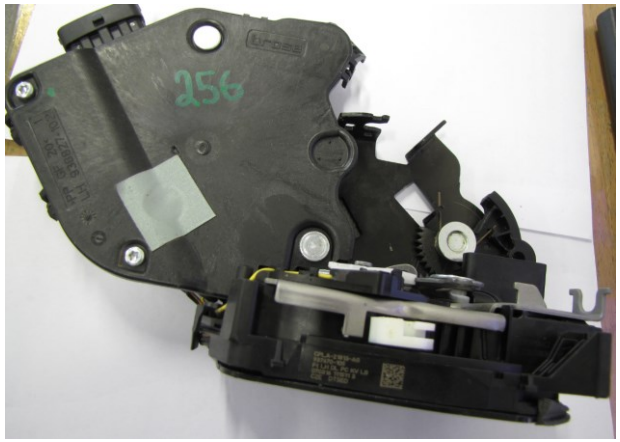
Brose Roznov, 21.09.2017

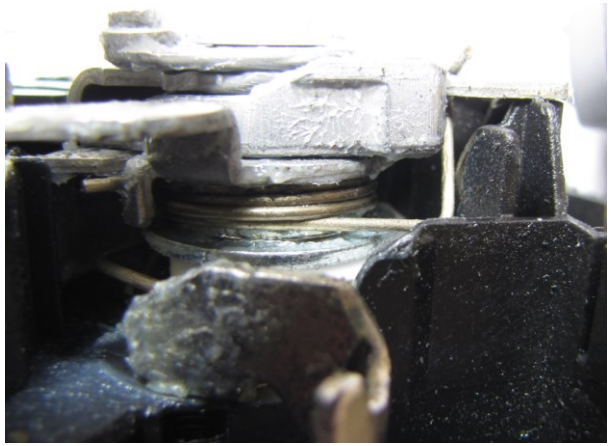
[redacted]

- **General:**
  - 5 latches have been received: [redacted].
- **Analysis:**
  - Customer verbatim:
    - *„Will not latch or door bounce back“.*
  - Technician verbatim:
    - Issue confirmed, replace door latch, test, OK.
  - Visual inspection:
    - Latches have been received in not failed conditions,
    - KV lever in home position,
    - KV transmission lever in home position,
    - No corrosion of KV motor,
    - Greasing OK,
    - No issues detected.
  - Electrical check:
    - All functions OK on IDU 2 and TB,
    - KV function checked 25x times, seal load 311N included → failure is not reproduciable.
    - No issues detected.
  - Mechanical check:
    - All levers release or non release in all states as it is specified.
    - No issues detected.

[redacted]

- **Systematic disassembly:**



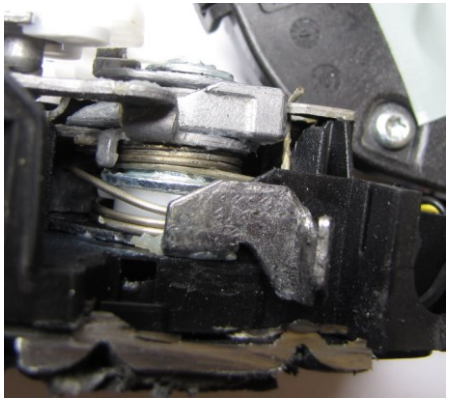


- All single components have been assembled correctly,
- Abbrasion on KV transmission lever detected,
  - Height: 5,04/4,95mm
- Damage on bush surface from spring detected.

Conclusion: Spring winding jammed between outside release lever and bush as per [redacted].

[redacted]

- **Systematic disassembly:**



- All single components have been assembled correctly,
- Abbrasion on KV transmission lever detected,
  - Height: 5,05/4,95mm
- Damage on bush surface from spring detected.

Conclusion: Spring winding jammed between outside release lever and bush as per [redacted]

- **Next steps:**
  - 3D scan of KV transmission lever and bush, TBD CW39.
  - Failure simulation:
    - Following carset to be build:
      - 2 latches:
        - bush with milled chamfer 0,1mm above the spec.
        - KV transmission lever from:
        - [redacted], height: 5,04/4,95mm,
        - [redacted], height: TBD/4,92mm.
      - 2 latches:
        - Serial latches from current production.
    - Test specification:

Test:	Reproduce failure mode "sticky KV-transmission lever"	
Latches with:	KV-Transmission lever from field parts approx 5mm (Spec. 5,2 -0,05)	
	Bush with champfer similar to field part - 0,5 (Spec. -0.4) and -0,7 (Spec. -0.6)	
	Rest: current series components	
Variant:	LH latches	
Amount:	2	
	2	total series parts for comarison
Procedure:		
	Testing within specification limit did not leed to any failed function in validation/requalification test	
	Test procedure needs to be definded with conditions out of specification	
Potential criteria:		
	Number of needed cycles according MTF of field parts = 10% of spec. cycles	
	Wet-Dust application directly to critical KV-lever area to provoke abrasion	
	Salt spray application earlier in test sequence	
	Temperature / humidity	
	We need extra storage time simulate real conditions in usage	
Timing		
	Procedure	22.09.2017
	Test duration	approx. 30% of total life cycle testing (approx 3 weeks)
	Test start	tbd

brose

System supplier of the international automotive industry