EA11003EN-00826[0]

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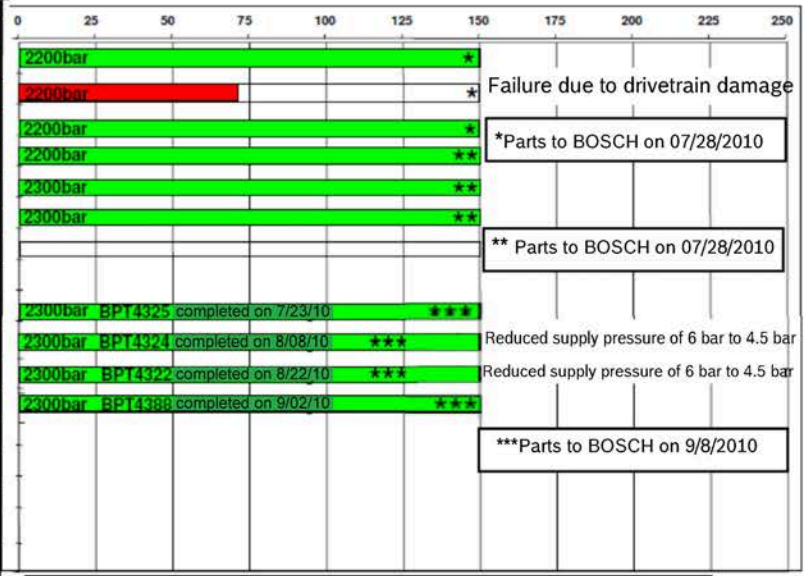
TF: Audi overload tests

Status of check - CP4.2 with series / RP1 / RP2

Audi IAV GmbH KW36

Pump test bench trial - CP4.2

Pump type	Test type	ER start SET	Fuel type	Actual running time)	Target running time
Serie (C3)	QHALT	15/10	EU3	150	150
Serie (C3)	QHALT	15/10	EU3	68	150
Serie (C3)	QHALT	16/10	EU3	150	150
Serie (C3)	QHALT	18/10	EU3	150	150
RP1 (C2)	QHALT	19/10	EU3	150	150
RP1 (C2)	QHALT	20/10	EU3	150	150
RP2 (C2)	QHALT	29/10	EU3	150	150
RP2 (C2)	QHALT	30/10	EU3	150	150
RP2 (C2)	QHALT	31/10	EU3	150	150
RP2 (C2)	QHALT	??/10	EU3	150	150



Inflow pressure (rel.)	3.5 bar	4.0 bar	4.5 bar	5.0 bar
ml/15s	600	940	1280	1550
l/h	144	225,6	307,2	372

Comments:

Audi Vorsprung durch Technik

BOSCH

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TF: Audi overload tests

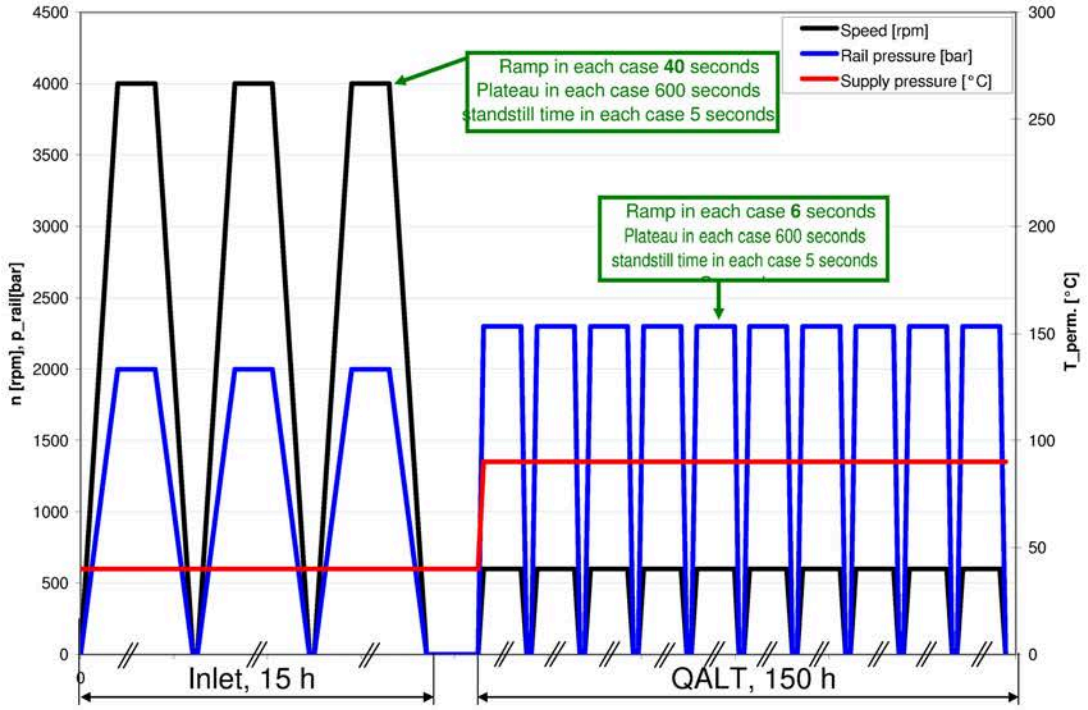
Test conditions

Overload test on drivetrain - CP4 LR/RS-QALT

Variant 1: Mixed friction at low speeds

Start-up program (15 h, 4000 rpm, 2000 bar, 40°C, Arctic diesel Cl. 4.)

Start-up program (150 h, 600 rpm, 2300 bar, 90°C, Arctic diesel Cl. 4.)



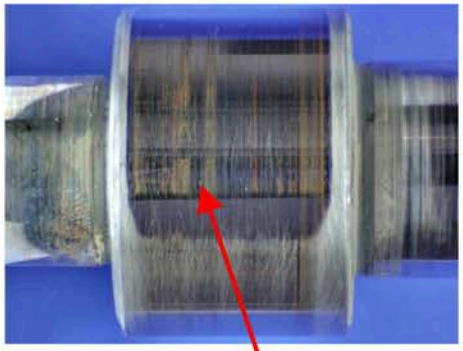
BOSCH

TF: Audi overload tests

2010-CP4_0576; series; 0445010611; 05 100205 BPT
0604 AH; running time: 150h

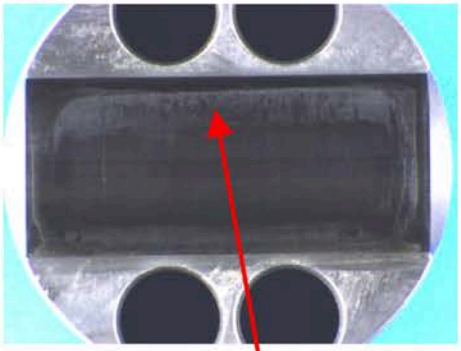
Production (C3)

TDC



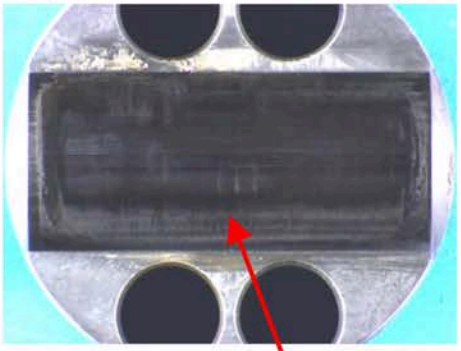
Chatter marks

Cyl.1



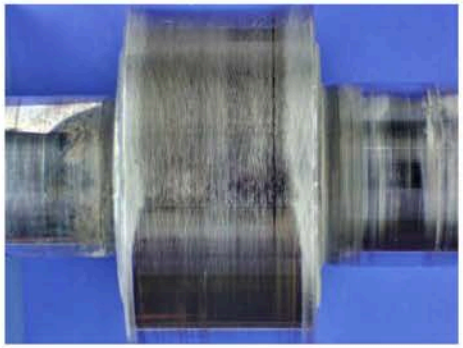
Considerable deposits

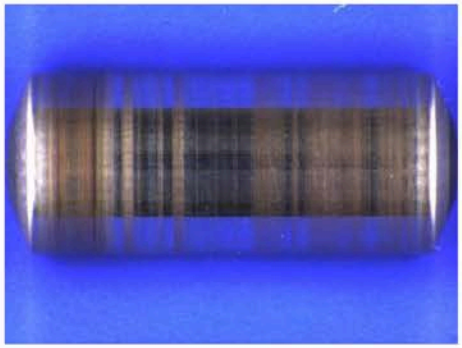
Cyl.2

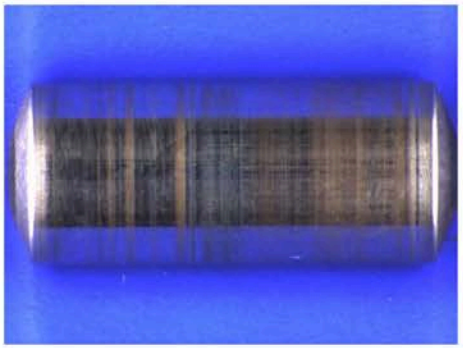


Considerable deposits

BDC







BOSCH

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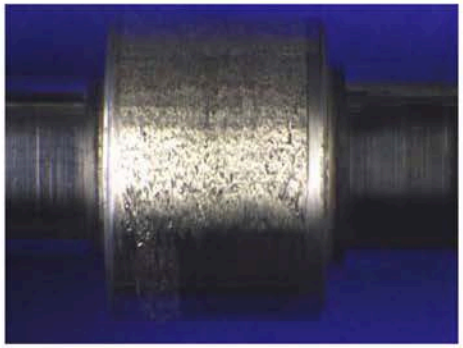
TF: Audi overload tests

2010-CP4_0577; series; 0445010611; 05 100205 BPT 0607 AH; running time: 68 h

Production (C3)

TDC



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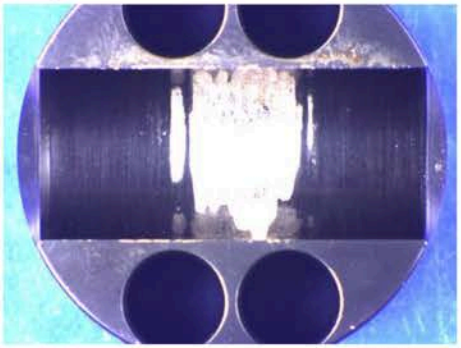
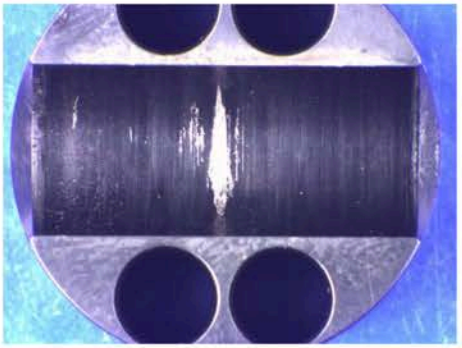
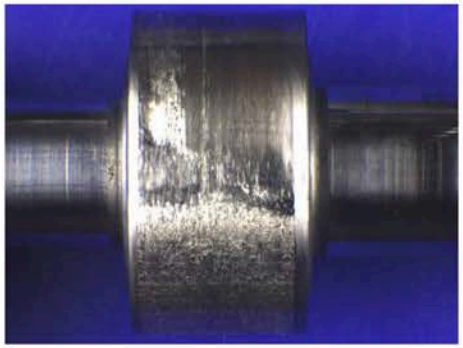
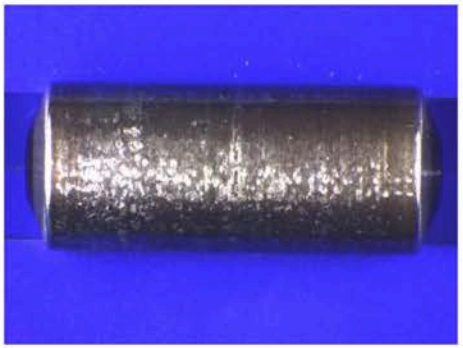


Cyl.2



BDC





BOSCH

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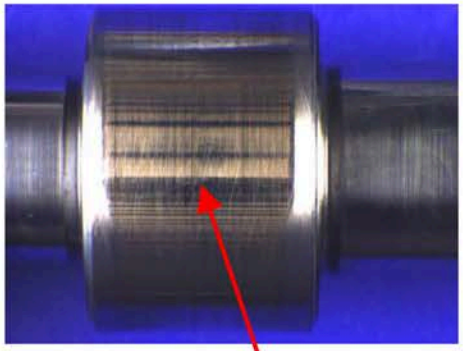
TF: Audi overload tests

2010-CP4_0575; series; 0445010611; 05 100205 BPT
0608 AH; running time: 150h

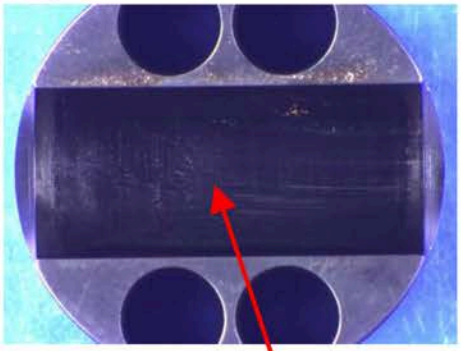
Production (C3)

TDC



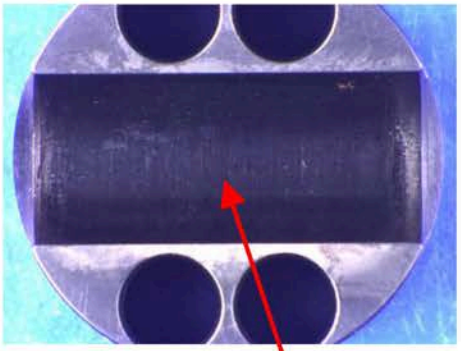
Chatter marks

Cyl.1



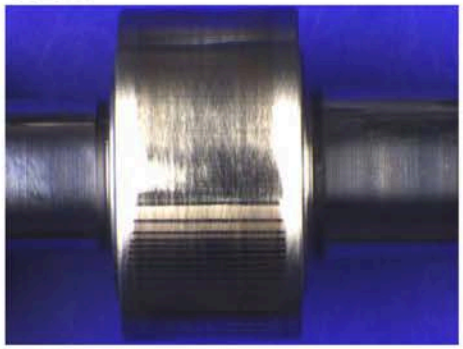
slight deposits

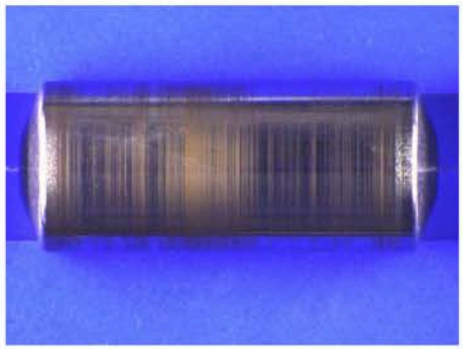
Cyl.2

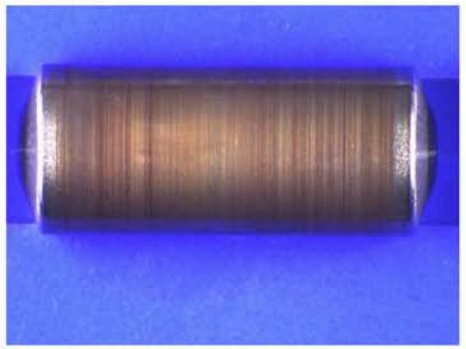


slight deposits

BDC







BOSCH

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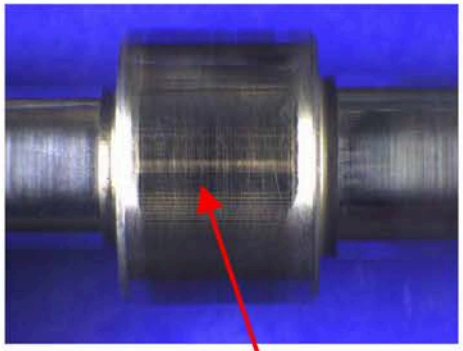
TF: Audi overload tests

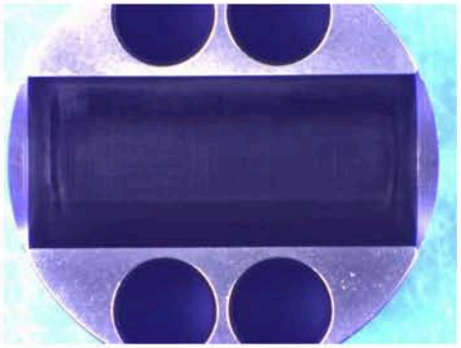
2010-CP4_0579; series; 0445010611; 05 100205 BPT 0603 AH; running time: 150h

Production (C3)

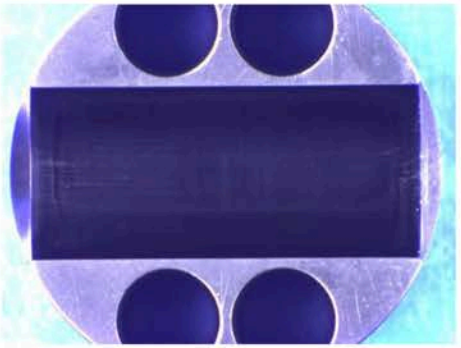
TDC



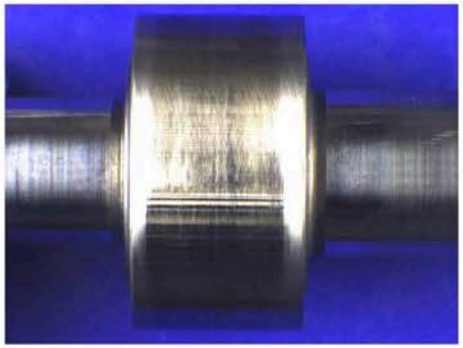
Cyl.1

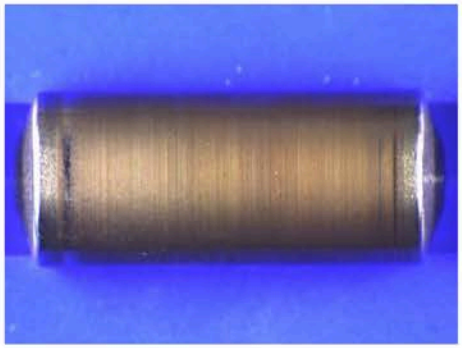


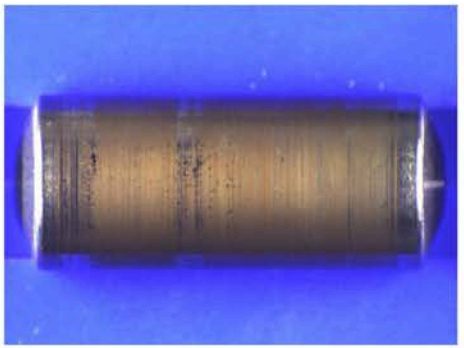
Cyl.2



BDC







BOSCH

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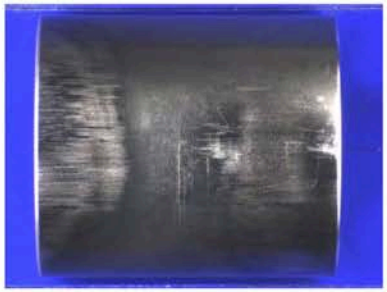
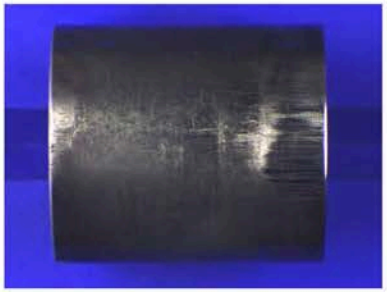
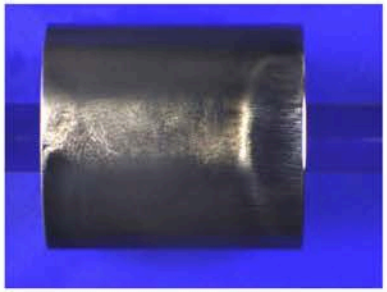
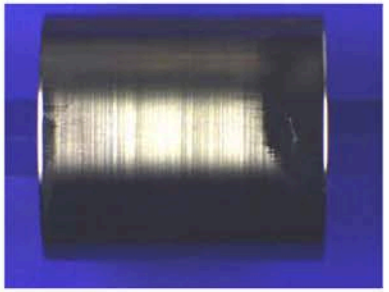
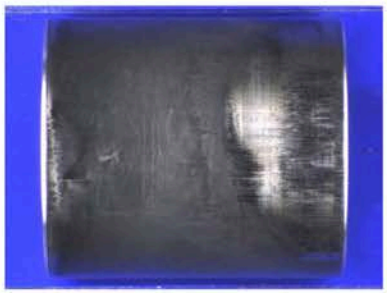
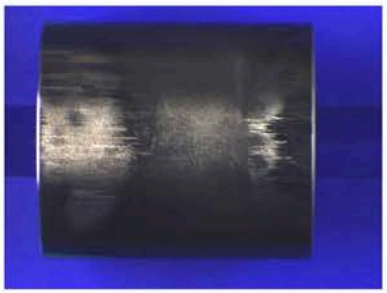
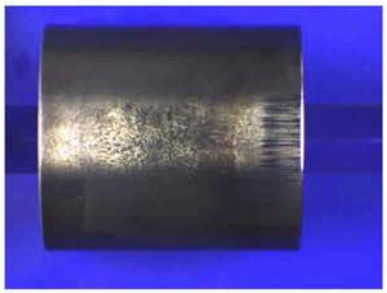
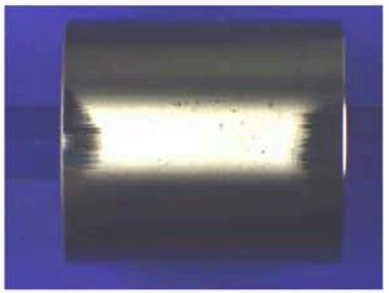
TF: Audi overload tests

2010-CP4_0576; series; 0445010611; 05 100205 BPT 0604 AH; running time: 150h

Production (C3)

	_0576 (150 h)	_0577 (68 h)	_0575 (150 h)	_0579 (150 h)
Cyl.1				
Cyl.2				

Considerable aluminum oxide formation (black) as an indication of high temperatures

BOSCH

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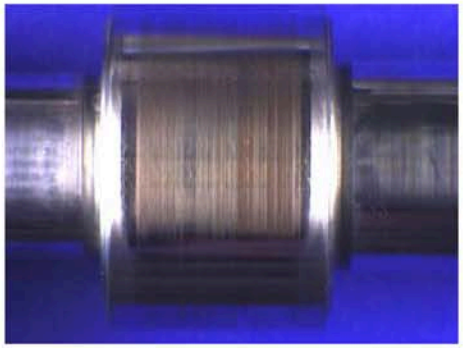
TF: Audi overload tests

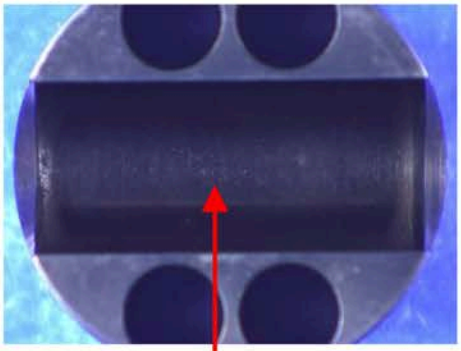
2010-CP4_0578; series; 0445010611; 05 100402 BPT
1142 BB; running time: 150h

RP1

TDC

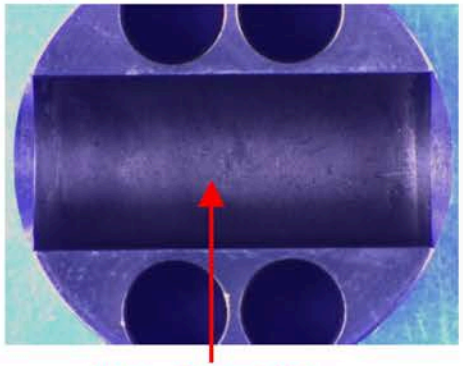


Cyl.1



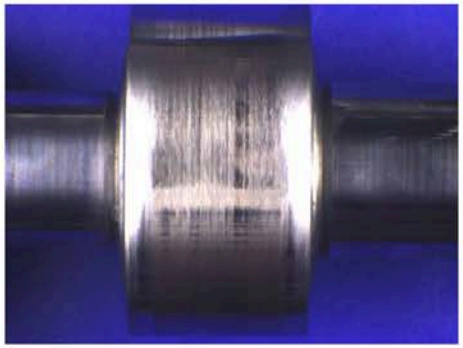
No deposits

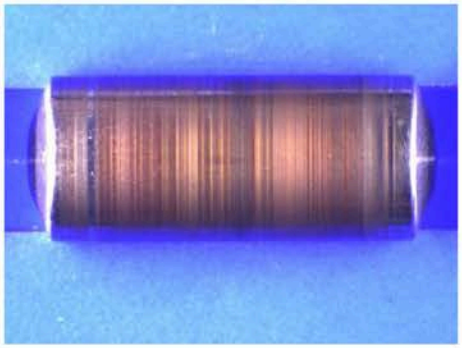
Cyl.2

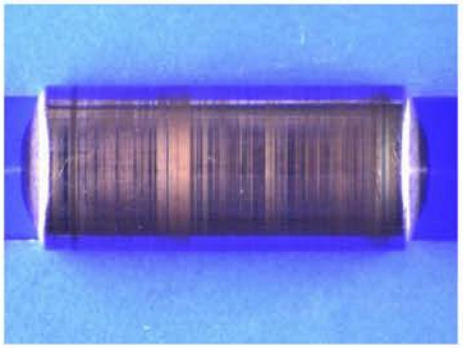


No deposits

BDC





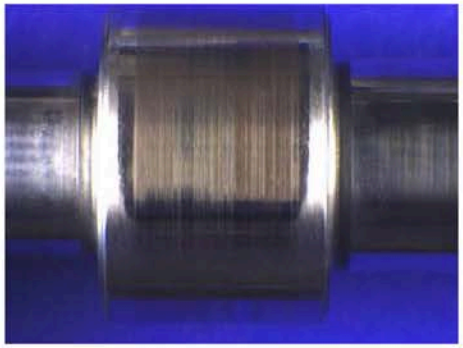
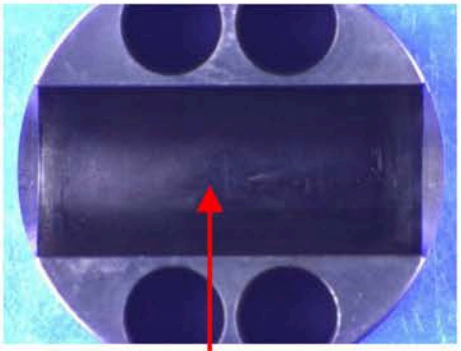
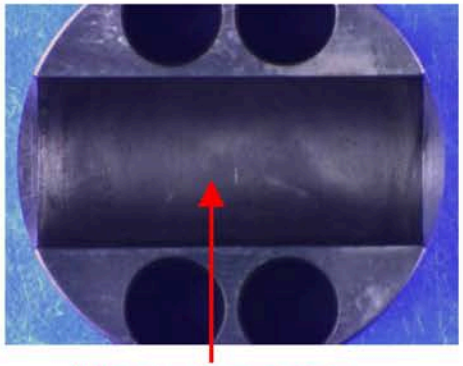
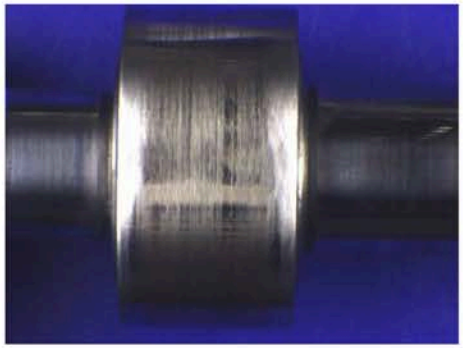
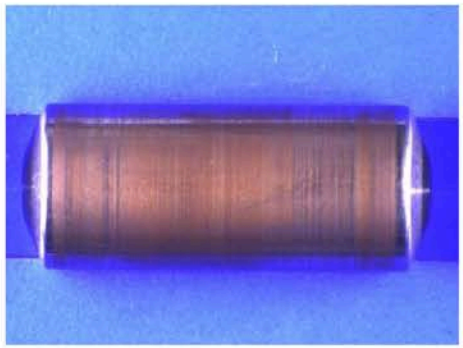
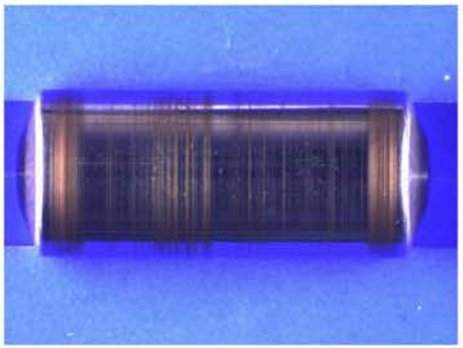


BOSCH

TF: Audi overload tests

2010-CP4_0580; series; 0445010611; 05 100402 BPT
1138 BB; running time: 150h

RP1

	TDC	Cyl.1	Cyl.2
			
		Minor deposits	Minor deposits
BDC			

BOSCH

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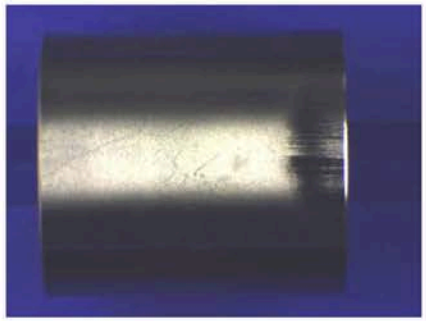
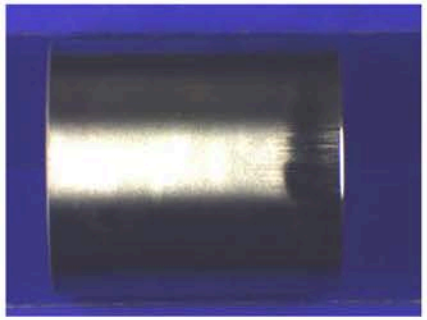
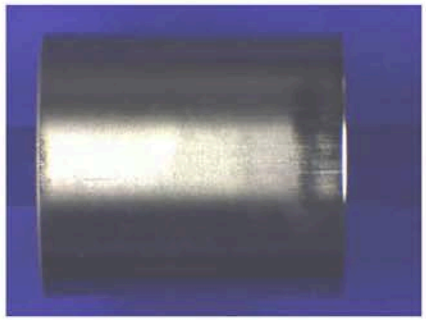
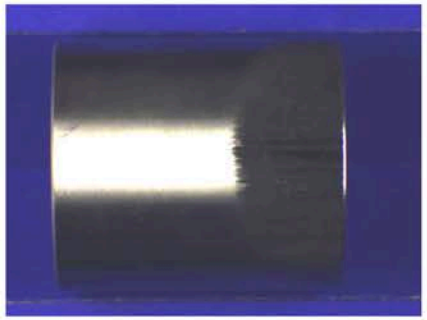
TF: Audi overload tests

2010-CP4_0576; series; 0445010611; 05 100205 BPT 0604 AH; running time: 150h

RP1

	_0578 (150 h)	_0580 (150 h)
Cyl.1		
Cyl.2		

Aluminum oxide formation (black) as an indication of increased temperatures

BOSCH

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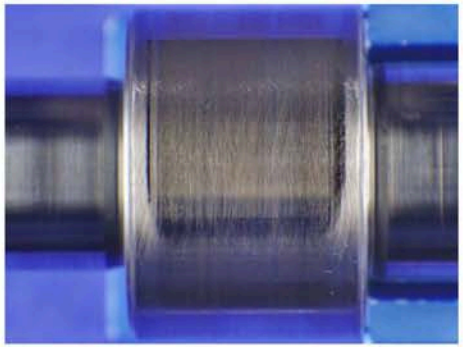
TF: Audi overload tests

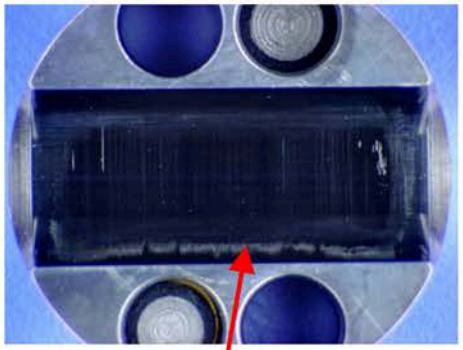
2010-CP4_0633; series; 0445B20318; 007-4325 (W19 EU5) running time: 150h

RP2

TDC

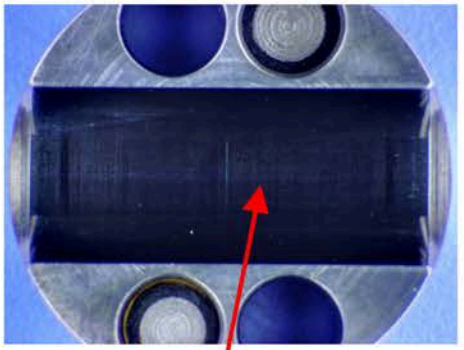


Left



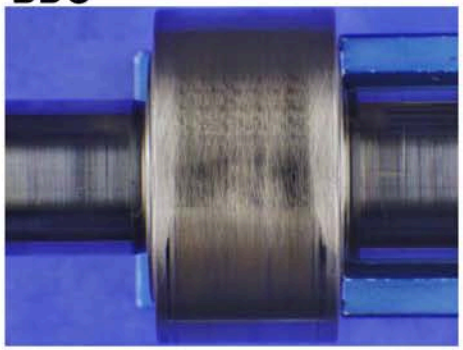
Minor deposits

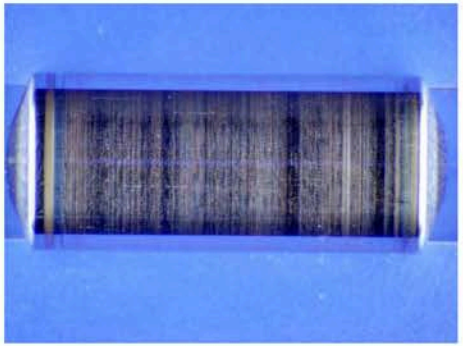
Right

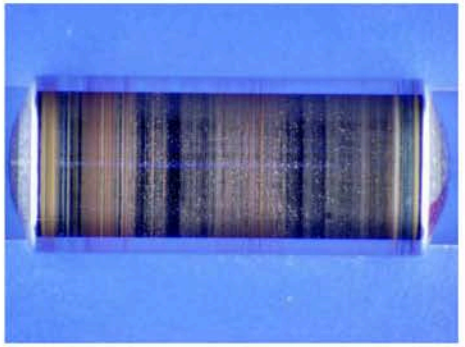


No deposits

BDC







BOSCH

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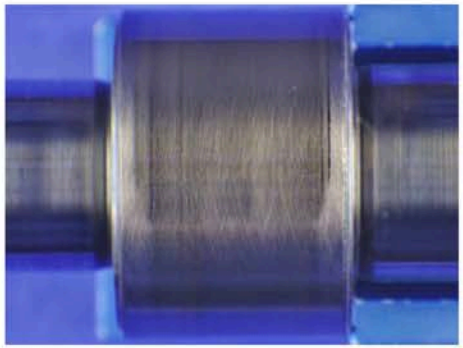
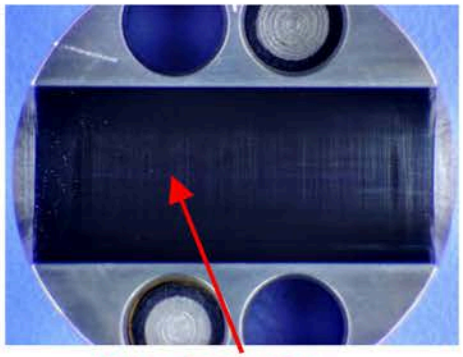
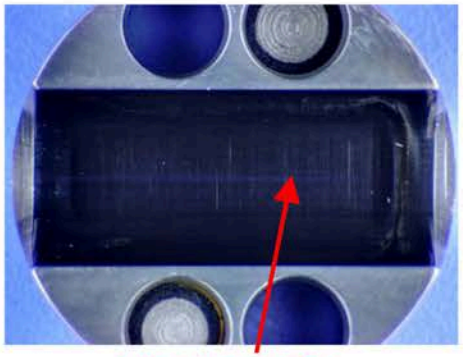
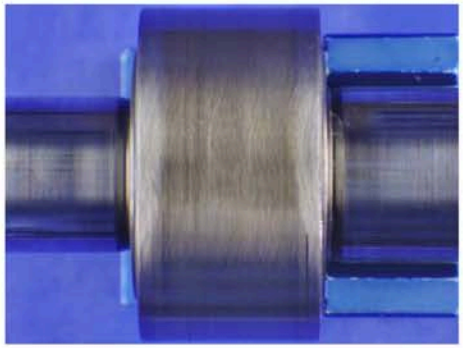
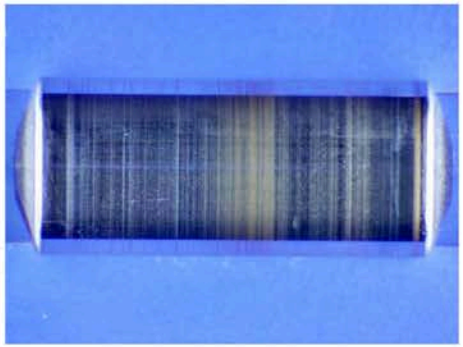
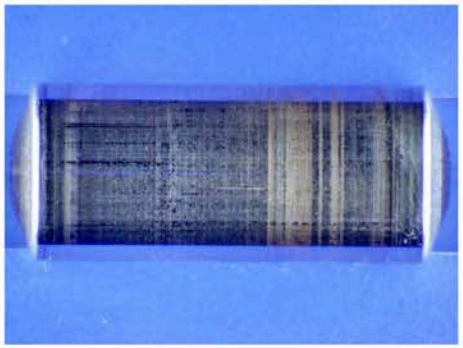
TF: Audi overload tests

2010-CP4_0631; series; 0445B20318; 007-4324 (W19 EU5) running time: 150h

RP2

TDC	Left	Right
		
	No deposits	No deposits
BDC		
		

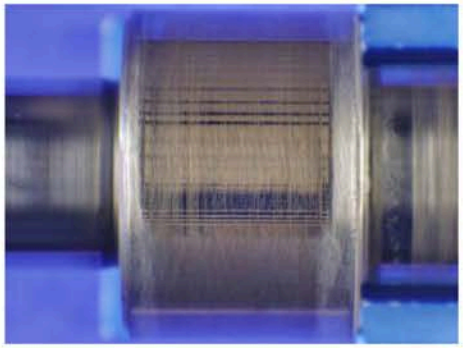
BOSCH

TF: Audi overload tests

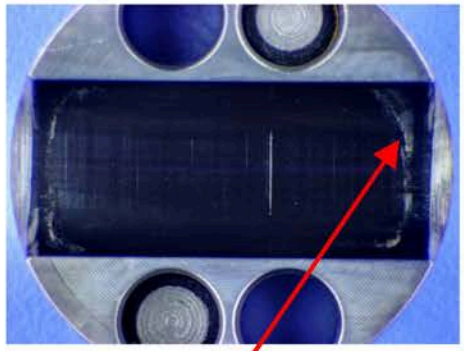
2010-CP4_0632; series; 0445B20318; 007-4322 (W19 EU5) running time: 150h

RP2

TDC

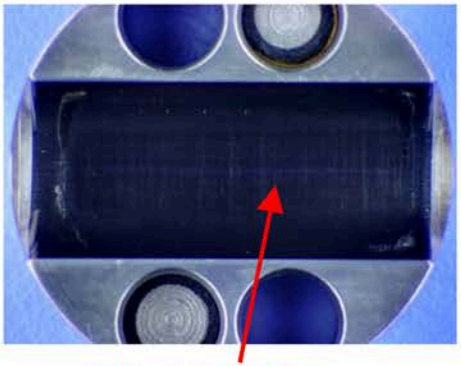


Cyl.1



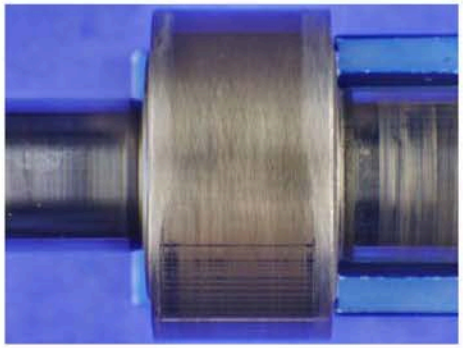
Minor deposits

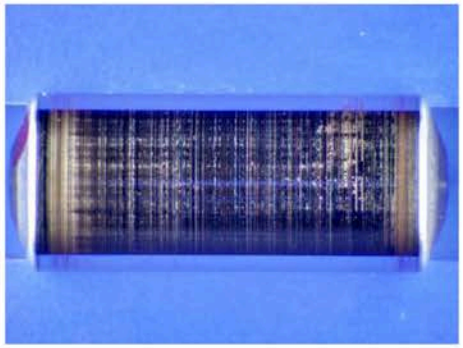
Cyl.2

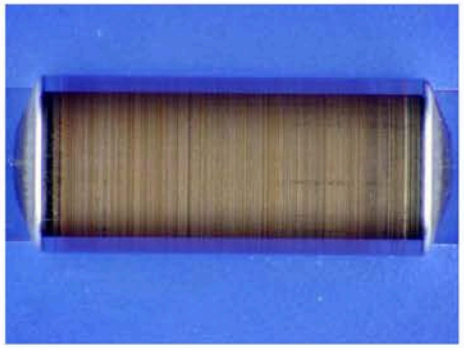


No deposits

BDC







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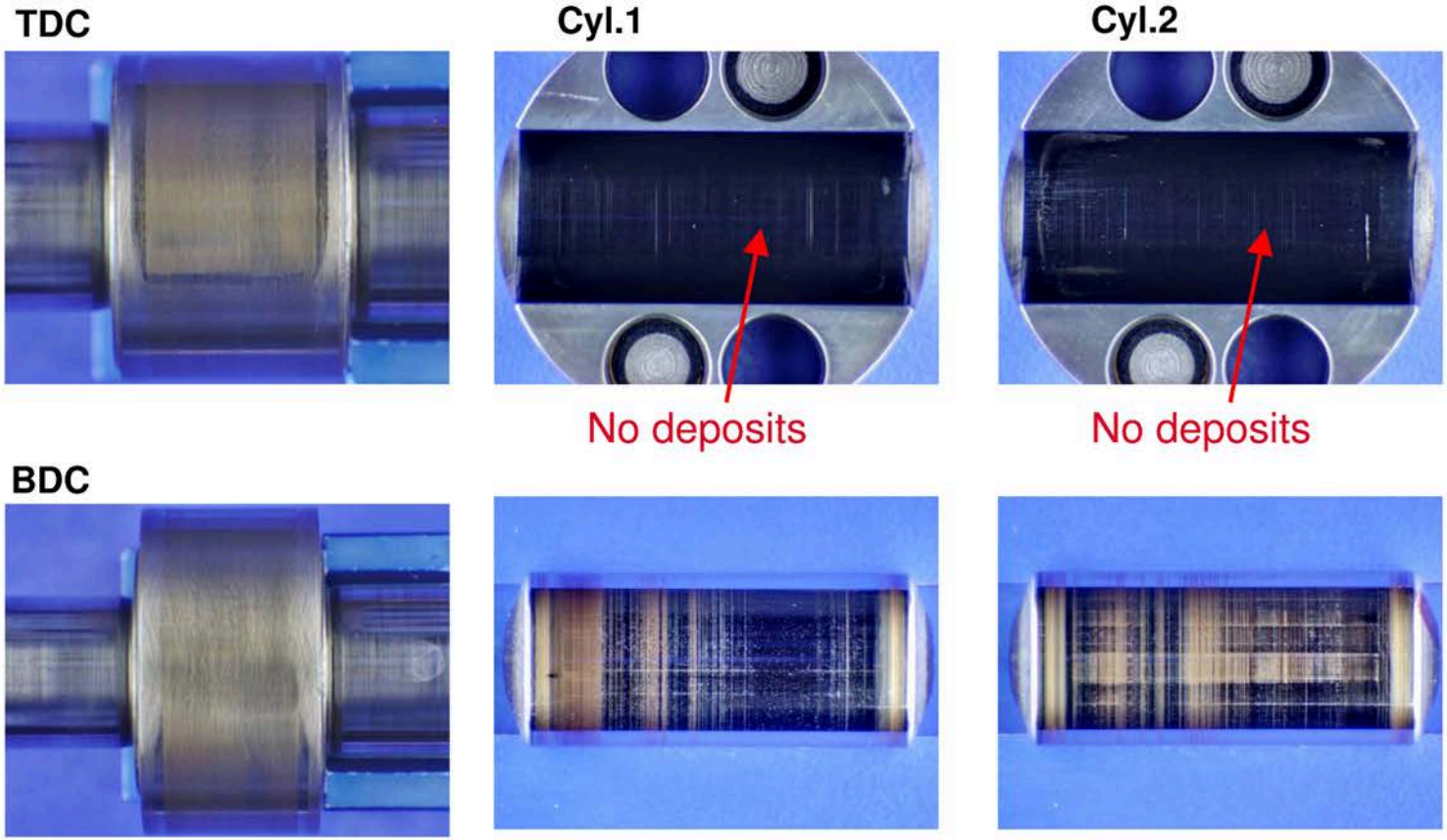
TF: Audi overload tests

2010-CP4_0630; series; 0445B20318; 007-4388 (W19 EU5) running time: 150h

RP2



BOSCH

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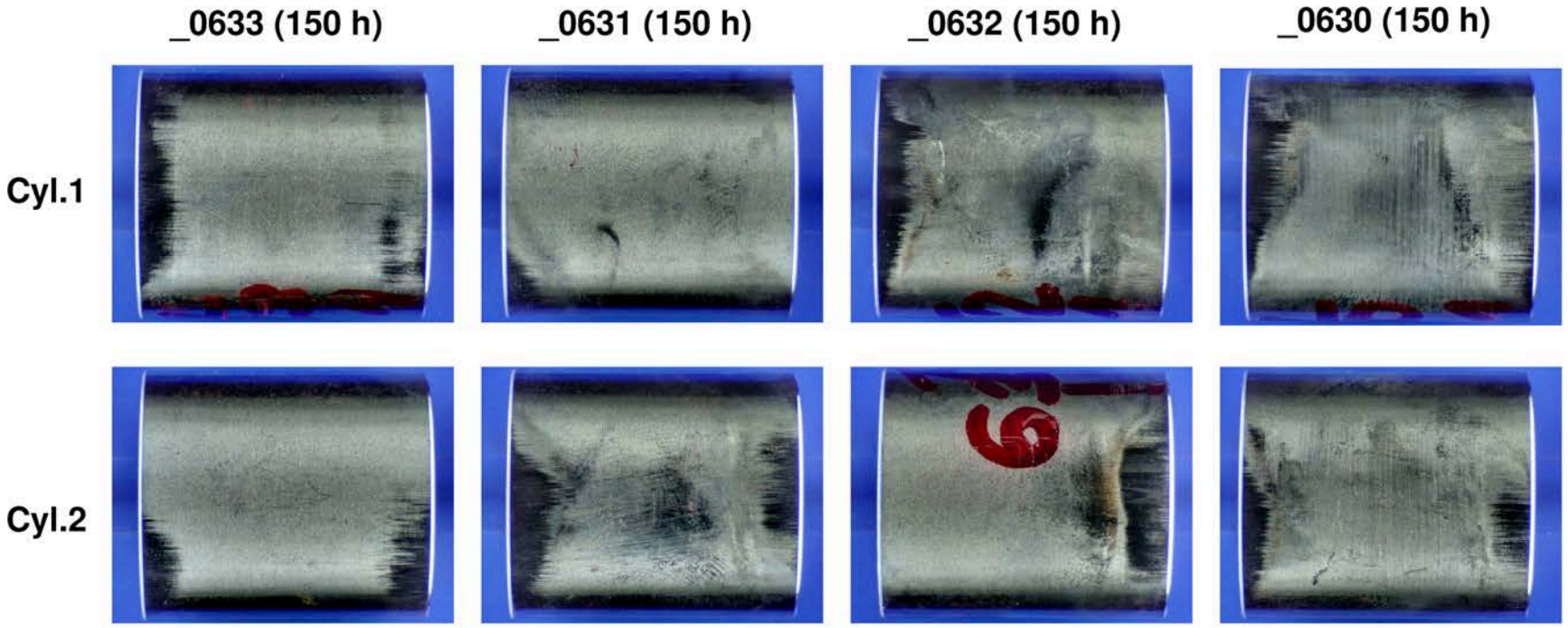
TF: Audi overload tests

2010-CP4_0576; series; 0445010611; 05 100205 BPT 0604 AH; running time: 150h

RP2



Minor aluminum oxide formation (black) as an indication of low temperatures

BOSCH

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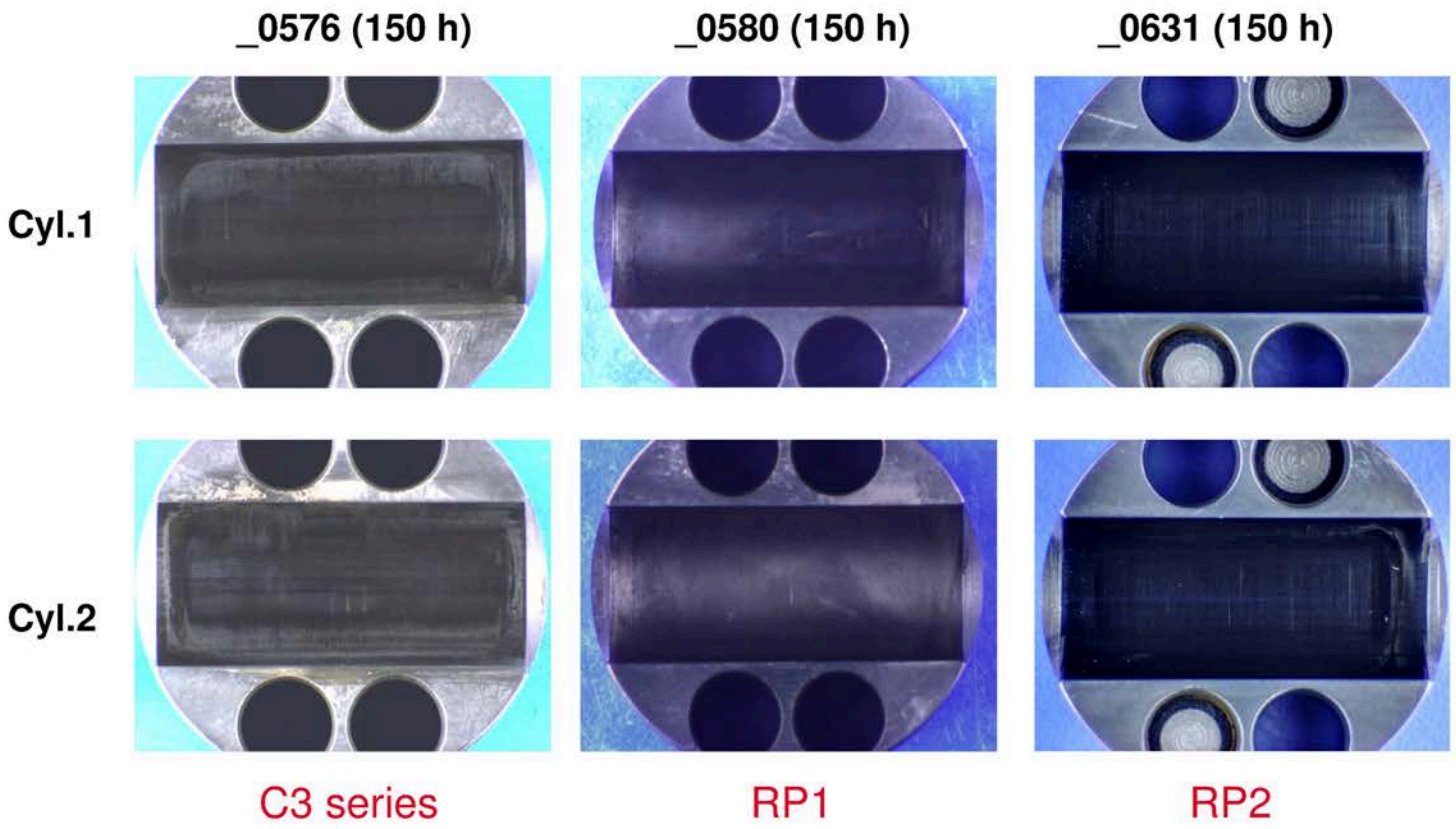
TF: Audi overload tests

Summary of visual findings



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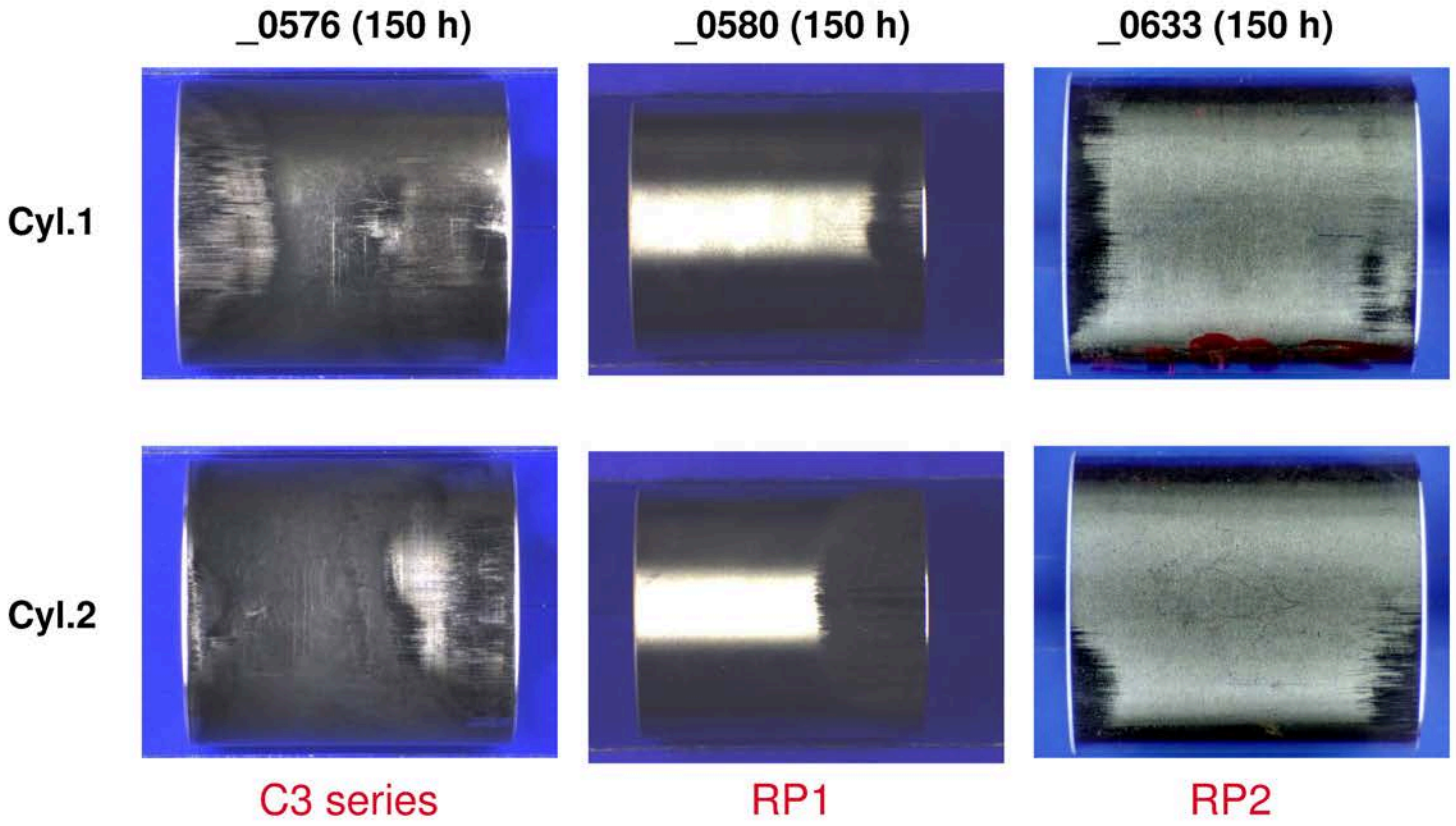
TF: Audi overload tests

Summary of visual findings



BOSCH

BOSCH CP4	CR pump CP4 - Diagnosis report	Report no.	2010-CP4_0730
		Date	3/24/2011

Department:	Person responsible:	Telephone:	Use	
[redacted]	[redacted]	Non-responsive content removed	internal	
			external	x
			Confidentiality note: Confidential	

To: Non-responsive content removed
Attn. of:

Pump type:	Customer:	Project:	Project/ design sample version
CP4.2HS_747_2x5,63_REC_3,3_1,3_MT4,2	AUDI	W36 2000bar (Q7)	D / D
Part number (TT no.) :	**Production date:**	**Serial number:**	**Manufacturing plant - line**
0445B20321_01	005	4062	[redacted]
ACTUAL mileage [h]	**Fuel:**		**MAP-No.**
18485 km	[redacted]		DS-259395
SAP-No.:	**Samos no.:**	**Customer order no.:**	**Engine/Vehicle number**
30-103256-08	790791		Veh. AU716 18038
Customer part number	**DSBFD no.:**	**Endurance run type [customer]:**	**Endurance run conditions:**
ENT 301 181 KL	29135	Vehicle endurance run	Non-responsive content removed

Complaint: Engine running untrue

1. Subject

CP4 customer returns **with complaint** : "Engine running irregularly"
Engine no.: CJGA, chassis no.: WAUAMD4L9BD[redacted], Vehicle no.: AU716 18038 pump with AWP2
18,485 km Non-responsive content removed

2. Conclusion

Function
- On account of the suspicion of drivetrain damage, no functional inspection was carried out in order to avoid any additional damage to the pump. The pump function on the engine was complained about.

Components
- Deposits and/or corrosion products were found on the majority of components in the pump which come into contact with fuel.
- The MU control piston had deposits/corrosion products caked on it.
- The left tappet assembly shows central adhesion wear (material removal; rating 8) at one location on the roller coating surface with material transfer to the cam track.
- The wear on the remaining components is low and without significant striking features.

Result
- The deposits and corrosion products are clearly an indication of operation using a fuel that does not conform to the released specifications (EN590).
- After a gradual sluggishness, the left roller had come to a stop and therefore caused adhesion wear. The sluggishness was caused by the deposits found in the roller support. The Task Force "CP4 Aud[redacted] has seen such preliminary damage before due to fuel problems. The precise mechanism of this damage is currently being ascertained by the previously mentioned Task Force.
  Such adhesion wear represents a preliminary damage that would probably lead to drivetrain damage.
- On account of the corrosion damage due to free water in the fuel, RB considers it necessary for applications for markets, like [redacted] to be equipped with a water separator!
- Due to the **malfunction**, the pump has not **passed the endurance run**.
- Cause for the malfunction is operation outside of the pump specification.

3. Results of diagnosis (visual findings)

Legend rating stages

OK	x		
non-critical		x	
Critical			x

3.1 Drive

	x	

Camshaft: Deposits and corrosion products between the flange bearing and radial shaft seal and on the cam track outside of the support area (see 3.10, Figures 2 and 3)

BOSCH CP4	CR pump CP4 - Diagnosis report	Report no.	2010-CP4_0730
		Date	3/24/2011

Department:	Person responsible:	Telephone:	Use	
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			external	x

Confidentiality note: Confidential

3.2 Drivetrain [ ] [ ] [x]

Roller left: Adhesion with material transfer to the camshaft (braking flat rating 8; see 3.10, Figures 1 and 2)

3.3 High pressure [ ] [x] [ ]

Intake valves: Deposits and corrosion products (see 3.10, Figures 4 and 5)

3.4 Bearing [x] [ ] [ ]

No striking features

3.5 Shaft seal [x] [ ] [ ]

No striking features

3.6 Holes [x] [ ] [ ]

No striking features

3.7 Attached components (Metering Unit, Overflow Valve, Counting Point) [ ] [ ] [x]

- Metering unit: Function not OK; control pistons caked on due to corrosion (see 3.10, Figures 6 to 8 and report in the appendix)

3.8 O-rings [x] [ ] [ ]

No striking features

3.9 Other [x] [ ] [ ]

No striking features

3.10 Images

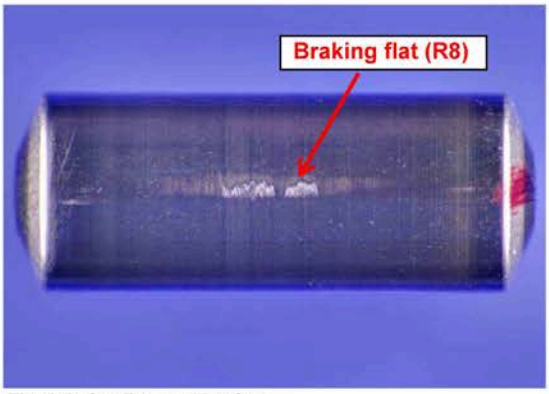

Fig. 1: Left roller, running face

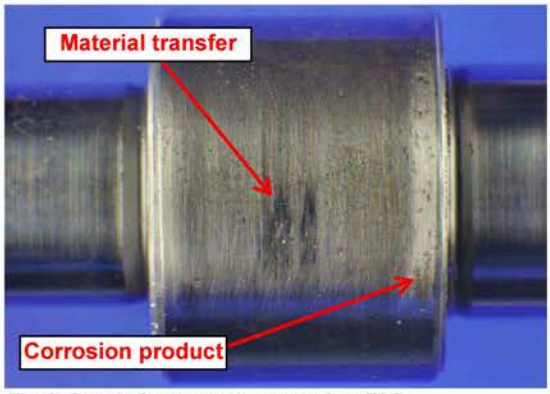

Fig. 2: Camshaft, cam track running face TDC

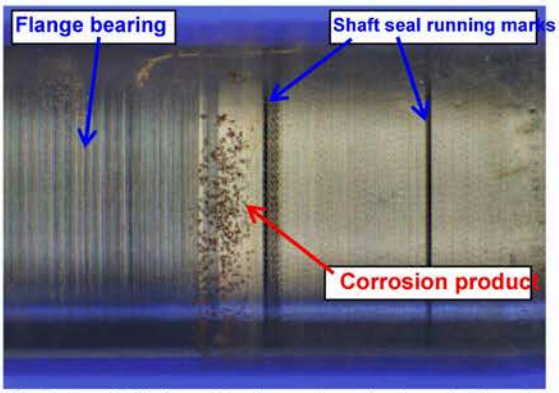

Fig. 3: Camshaft, flange bearing and running face shaft seal

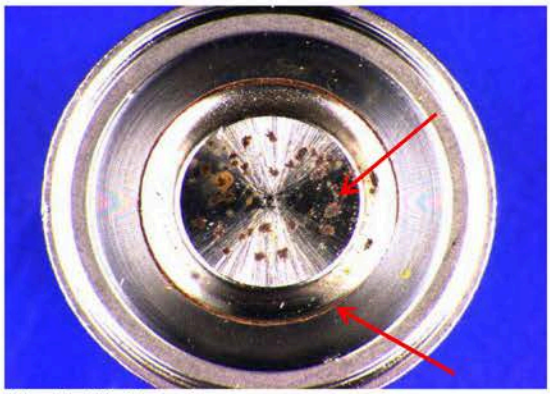

Fig. 4: Left intake valve

ENTIRE PAGE CONFIDENTIAL

BOSCH CP4	CR pump CP4 - Diagnosis report	Report no.	2010-CP4_0730
		Date	3/24/2011

Department:	Person responsible:	Telephone:	Use	internal	
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			Confidentiality note	Confidential	

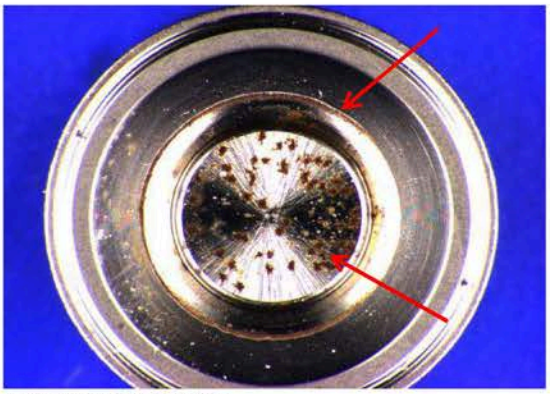

Fig. 5: Intake valve - right

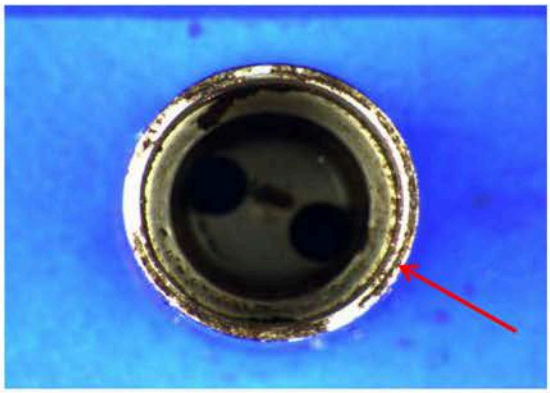

Fig. 6: MU pistons - pump side

Fig. 7: MU pistons - housing side

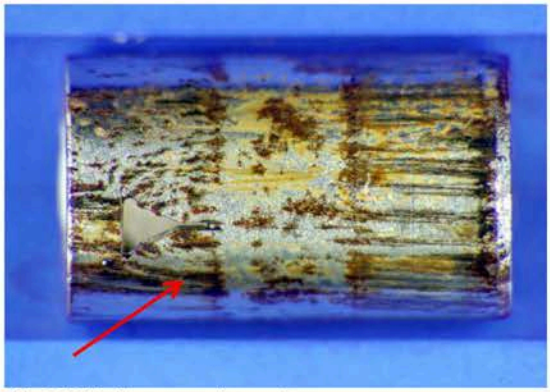

Fig. 8: MU pistons - coating surface

4. Hydraulic function

On account of the suspicion of drivetrain damage, no functional inspection was carried out in order to avoid any additional damage to the pump.

5. Parts storage

The pump will be scrapped at the request of Audi.

6. Appendix

Appendix 1: Drivetrain photographs and findings report from the Audi Task Force
Findings report metering unit 4 (ZVM 30115)

Tested:	Non-responsive content removed	Telephone:	Non-responsive content removed	Date:	3/31/2011	Signature:	Non-responsive content removed
Department:		Telephone:		Date:	3/31/2011	Signature:	

CP4.2 Audi Task Force

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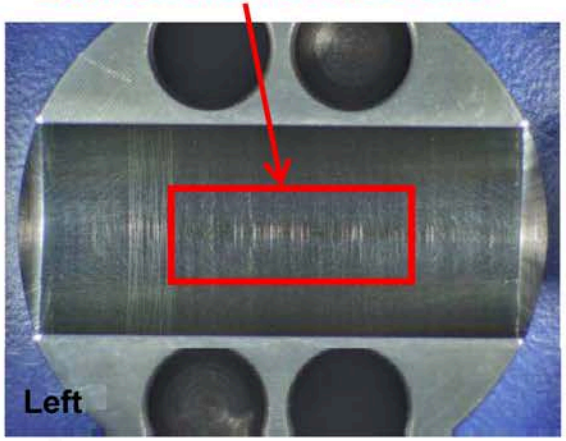
Q-AL AWP2 with 18,485 km (2010-CP4_0730)

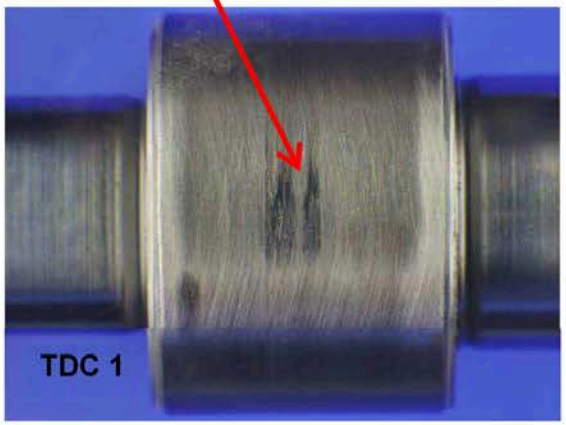
W36 0445 B20 321_01; 000005 BPT 4062; W36 (2000bar) Q7 (AU716 18038)

Complaint: Engine running irregularly

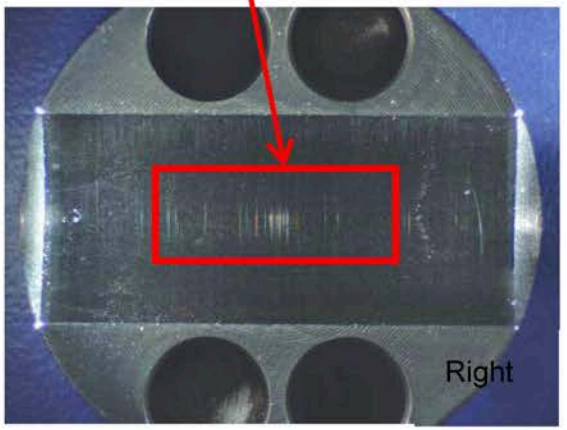
Signs of wear on the roller

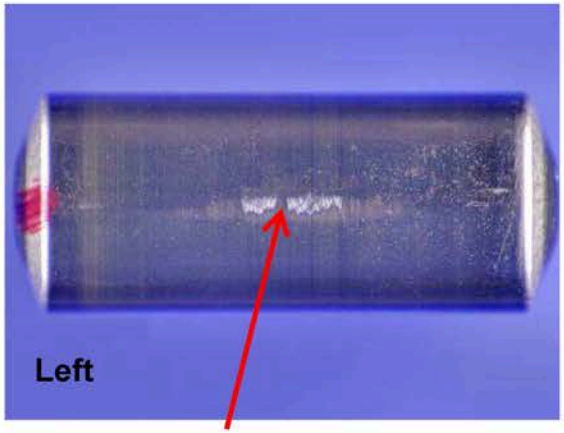


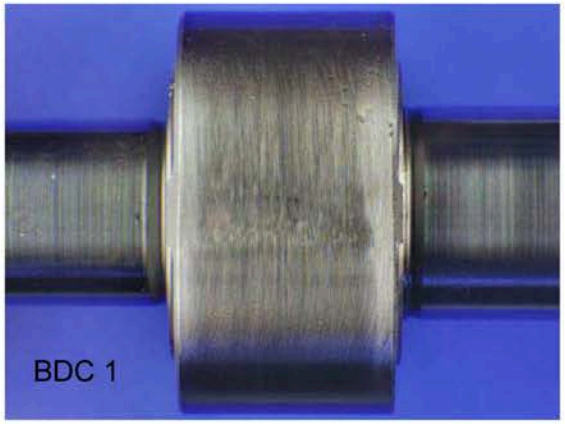
Material transfer roller -> cam

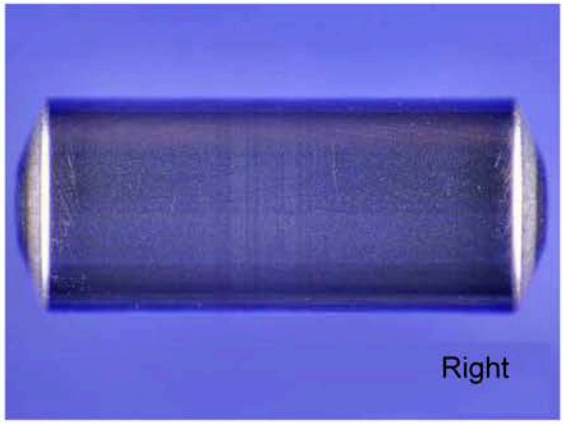


Signs of wear on the roller









Braking flat (R8) Material transfer roller -> cam

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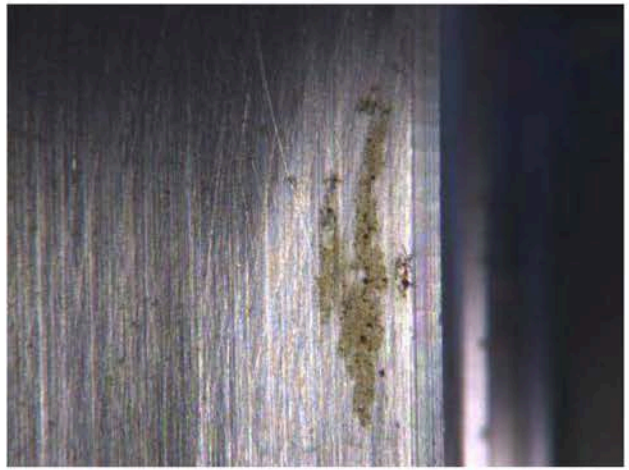
CP4.2 Audi Task Force

Non-responsive content removed Q-AL AWP2 with 18,485 km (2010-CP4_0730)

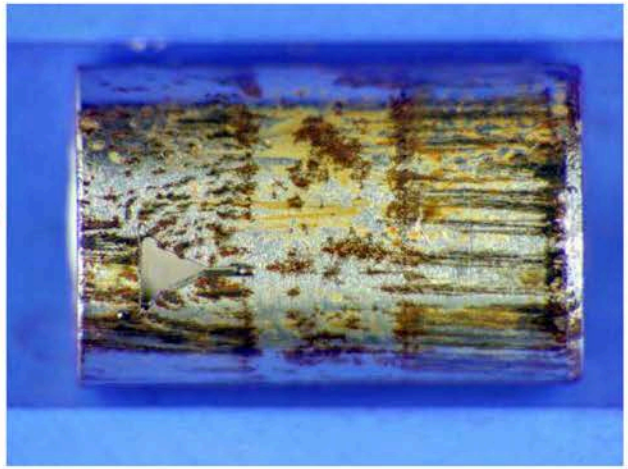
W36 0445 B20 321_01; 000005 BPT 4062; W36 (2000bar) Q7 (AU716 18038)

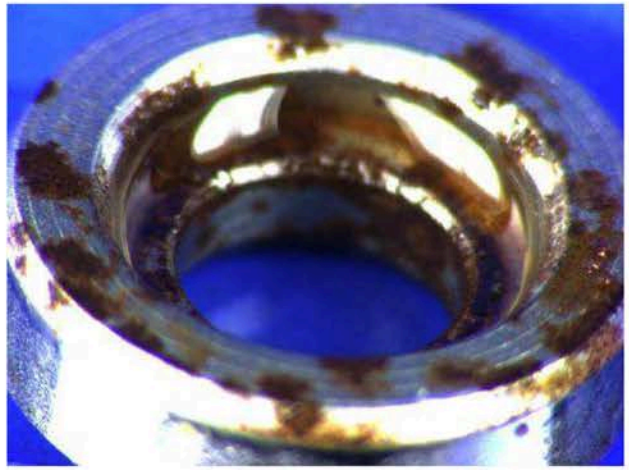
Complaint: Engine running irregularly

Corrosion on the cam track



MU corrosion (Pistons, safety element, etc.)





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CP4.2 Audi Task Force

[redacted] **Q-AL AWP2** with 18.485 km (2010-CP4_0730)

W36 0445 B20 321_01; 000005 BPT 4062; W36 (2000bar) Q7 (AU716 18038)

Complaint: Engine running irregularly

Findings

- Material transfer from roller to cam
- Signs of wear on the roller on the roller support running face (⇨ fuel viscosity ↓)
- Corrosion on various components, among others MU pistons (⇨ water)
  MU pistons sluggish → quantity deviation → engine running irregularly)
- Fuel smells of petrol
  (Petrol quantity proven with gas chromatograph, flash point <40°)

Summary

- Cause of complaint: Corrosion on the MU pistons due to water
- Cause for material transfer from the roller and signs of wear on the roller support: probably petrol + water

⇒ **Fuel does not comply with that which has been released for this pump**

BOSCH

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BOSCH CP4	Diagnosis ZVM 30115	[redacted] 10/06/2010
Metering unit 0928400799 serial no. 30516 date of manufacture 99022		

Customer Audi
To Non-responsive content removed
Cc
Pump 0445E20321_01 con. no. 4062 FD 005
Endurance run findings no.
SAP 30-103256-08

1. Description

MU complaint: Engine running irregularly and corrosion and deposits found in CP4

System design Vehicle
Endurance run type [redacted] road test
Running time 18485km

Remark
VN: 2010-CP4 0730/02
Fuel: Others

2. Diagnosis

- Visual findings (external):
  a brown film with hard particles in it was found on the magnet core and on the filter: a piece has broken off the MU connector;
- Function:
  The characteristic curve of the displacement / current measurement is not OK.
- Wear:
- Other:
  Considerable corrosion on the pistons, piston guidance, safety element and on the pump-side edge of the anchor

3. Result

[ ] Passed ***[ ] Conditionally passed*** ***[X] Failed***

The corrosion has caused the pistons to cake and therefore the MU function is not OK.

4. Corrective actions

No error.

5. More tests (e.g. material analysis, process analysis)

No further tests are performed.

6. Parts storage

Metering unit remains with Non-responsive content removed

Person responsible/Release (up to rating 6):	Non-responsive content removed
Approval:	Date/signature

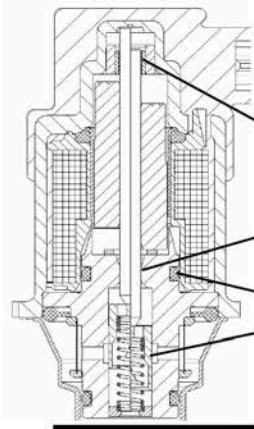
Non-responsive content removed

BOSCH CP4	Diagnosis ZVM 30115	[redacted] 10/06/2010
MU0928400799 con. no. 30516 date of manufacture 99022		

Function:

Wear:

External	1	2	3	4	5	6	7	8	9	10
Contamination:								x		
Damage:					x					
Filter contamination					x					
Filter damage		x								
O-ring outside		x								
Seal		x								



internal	1	2	3	4	5	6	7	8	9	10
Tappet housing:		x								
Bearing housing:		x								
Tappet magnetic core:		x								
Bearing magnetic core		x								
O-ring inside:		x								
Valve piston:										x

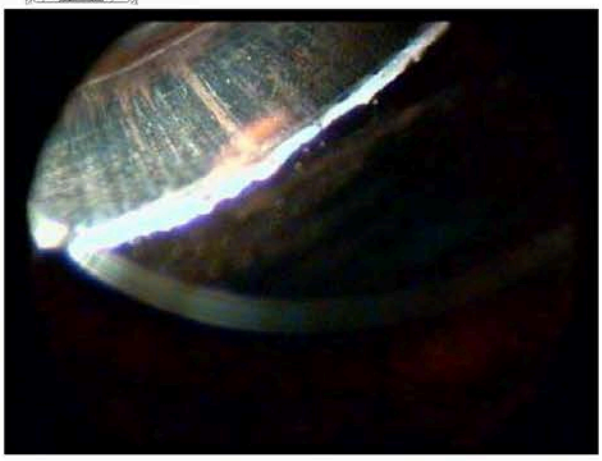


Fig. 1 Housing bearing

Fig. 2 Tappet housing

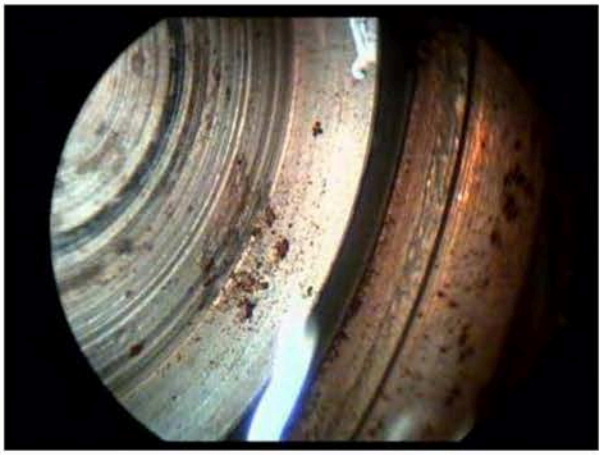


Fig. 3 Housing floor

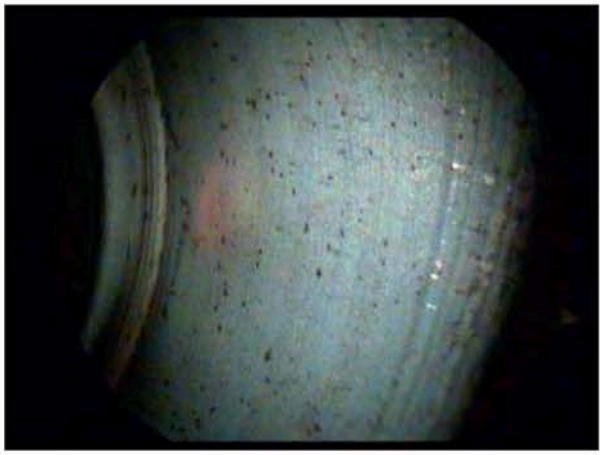


Fig. 4 Housing corrosion

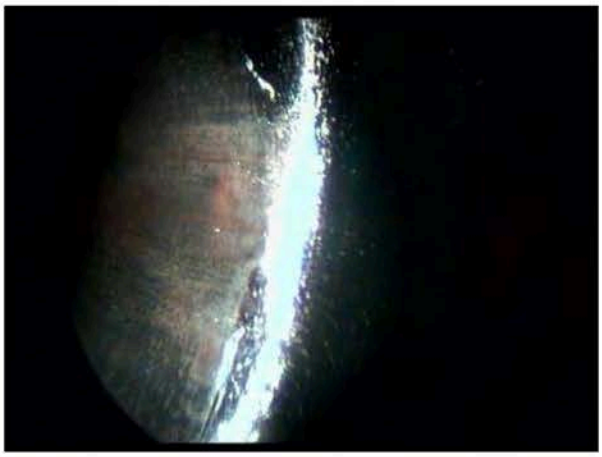


Fig. 5 Magnet core bearing

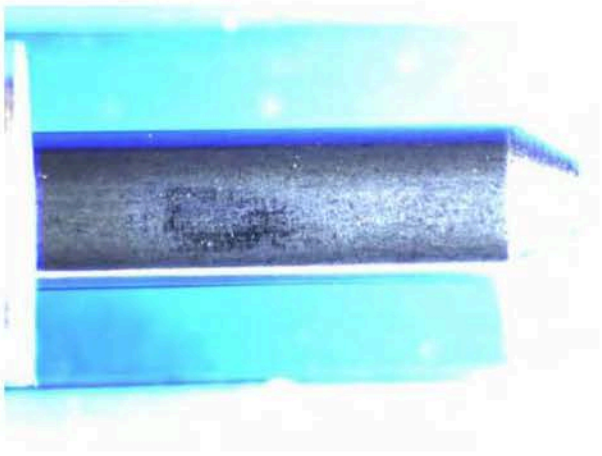


Fig. 6 Tappet magnet core

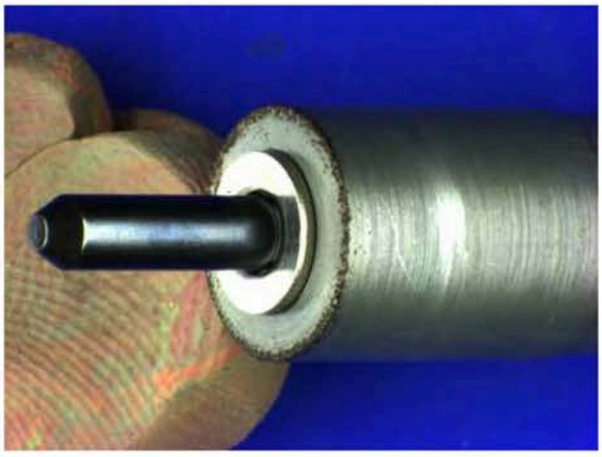


Fig. 7 Anchor

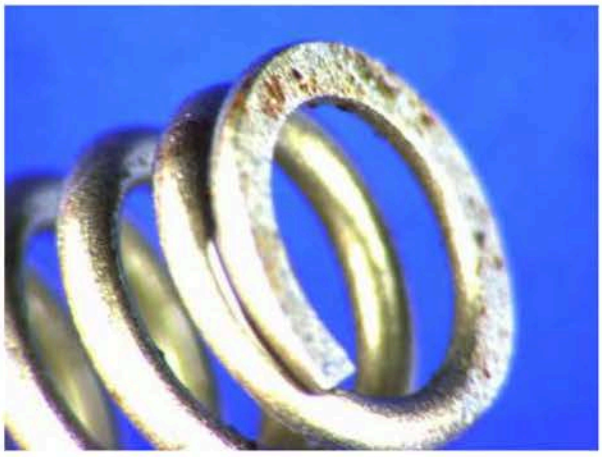


Fig. 8 Spring

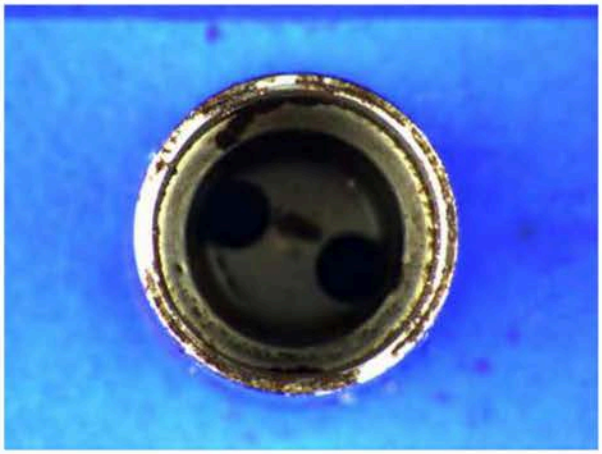


Fig. 9 Pistons - pump-side

Fig. 10 Pistons - housing-side

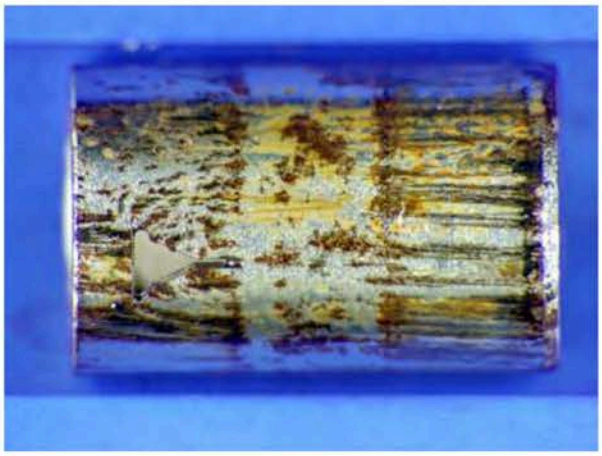


Fig. 11 Pistons

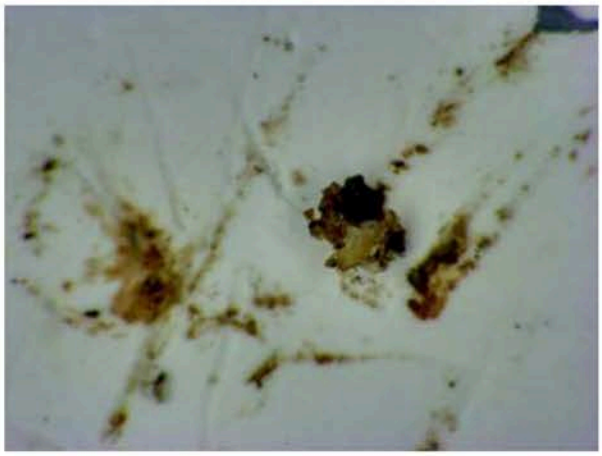


Fig. 12 Particles on the outside of the MU - close-up

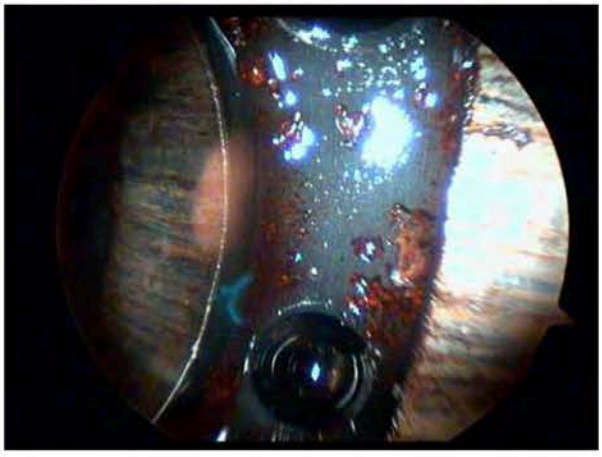


Fig. 13 Ring channel

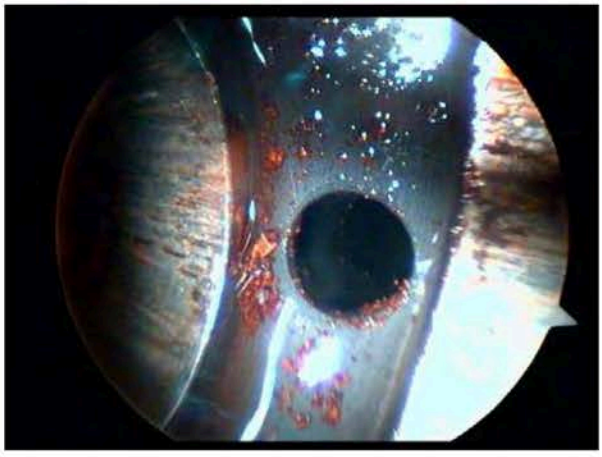


Fig. 14 Ring channel

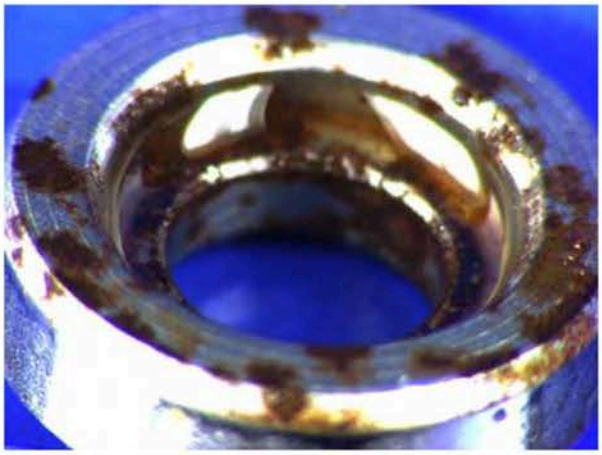


Fig. 15 Safety element

Fig. 16 MU no.

ENTIRE PAGE CONFIDENTIAL

Diesel Systems

BOSCH

From	Person responsible	Tel	Fax
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Feuerbach
7/26/2006
No. 687182

Minutes

Recipients For info.	Non-responsive content removed
Host	DS/SVA2
Participants	AUDI:
	Non-responsive content removed
Management Minutes	
Date/location	**07/25/2006, 01.00 PM - 5.30 PM / Feuerbach 320/3 Sa3**
Topic	Non-responsive content removed **- CP4 special meeting**
*) at times	

General:

-Audi requests that the slides are submitted within 3- 4 days

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ENTIRE PAGE CONFIDENTIAL

Diesel Systems

BOSCH

From	Person responsible	Tel	Fax
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Feuerbach
7/26/2006
No. 687182

Minutes

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ENTIRE PAGE CONFIDENTIAL

From	Person responsible	Tel	Fax
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Feuerbach
7/26/2006
No. 687182

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TOP 2
CP4 special meeting

Cavitation in tappet hole

- After an internal RB endurance run, cavitation could be seen clearly in the tappet hole. This was already known by the VP44, however this was clearly a more severe cavitation. In the VP44 there were no failures with regard to cavitation and consequential damage (particles in the nozzle seat)
- Audi does not accept the comparison, as Piezo injector is much more sensitive.
- RB considers cavitation to be noncritical as it has no negative effect on the pump function and there is no risk concerning the particles blocking the nozzle
- Written confirmation from injector/nozzle department management that continuous particle stream is not a risk for nozzle blockage
- Material specification for CP4 housing forwarded to Audi
- The load profiles for RB internal endurance runs are noticeably sharper than the vehicle tests in the field, therefore 2000 PER show much more cavitation than a 400 h vehicle / engine endurance run, which would show much less cavitation even with the same mileage.
- Rating catalog for cavitation is to be drawn up
- Audi is providing engine endurance runs with 840 h for the purpose of diagnosis.

  Addendum: Audi's Non-responsive content removed supplied the pump to DS/SVA-Reyle on 07/26/2006. C1 sample with 4.85mm stroke
- Possible back-up solution for minimizing the cavitation would be additional thermal treatment of the housing analogous to RP.
- Audi is urgently requesting 5 pumps (V6 TDI EU5) to be provided free-of-charge for engine testing purposes. Coordination via N/EA62-Non-responsive content removed
- Check to see if pumps can be provided quickly and free of charge

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Diesel Systems

BOSCH

From	Person responsible	Tel	Fax
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Feuerbach
7/26/2006
No. 687182

Minutes
Non-responsive content removed + CP4 special meeting

C coating of roller support (edge)

- The familiar C2 layer has been replaced with the further developed C3 layer resulting in a significant increase in performance.
- The chipping of the C layer on the nozzle seat (injector) came about as a result of internal stresses -Compare nozzle seat with roller support (edge)
- not comparable, as nozzle seat is heavily contaminated. The roller support edge serves to avoid the penetration of dirt and particles.
- Audi question: Are all sample / series parts now being tested for chipping of the C layer? Audi requests, if necessary, checking the PSR and PPS batches
- Friction coefficient est has been introduced 100% in production

Cold tests in the cold cell

- Test on cold cell at -29°C with max. pump play (60 µm) was presented. No leaks were ascertained on the shaft seal.
- Audi requests that cold cell testing is carried out using Audi pre-stressing force

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Tests at lower pump speed

- Audi requests that tests are carried out at lower speeds "< idling mixture" and also at low and high temperatures, and that tests are coordinated, if necessary, with Audi
- Audi requests "fault tree" and that faults are overcome

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ENTIRE PAGE CONFIDENTIAL

CP4 - Findings 17206 and 17325

BOSCH

From	Person responsible	Telephone extension	Telefax extension	Feuerbach
Non-responsive content removed	[redacted]	Non-responsive content removed	Non-responsive content removed	3/26/2007

To: Non-responsive content removed

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Customer: VW
Component: CP4.1S-348-2x5.25-REC
Project: R4 2,01 TDi
Engine / block no.:
TTNo.: 0 445 B21 058_07
DM: 241106
Serial no. Dummy001 and Dummy002
Add-on parts.: MU

IBAS number: 105 222 244
105 223 037
Samos: 0550562
0555146
Customer order / MKV no.:
Parts receipt at dept. DS / EHP: 02/20/2007 & 02/28/2007
Manufacturing site: 0110 (Feuerbach plant)
Sample type: C
Running time:
Complaint: ; Visual findings by RB after VW testing agreed according to PV1209.

Operating conditions: 5 cycles according to VW standard (it concerns a cyclic test). 1 test cycle consisting of: 5 "sub-cycles"" (as per PV1210) with 4h salt spray test with modified test solution (approx. 4% NaCl, 1% CaCl2). 4h Cooling down phase and 16h warm, humid conditions (DIN 50017KK), at 40°C and 100% rel. air humidity. 2 days storage in climate change test (as per PV1200). Temp. change between limit temperature +80°C and -40°C with 4h pause and 2h heating up or cooling down, at 80% rel. air humidity)

1. Description of problem

Based on VW criteria, due to the considerable visible corrosion on the overflow valve (OV), the corrosion test was not successful. But VW did not complain about any leaks.

2. Findings

Leak-tightness: The pumps did not leak during the immersion test (bubble test, 10 min; 6 bar').

Function: No functional inspection possible as these were dummy pumps (not functioning).

Cover: It was still in place after the test as they had been removed with force by the customer; evident prying marks.

Visual findings: The differences in the degrees of corrosion could be due to the respective relative position of the pumps in the test chamber (see Fig. 1 to 4).

By contrast with 002, the OV of the pump 001 showed considerable corrosion, both on the surface as well as on the supporting surface. The corrosion on the surface would have been promoted by the laser labeling which is only found on sample pumps. The corrosion on the supporting surface for the housing could lead back to an evidently too low tightening torque (break-loose torque = 5Nm). The tightening torque (in production 25 Nm) is not defined for dummy pumps. They are tightened manually and can therefore move quite a lot (Fig. 5 and 6).

The sealing area of the housing/cylinder head is not critical: no rust under the sealing area (Fig. 7 and 8).

3. Conclusion

The laser labeling of the OV is not used on serial parts and will therefore not cause the corrosion here anymore.

According to RB criteria (pumps leak-tightness), the pumps have passed the test.

4. Parts storage

The parts will be stored at RB until the end of May 2007.

Checked by: [redacted]
E. dept.: Non-responsive content removed
Report passed on to the customer: yes

Telephone: Non-responsive content removed
Telephone: [redacted]

Date: 18.4.07
Date: 19.04.07

Signed:
Signed:

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CP4 - Findings 17206 and 17325

BOSCH

From	Person responsible	Telephone extension	Telefax extension	Feuerbach
[redacted]	Non-responsive content removed	Non-responsive content removed	Non-responsive content removed	03/26/2007

Fig. 1 001-Housing

Fig. 2 002-Housing

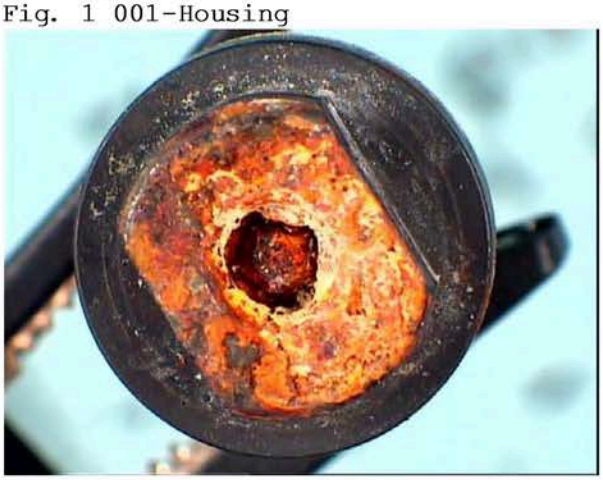

Fig. 3 001-OV

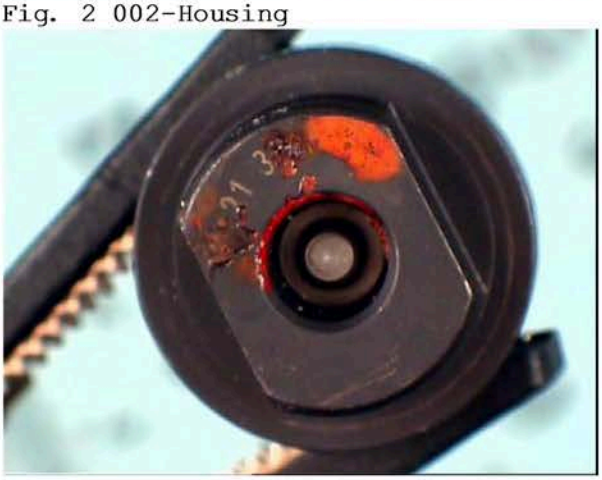

Fig. 4 002-OV

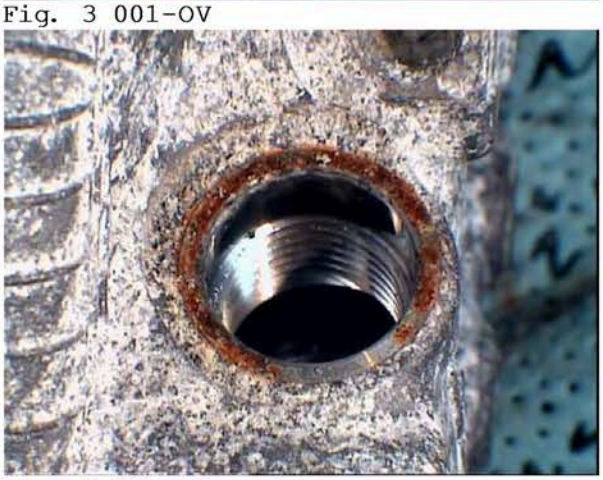

Fig. 5 001 OV sealing area

Fig. 6 002 OV sealing area

CP4 - Findings 17206 and 17325

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From	Person responsible	Telephone extension	Telefax extension	Feuerbach
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Fig. 7 001 Housing/cylinder head O-ring

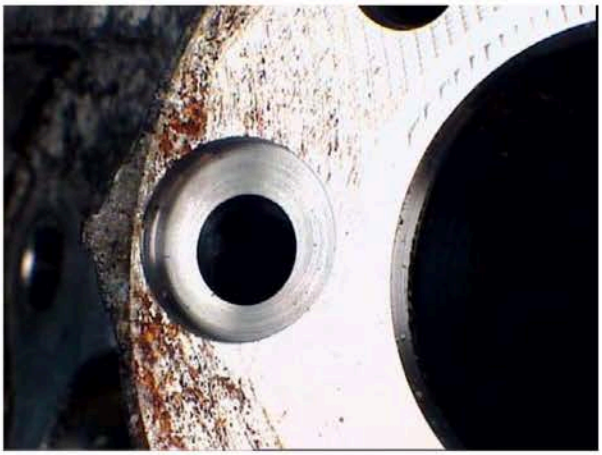

Fig. 8 002 Housing/cylinder head O-ring

ENTIRE PAGE CONFIDENTIAL

CP4 – Diagnosis 18010

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From	Person responsible	Telephone extension	Telefax extension	Feuerbach 5/25/2007
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Appendix 0 page (s)

To: Non-responsive content removed
z. K.

Customer: VW
Component: CP4.1S-348-2x5.25-REC
Project: R4 2,0l TDi
Engine / set no.:
PNo.: 0 445 010 508
DM: 150207
con. no. 0189
Add-on parts: MU

IBAS number: 105 227 253
Samos: 0563019
Customer order/MKV no.:
Parts receipt at dept. DS-PC/EDI: 05/11/2007
Manufacturing site: 0110 (Feuerbach plant)
Sample type: D
Running time:
Complaint: ; Visual findings by RB after VW testing agreed according to PV1210.

Operating conditions: 5 cycles according to VW standard PV1210 (it concerns a cyclic test). 1 cycle consisting of: 4h salt spray test with modified test solution (approx. 4% NaCl, 1% CaCl2). 4h Cooling down phase and 16h warm, humid conditions (DIN 50017KK), at 40°C and 100% rel. air humidity.

1. Description of problem

According to VW criteria, from a material point of view, the surface was evaluated with grade 3. VW requires the classification from RB for the final evaluation. The pump should be evaluated according to RB criteria

2. Findings

Leak-tightness: The pump did not leak during the immersion test (bubble test, 10 min; 6 bar').

Function: Comparison of the test points for series production and according to VW testing showed no negative effect on the
function.

Cover: It was still fixed after the test. Pull-out force >600N.

Visual findings: The OV showed slight corrosion on the hollow screw. This concerns
corrosion overflow starting from the plugs (rust could be scratched off).

The sealing point OV/housing showed no traces of rust. The sealing area of the housing/cylinder head is not critical: no rust under the sealing area (Fig. 1 and 4).

3. Conclusion

According to RB criteria (pumps leak tightness and function), the pump has passed the test.

4. Parts storage

The parts are returned to the customer.

Tested by: Non-responsive content removed	Telephone: Non-responsive content removed	Date: 29.5.07	Signed:	Non-responsive content removed
Department: Non-responsive content removed	Telephone:	Date: 11.6.07	Signetd:	
E. dept.: Non-responsive content removed	Telephone:	Date: 14.6.07	Signed:	
Report passed on to the customer: yes				

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CP4 – Diagnosis 18010

BOSCH

From	Person responsible	Telephone extension	Telefax extension	Feuerbach
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Fig. 1 Housing

Fig. 2 OV

Fig. 3 OV sealing area

Fig. 4 Housing/cylinder head O-ring

ENTIRE PAGE CONFIDENTIAL

BOSCH

CP4 – Diagnosis 17856

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DS-PC/EDI2	Leblanc	+49 (0) 711 811- 52384	+49 (0) 711 811- 44902

Feuerbach
07/09/2007

To: DS Non-responsive content removed
z. K.:
-/COS2; -/PJ-CP4; -/MSC-Q2-Fischer

Customer: VW
Component: CP4.1S-348-2x5.25-REC
Project: R4 2.01 Tdi
Engine / block no.: 03LA/17779
PNo.: 0 445 B21 058_07
Date of production: 691
Serial no. 4001
Add-on parts: MU
Operating conditions: OCR-DL1-OCR (customer information)

IBAS number: 105 225 877
Samos: 0560410
Customer order / MKV no.:
Parts receipt at dept. DS-PC/EDI: 5/7/2007
Manufacturing site: 0110 (Feuerbach plant)
Sample type: C
Running time: 648h
Complaint: ; ER end

1. Description of problem

The pump should be diagnosed and assessed according to the durability trial.

2. Findings

Residual dirt test:

Copper particles were detected in the residual dirt test (see Table 1).

Leak-tightness:

The pump did not leak in the immersion test (air with 6-bar rel, 10 min) at the interfaces cylinder head/flange/ MU/overflow valve/housing.

The pump did not leak in the cold cell at -27°C (locking screw/cylinder head, cylinder head/housing, MU molded seal and insert molding, radial shaft seal and flange/housing).

Function:

Quantity is within test tolerance for new parts at all testing points. The seal-tightness of the HP valve is OK. No hydraulic defects were found (see Table 2).

Parts visual findings:

The drivetrain parts (camshaft, roller, roller support, LP pistons, bearings) show no significant signs of wear (Fig. 1 to 3). Copper particles were found pressed into the flange bearing (Fig. 4). The slight scoring marks on the running surface of the contact bearing of the camshaft can be explained by particle contamination (Fig. 5). The tappet bore shows initial stages of cavitation erosion (Fig. 6).

3. Conclusion

The pump shows no significant functional change and no critical signs of wear. The pump has passed the test.

The origins of the copper can be clarified as there is evident coking on the associated set of injectors.

4. Parts storage

The parts are returned to the customer.

Checked by: DS	Non-responsive content removed	Telephone	Non-responsive content removed	Date: 11.07.07	Signed: Non-responsive content removed
DS-PC/EDI		Telephone		Date: 13.7.07	Signed:
E. dept.: DS/EH		Telephone		Date: 11.07.07	Signed:

report passed on to the customer: yes

CP4 – Diagnosis 17856

BOSCH

From	Person responsible	Telephone extension	Fax extension	F
Non-responsive content removed				7/9/2007

Measurement for each class:
Length µm

Class	<50.00	50.00-100.00	100.00-200.00	200.00-400.00	>=400.00
Copper 0		9	28	40	9
HL steel 0		3	4	2	0
Ba-sulphate 0		2	3	0	0
Permissible (TCD)	**doku**	**200**	**20**	**5**	**0**

Table 1: Particle analysis, magnitude

				Delivery measurement [l/h]	Remeasurement
	n [rpm]	p [bar]	Metering U	11/25/2006	5/15/2007
KL1-S	**3375**	**500**	**0.40**	66.4	67.2
LG	**1000**	**1800**	**0.40**	17.1	17.0
ST	**200**	**200**	**0.40**	3.9	3.9

Table 2: Functional test 691-4001

Fig. 1 Camshaft running surface

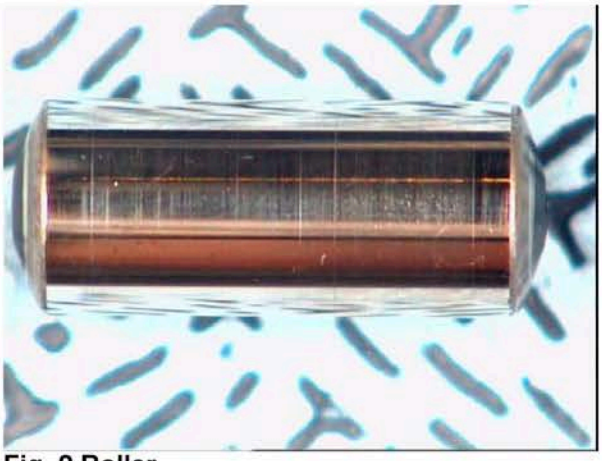

Fig. 2 Roller

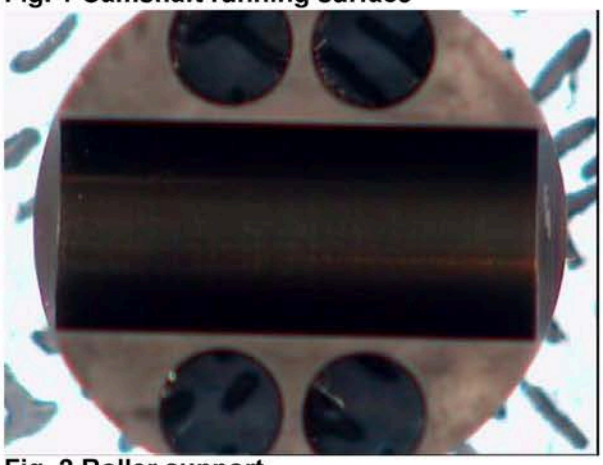

Fig. 3 Roller support

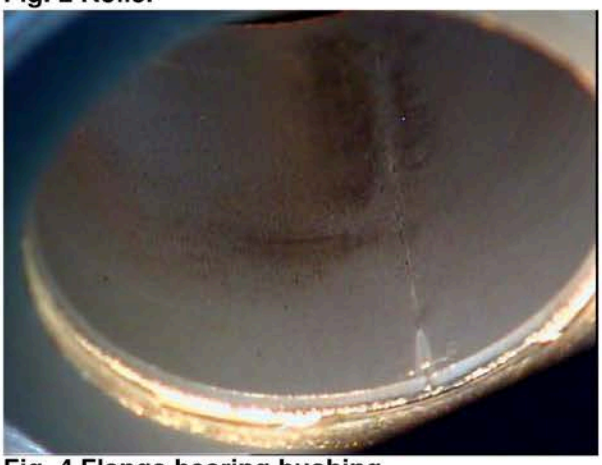

Fig. 4 Flange bearing bushing

CP4 – Diagnosis 17856

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[redacted]
7/9/2007

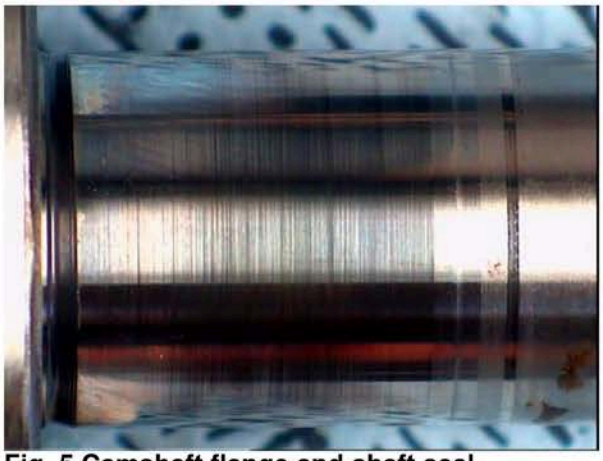

Fig. 5 Camshaft flange and shaft seal

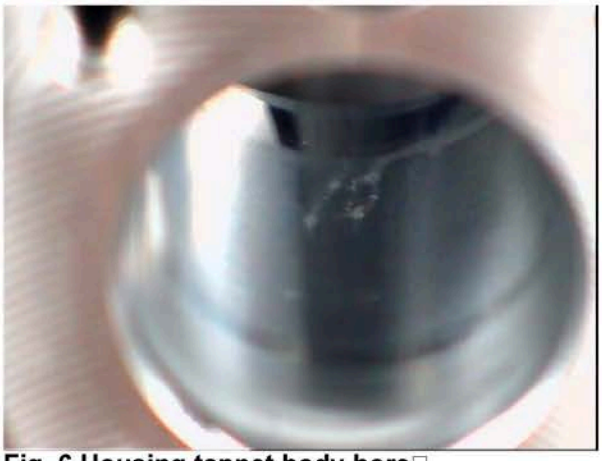

Fig. 6 Housing tappet body bore

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CP4 – Diagnosis 17852

BOSCH

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Feuerbach
7/11/2007

Appendix 0 page (s)

To: DS
z. K.: Non-responsive content removed

Customer:	**VW**	**IBAS number:**	105 225 884
Component:	CP4.1S-348-2x5.25-REC	**Samos:**	0560420
Project:	R4 2.01 Tdi	**Customer order / MKV no.:**	
Engine / block no.:	03LD/16368	**Parts receipt at dept. DS-PC/EDI:**	5/7/2007
PNo.:	0 445 B21 058_01	**Manufacturing site:**	0110 (Feuerbach plant)
DM:	684	**Sample type:**	**C**
Serial no.	4551	**Running time:**	200h
Add-on parts:	MU	**Complaint: ;**	ER end

Operating conditions: EGT coordination (customer specifications)

1. Description of problem

The pump should be diagnosed and assessed according to the durability trial.

2. Findings

Leak-tightness:

The pump did not leak in the immersion test (air with 6-bar rel, 10 min) at the interfaces cylinder head/flange/ MU/overflow valve/housing.

Function:

Quantity is within test tolerance for new parts at all testing points. The seal-tightness of the HP valve is OK. No hydraulic defects were found (see Table 1).

Parts visual findings:

The drivetrain parts (camshaft, roller, roller support, bearings) show no significant signs of wear (Fig. 1 to 3). 4). The machining marks on the cam track are still visible. No striking feature present.

3. Conclusion

The pump shows no significant functional change and no critical signs of wear. The pump has passed the test.

4. Parts storage

The parts are returned to the customer.

Checked by:	Non-responsive content removed	Telephon	Non-responsive content removed	Date: 11.07.07	Signed: Non-responsive content removed
Department		Telephon		Date: 13.7.07	Signed:
E. dept.: DS/EH		Telephon		Date: 11.07.07	Signed:

Report passed on to the customer: yes

ENTIRE PAGE CONFIDENTIAL

CP4 – Diagnosis 17852

BOSCH

From	Person responsible	Telephone extension	Fax extension	Feuerbach 7/11/2007
Non-responsive content removed				Page 2 of 2 Appendix 0 page (s)

				Delivery measurement (l/h)	Remeasurement
	n [rpm]	p [bar]	Metering	4/12/2006	5/11/2007
KL1-S	3375	500	0.40	67.5	66.6
LG	1000	1800	0.40	17.3	17.3
ST	200	200	0.40	3.9	3.9

Table 1: Functional test 684-4551

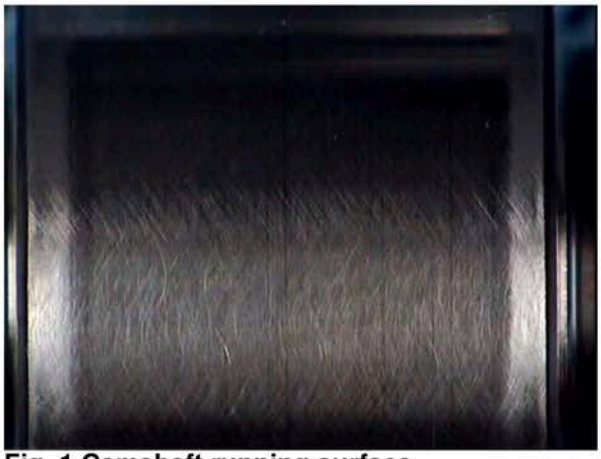

Fig. 1 Camshaft running surface

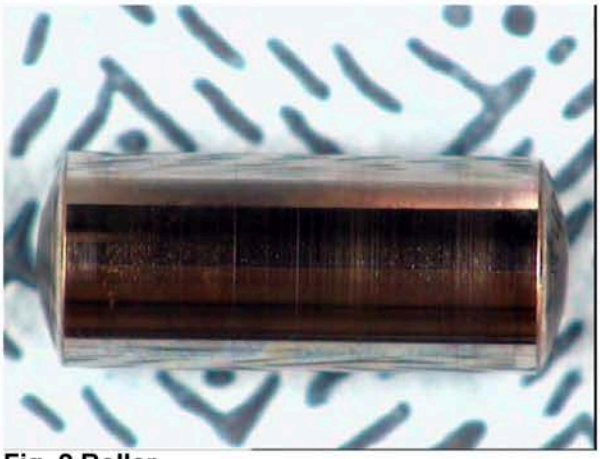

Fig. 2 Roller

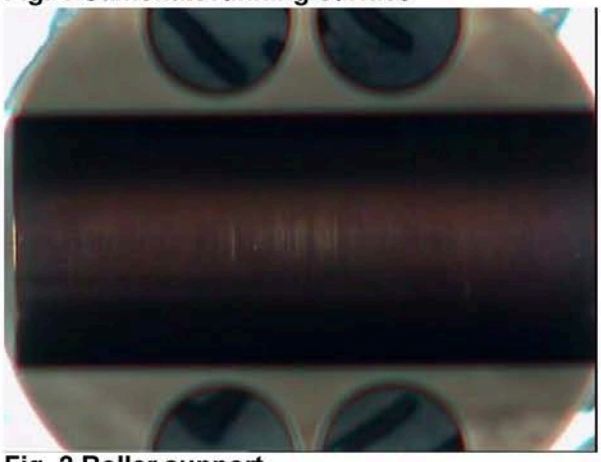

Fig. 3 Roller support

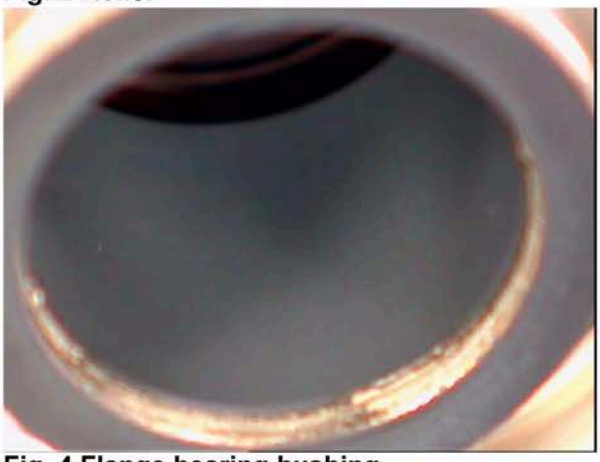

Fig. 4 Flange bearing bushing

BOSCH

CP4 – Diagnosis 17860

[redacted] Feuerbach
7/11/2007

To: DS [redacted]
z. K.: [redacted]

Customer:	**VW**	**IBAS number:**	105 225 857
Component:	CP4.1S-348-2x5.25-REC	**Samos:**	0560387
Project:	R4 2.01 Tdi	**Customer order / MKV no.:**	
Engine / block no.:	03LD/17482	**Parts receipt at dept. DS-PC/EDI:**	5/7/2007
PNo.:	0 445 B21 060_10	**Manufacturing site:**	0110 (Feuerbach plant)
DM:	690	**Sample type:**	C
Serial no.	4661	**Running time:**	453h
Add-on parts:	MU	**Complaint: ;**	ER end

Operating conditions: OCR-DL1 (customer specifications)

1. Description of problem

The pump should be diagnosed and assessed according to the ER test.

2. Findings

Leak-tightness:

The pump did not leak in the immersion test (air with 6-bar rel, 10 min) at the interfaces cylinder head/flange/MU/ overflow valve/housing.
The pump did not leak in the cold cell at -27°C (locking screw/cylinder head, cylinder head/housing, MU molded seal and insert molding, radial shaft seal and flange/housing).

Function:

Quantity is within test tolerance for new parts at all testing points. The seal-tightness of the HP valve is OK. No hydraulic defects were found (see Table 1).

Parts visual findings:

The drivetrain parts (camshaft, roller, roller support, bearings) show no significant signs of wear (Fig. 1 to 4). The C layer on the high-pressure pistons and piston foot show no signs of wear (Fig. 5 and 6). No striking feature present.

3. Conclusion

The pump shows no significant functional change and no critical signs of wear. The pump has passed the test.

4. Parts storage

The parts are returned to the customer.

Checked by: DS - PC	[redacted]	Telephone:	[redacted]	Date: 11.07.07	Signed: [redacted]
Department DS - PC		Telephone:	[redacted]	Date: 12.7.07	Signed:
E. dept.: DS/EHC		Telephone:	[redacted]	Date: 11.07.07	Signed:

Report passed on to the customer: yes

ENTIRE PAGE CONFIDENTIAL

CP4 – Diagnosis 17860

BOSCH

From	Person responsible	Telephone extension	Fax extension	Feuerbach 7/11/2007 Page 2 of 3 Attachment 0 page (s)
Non-responsive content removed				

				Delivery measurement	Remeasurement
				[l/h]	
	n [rpm]	p [bar]	Metering U	11/20/2006	5/9/2007
KL1-S	3375	500	0.40	67.2	67.4
LG	1000	1800	0.40	17.6	17.5
ST	200	200	0.40	3.9	3.9

Table 1: Functional test 690-4661

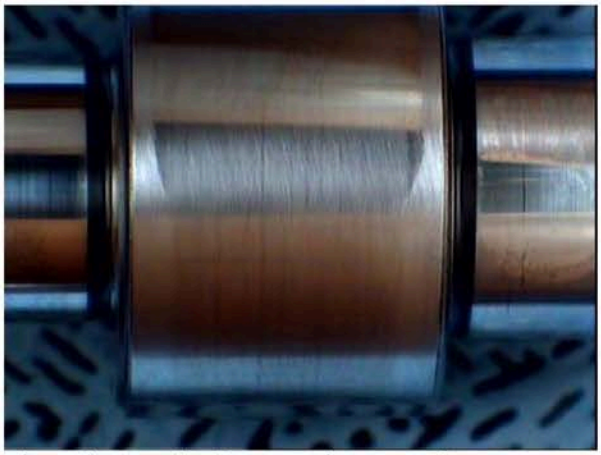

Fig. 1 Camshaft running surface

Fig. 2 Roller

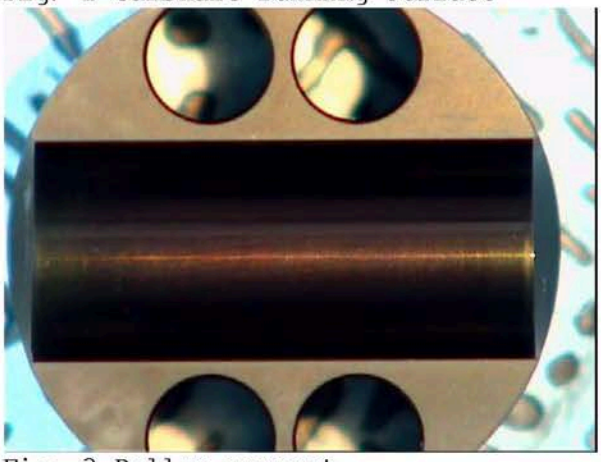

Fig. 3 Roller support

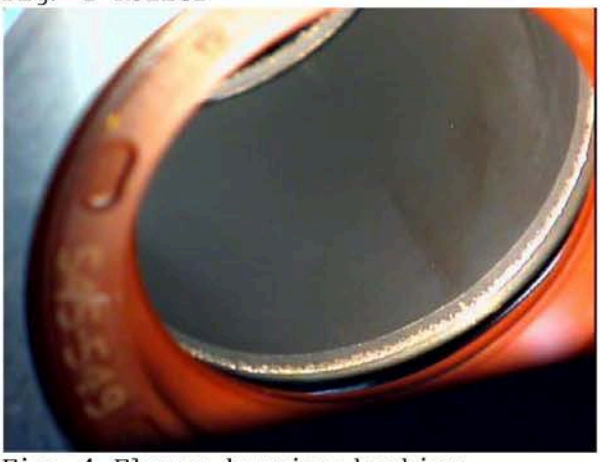

Fig. 4 Flange bearing bushing

ENTIRE PAGE CONFIDENTIAL

CP4 – Diagnosis 17860

BOSCH

From	Person responsible	Telephone extension	Fax extension	Feuerbach 7/11/2007 Page 3 of 3 Attachment 0 page (s)
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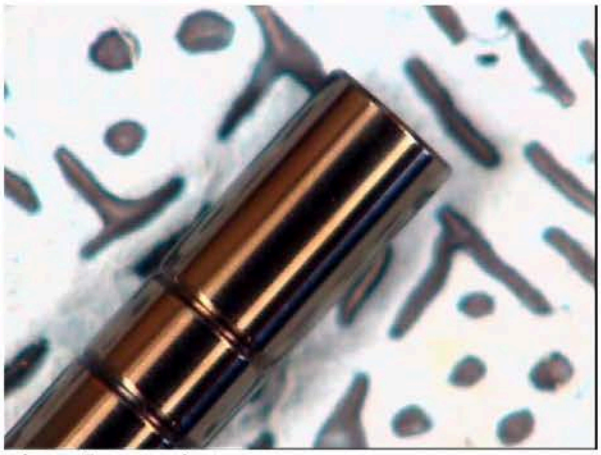

Fig. 5 HP pistons

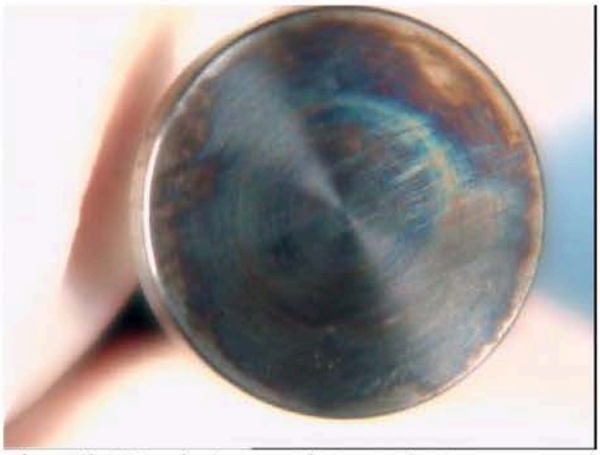

Fig. 6 HP pistons piston foot

CP4 – Diagnosis 19363

BOSCH

From	Person responsible	Phone extension	Fax extension	Feuerbach 1/9/2008 Page 1 of 3 Attachment 0 Page(s)
Non-responsive content removed				

To: DS Non-responsive content removed
z. K. :

Customer:	**VW**	**MAP:**	DS-164720
Component:	CP4.1S-348-2x5.25-REC	**Samos:**	0577763
Project:	R4 2.01 Tdi	**Customer order / MKV no.:**	
Vehicle no.:	VW 428-8-0021	**Parts receipt at dept. DS-PC/EDI:**	10/12/2007
PNo.:	0 445 B21 058	**Manufacturing site:**	0110 (Feuerbach plant)
DM:	081206	**Pattern type:**	D
Serial no.	0045	**Mileage:**	1231km
Add-on parts:	MU	**Complaint:**	; Shavings in the high-pressure pump

Operating conditions: Ehra enhanced for passenger cars in vehicle. Engine runs only at idle speed.

1. Description of problem

Particle contamination of the entire system. Suspect pump drivetrain damage.

2. Findings

The roller and cam track of the pump are very worn. The running mark on the cams and the roller indicates a twisting of the roller (Fig. 1 and 2) and confirms that the pump has failed due to a twisted roller. The basic material of the camshaft shows traces of rust. The C layer in the roller support shows eccentric wear (Fig. 3). Water was found in the pump (Fig. 4)
Roller support, intake valve and gasket also show signs of rust (Fig. 5 to 7). Steel and rust particles have pressed into the bearings and have caused scratches on the tappet body casing and in the tappet bore (Fig. 8 and 9).

3. Conclusion

The main hypothesis is the change of the rolling parameters between the cam track and the roller on account of free water in the fuel.

It is probable that rust would build up on the cam track during stand time. When restarting the pump, rust particles would have become loose and ended up between the roller and cam or the roller and roller support. As a result of which, the roller was subjected to a torque that brought about a twisted position and a 90° twisted roller tappet.

4. Parts storage

The parts are stored at RB until 10/2008 and then scrapped.

Checked by: DS	Non-responsive content removed	Telephone	Non-responsive content removed	Date: 9.1.08	Signed: Non-responsive content removed
department DS-P		Telephone		Date: 14.1.08	Signed:
E. dept.: DS-PC/		Telephone		Date: 15.1.08	Signed:
passed on to the customer: yes					

ENTIRE PAGE CONFIDENTIAL

CP4 – Diagnosis 19363

BOSCH

From	Person responsible	Telephone extension	Fax extension	Feuerbach 09.01.2008
Non-responsive content removed				Page 2 of 3 Attachment 0 page (s)

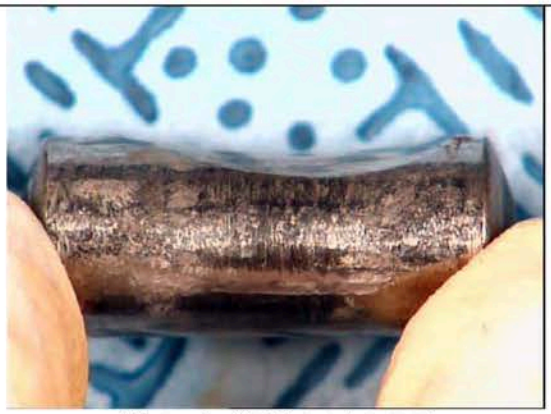

Fig. 1 Roller tappet

Fig. 2 Cam track roller TDC

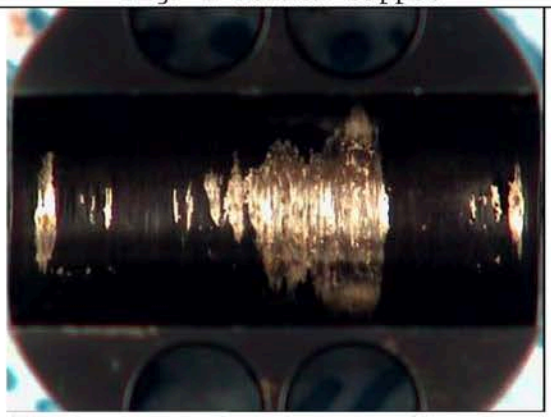

Fig. 3 Roller support running surface

Fig. 4 Fuel sample from pump

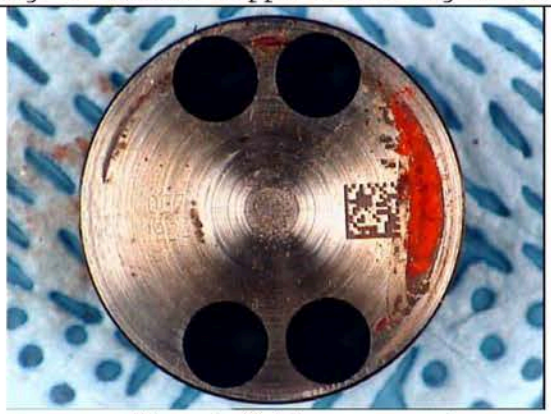

Fig. 5 Roller support

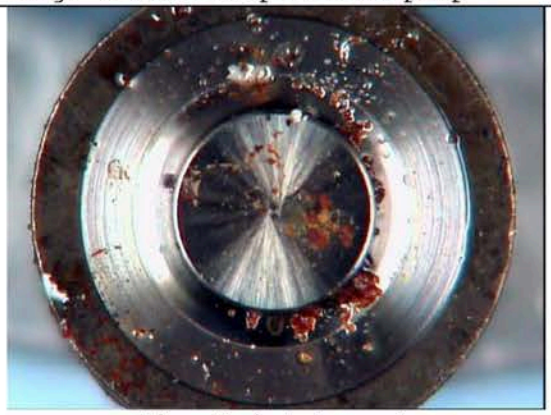

Fig. 6 intake valve

ENTIRE PAGE CONFIDENTIAL

CP4 – Diagnosis 19363

BOSCH

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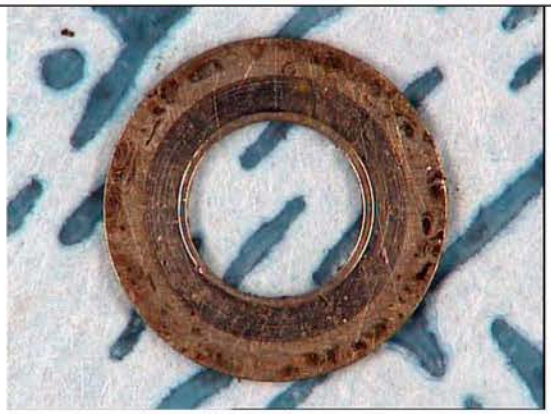

Fig. 7 Gasket

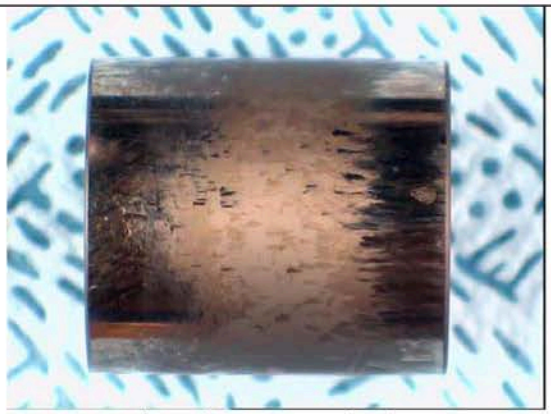

Fig. 8 Tappet body

Fig. 9 Tappet bore

BOSCH CP4	CR pump CP4 - Diagnosis report	Report no.	19420
		Date	12/4/2007

Department:	Person responsible:	Telephone:	Use	
Non-responsive content removed			internal	
			external	x

Pump type:	Customer:	Project:	Project/ design sample version
CP4.1XX_298_2x5,25_REC_3,3_1,95_MT4,2	VW	R4 2.0 EU5	D / C2
Item number (Part no.) :	**Date of manufacture:**	**Serial number:**	**Plant - line**
0445B21058	010207	0045	0110 FeP - 1
SAP-No.:	**Samos no.:**	**Customer order no.:**	**Engine/Vehicle number**
DS-164763	578256		AU 481-8-8008
Customer part number	**ER type [customer]:**	**Endurance run conditions:**	**DSBFD no.:**
	Q endurance run		19420
Mileage:	**Received by DS-PC/EDI on:**	**Process no.**	**Confidentiality note**
80000 km	10/22/2007	2007 - CP4 / 0006	Confidential
Complaint:	None. Endurance run end.		

1. Subject

CP4 customer return
Q-ER; CAG 0000 067; AU 481-8-8008

2. Conclusion

The results of the residual soiling test lie within the tolerance of new parts. Only light traces of wear can be seen.

The pump has passed the test.

3. Results of diagnosis (visual findings)

Legend rating stages

OK	x		
non-critical		x	
Critical			x

3.1 Drive — x
No wear visible

3.2 Drivetrain — x
Only very slight wear visible (Fig. 1 and 2)

3.3 High pressure — x
Only very slight wear visible

3.4 Bearing — x
No striking feature (Fig. 3)

3.5 Shaft seal — x
Minor embedding of the shaft seal

3.6 Bore holes — x
Only very minor cavitation erosion in the tappet bore (Fig. 4)

3.7 Attached components (MU, OV, GP) — x
No striking feature

3.8 Other — x
No striking feature

BOSCH CP4	CR pump CP4 - Diagnosis report	Report no.	19420
		Date	12/4/2007

Department:	Person responsible:	Telephone:	Use	internal	
Non-responsive content removed				external	x

4. Hydraulic function

	n [rpm]	p_rail [bar]	Metering unit [A]	Delivery rate [l/h] New part 2/6/2007	Delivery rate [l/h] after testing 11/5/2007			
ST	200	200	0.4	4.0	3.9	x		
Running limit	1000	1800	0.4	17.5	17.7	x		
KL1-S	3375	500	0.4	67.6	66.7	x		

OK

BOSCH CP4

CR pump CP4 - Diagnosis report

Report no.	19420
Date	12/4/2007

Department:	Person responsible:	Phone	Use	internal	
	Non-responsive content removed			external	x

5. Parts storage

The parts will be stored at RB until 06/2008

6. Attachments

Figure

Tested:	Non-responsive content removed	Telephone:	Non-responsive content removed	Date:	14.12.07	Signature:	Non-responsive content removed
Department:		Telephone:		Date:	19.12.07	Signature:	
Department:		Telephone:		Date:	07.01.08	Signature:	

BOSCH	CR pump CP4 - Diagnosis report	Report no.	19420
		date	12/4/2007

Department:	Person responsible:	Telephone:	Use	internal / external
Non-responsive content removed				x

Fig. 1 010207-0045_cam track_running surface

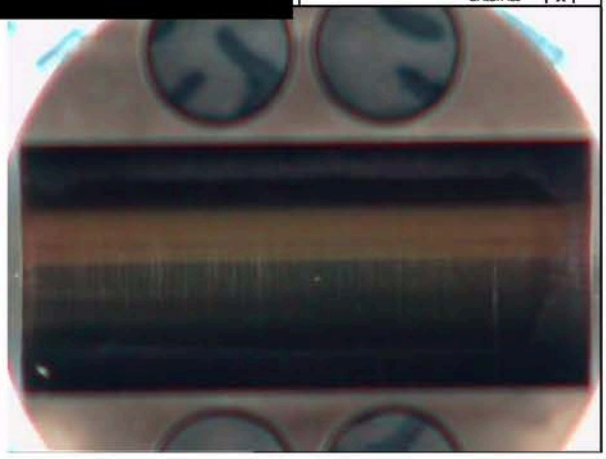

Fig. 2 010207-0045_roller support running surface

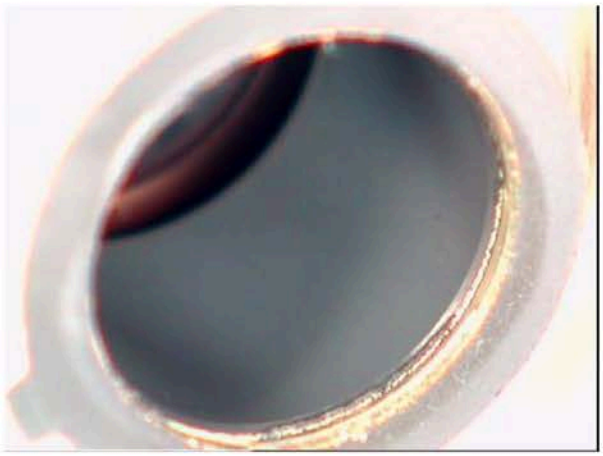

Fig. 3 010207-0045_flange bearing bushing

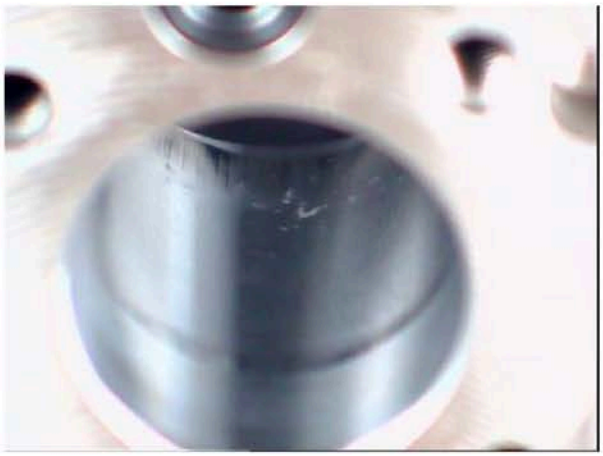

Fig. 4 010207-0045_housing tappet bore

EA11003EN-01019[0]

ENTIRE PAGE CONFIDENTIAL

From: Non-responsive content removed
To:
CC:

Date: 7/18/2008, 3:03:24 PM
Subject: Re: Updating the new list of drivetrain damage
Attachments: EHC2_0311_080718_Status KT_Triebwerksausfälle USA.pdf

Good day [redacted]

Here is the status for the KT analysis (based on the 2nd confirmed failed pump. No failure on the 3rd

pump). Further presentation in in Audi CP4 FG on 07/30/2008.
At the moment we are collecting facts (as agreed in the OPL from ZFM with the focus on the drivetrain)
We will update the KT analysis approx. every 2 - 3 days.
We do not have any results yet - we hope that the tests on the 6 replaced pumps as well as the 4th failed pump will give us some useful information / indications.

Mit freundlichen Grü??en / Best regards

Non-responsive content removed
Robert Bosch GmbH
Non-responsive content removed
www.bosch.com

From: Non-responsive content removed
Sent: Thursday, July 17, 2008, 6:36 PM
Non-responsive content removed

ENTIRE PAGE CONFIDENTIAL

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Subject:ANS: Updating the new list of drivetrain damage

We did not see the KT analysis yesterday / day before yesterday; how will you send us the result (compressed)?

With best regards

Non-responsive content removed

From: Non-responsive content removed
Sent: Monday, July 07, 2008, 7:16 PM

Non-responsive content removed

Subject: ANS: Updating the new list of drive-train damageHello

We will present you with the results of the KT analysis on July 15. We have set up a task force for the drivetrain damage.

Mit freundlichen Grü??en / Best regards

Robert Bosch GmbH

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www.bosch.com

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From: Non-responsive content removed
Sent: Monday, July 07, 2008, 3:31 PM

Non-responsive content removed

Subject: Updating the new list of drivetrain damage
Importance: High

Hello

Please report all cases to me.
2 Q-AL cases WK 27 = red.
2 failures from today = blue/green
As many of the failures were in export and the parts return is very thin there, please **always** provide a photograph of the pump ID plate and the vehicle data.

EA11003EN-01019[2]

Please let us know if these parts for the pumps in the list are coming.
I will be monitoring via daily damage meeting minutes; I will be asking at the damage meeting for the pumps to come to me.

Hello [redacted]
Please add the missing Bosch data by the end of this week [redacted] knows the columns).
Please also deal with the analysis of the 4 x ECU (topic of rail pressure fluctuation)?

To all,
who is participating in the Q meeting drivetrain damage (ZFM) on the afternoon of 7/15 in FeP?
Could it be the case that a vehicle that has already run (with reserve tank) by ship or plane (transport location; temperature; etc.) could have problems with restarting?

Dear [redacted]
Do we have the results of the KT analysis?

At the request of [redacted], have we already initiated a task force (for testing / field failures)? <<Triebwerkschäden

CP4 alle KW28_08.xls>>

Yours sincerely,
[redacted]

[redacted]

EA11003EN-01020[0]

ENTIRE PAGE CONFIDENTIAL

CT analysis Audi Q verification - USA

Collection of facts	IS	No.	IS NOT	Differences / peculiarities (IS/IS-NOT)
WHAT?				
Object with fault	Drivetrain consisting of 2 x roller, 2 x roller support, 1 x cam track 2 x tappet bodies outside; 2 x cylinder bores housing	1		Delivery rate 1 pump cylinder suffices for operation in lower partial load area (cruise control ???; each CH operates a rail - must be checked)
Fault on object	Turned tappets left and right tappets seized in TDC left and right cam track completely worn roller completely worn with braking flat from final turned tappet roller failure 2 with slight lateral start-up roller support - in running direction C3-coating-abrasion in accordance with load distribution		only one / no tappet body turned only one / no tappet body clamped Roller failure 1 with start-up Roller support- unsymmetrical or complete C3-coating abrasion	
WHERE?				
is object with fault observed **geographically**	USA (Federal States); Vehicle Q7 2338 20,000km [Non-responsive content removed] not clarified) 2449	2	Europe (clarify whether vehicles with mileage are available)	USA fuel Transport Driving (load) profile Climate
is the fault **on the object**	Housing: (Clarify wear) Tappet body: Scuffing; partly across entire tappet body	3	Clarify - pump with tappet seizure (comparison of images)	

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EA11003EN-01020[1]

ENTIRE PAGE CONFIDENTIAL

CT analysis Audi Q verification - USA

Collection of facts	IS	No.	IS NOT	Differences / peculiarities (IS/IS-NOT)
WHEN?				
at first did object with defect occur, was observed, reported?	05/21/2008 (arrived at RB) All DM 11/30/2007	4	before; after	before: Clarify structure of sample pumps after: visual inspection + inspection catalog RS (reworked several times) Friction coefficient testing +/- 10° Test program for Audi (Date?) Straightedge test Cleaning cloth after C coating Optimized C coating introduced as per DM 11/30/2007
again (course, rhythm of the occurrence)	06/26/2008 (2. pump) 7/18/2008 (3. (Not this fault pattern) + 4. pump will still be delivered to RB)	5		
in the **life cycle** of the objects was the defect observed	Field 1. 40 Tkm; 2 62Tkm	6	Further pumps run with max 49 tkm	
HOW MANY?				
How many objects have this defect	2	7	Not all (>10)	
How many objects are affected	Drivetrain complete	8		
How many faults on object	1	9		
Tendency	Cannot be assessed	10		

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CT analysis Audi Q verification - USA

Hypotheses being tested

- → Water gushing from water separator
- → CP4 cam track in bathtub form
- → Roller with metal splashes (sluggish roller)
- → Unsuitable fuel (sticking, etc.)
- → Temporary production fault
  (Slip due to later improved tests)

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CT analysis Audi Q verification - USA

Further work

- → Findings 4. failed pump
- → Complete the collection of facts together with Audi
- → If necessary, list further hypotheses
- → Plausibility check of the hypotheses
- → Check necessary assumptions
- → Confirm hypothesis (hypotheses)
- → Define package of measures

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ENTIRE PAGE CONFIDENTIAL

CP4 findings on Audi W19 EU6/BIN5

Status of findings on Audi 0445 010 613 #080605-0388 complained about with loss of power during Q verification in USA

Mileage of pump: 6,812km (Audi vehicle AU716 98017)

Result of visual findings: (see also pictures from slides 2 and 3)

- NO drivetrain damage
- Lateral roller start-up with no striking features
- Black particles on the MU and IV strainer and in the MU bore
- No particles in the intake valve / non-return valve

Damage hypothesis:
Strainer blocked and/or pistons sluggish on MU and OV

Further work:

- Analysis of MU at GS-CP/EEC1 (MU development in Non-responsive content removed) *ongoing*, D: 7/25/2008
- Analysis of the black particles *ongoing*, D: 7/28/2008

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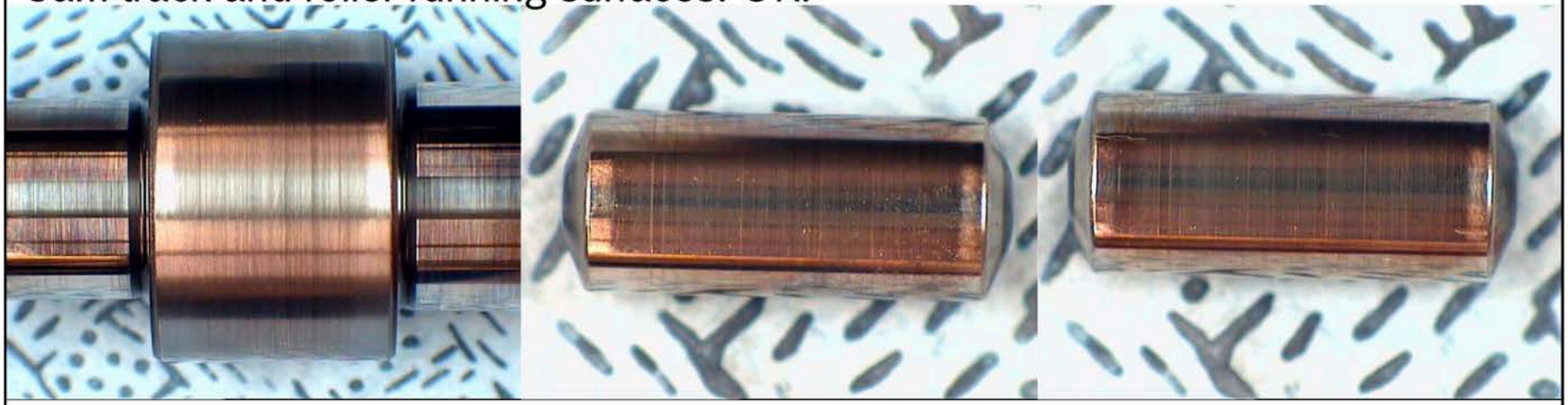
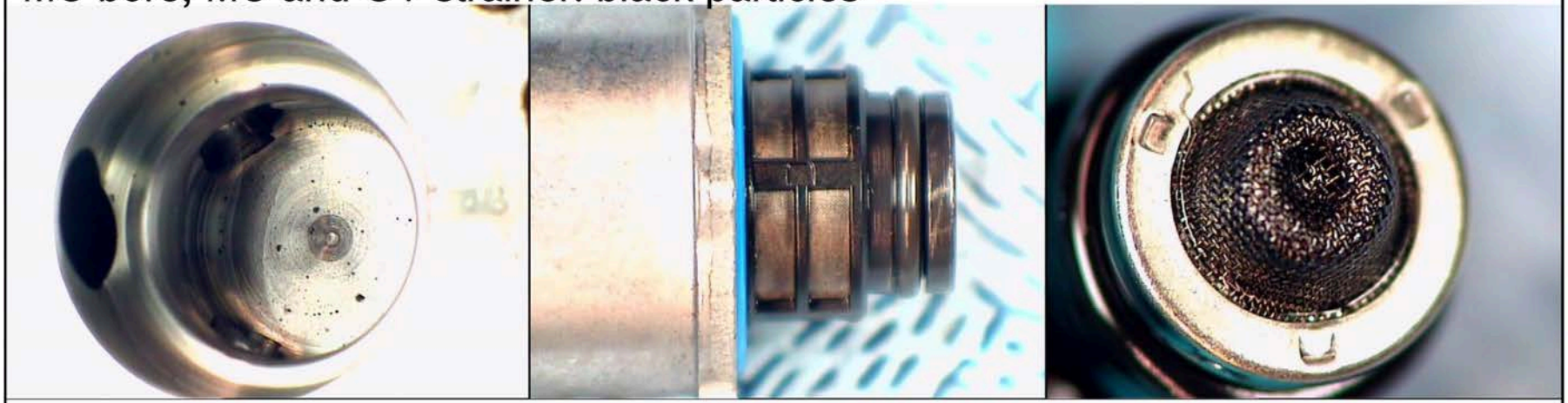
CP4 findings on Audi W19 EU6/BIN5

Cam track and roller running surfaces: OK.



MU bore, MU and OV strainer: black particles



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EA11003EN-01022[2]

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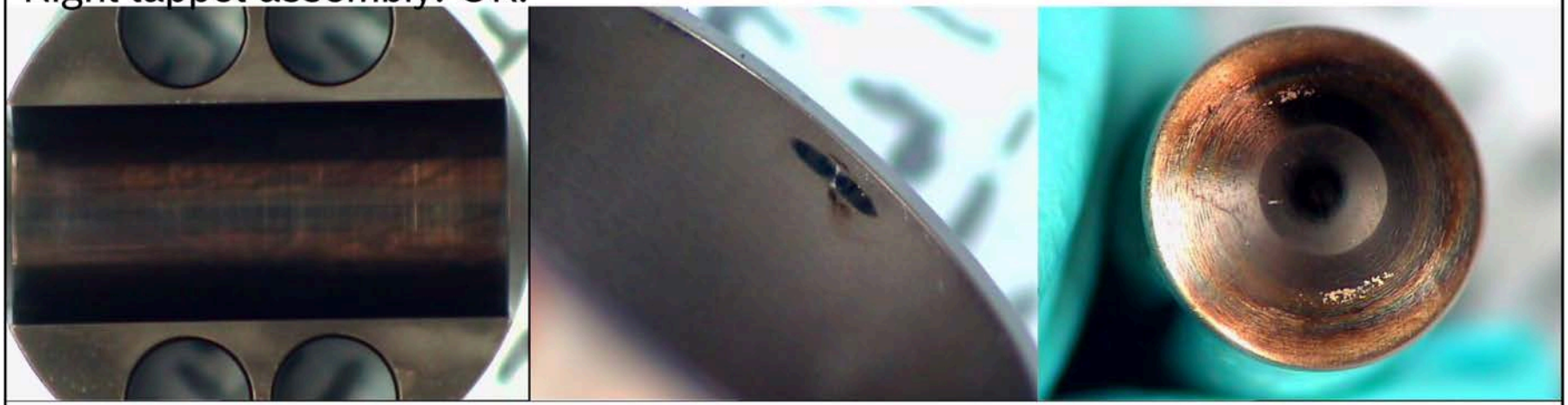
CP4 findings on Audi W19 EU6/BIN5

Left tappet assembly: OK.

Right tappet assembly: OK.



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EA11003EN-01025[0]

ENTIRE PAGE CONFIDENTIAL

From: Non-responsive content removed
To:
CC:
Date: 7/25/2008 9:45:34 AM
Topic: ANS: Audi CP4 pump replacement

Hello Non-responsive content removed

I have taken the testing point 5,000 rpm & 2,000 bar from the e-mail from Non-responsive content removed as it was not possible to speak to the USA.

I am considering two approaches at present:

1) Pump was tested under the correct operating conditions, was not OK. & [redacted] did not understand the operating conditions properly
2) Pump was tested under the incorrect operating conditions, and was therefore not OK.

I´ll clarify this.

Best regards / mit freundlichen Grüßen

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Robert Bosch GmbH
Non-responsive content removed

www.bosch.com

Non-responsive content removed

Domicile: Stuttgart, Court of Registry: Local District Court Stuttgart, Commercial Register No. 14000
Chairman of the Supervisory Board: Hermann Scholl; Management: Franz Fehrenbach, Siegfried Dais;
Bernd Bohr, Rudolf Colm, Gerhard Kümmel, Wolfgang Malchow, Peter Marks;
Volkmar Denner, Uwe Raschke, Peter Tyroller

From: Non-responsive content removed
Sent: Friday, July 25, 2008, 10:35 AM
Non-responsive content removed
Subject: ANS: Audi CP4 pump replacement

Non-responsive content removed

It is your people and your testing technology.
Please clarify by Wednesday.

Another point for Wednesday:
From the 3 fuel samples taken from the USA failure no. 3, please bring approx. half of the 3 liquids with you to [redacted] for our laboratory; we would also like to analyze these and compare the results.
Important: Make sure the samples are shaken / stirred well beforehand, so that the particles, contents etc. are distributed as evenly as
possible in the liquid.

ENTIRE PAGE CONFIDENTIAL

Now I´ll let you get on in peace until then.
Have a nice weekend!
Hi Non-responsive content removed,
For the technical meeting on Wednesday (US failures topic) we require a fuel filter expert from EA-9x, who is familiar with both the
fuel supply and the filtration efficiency, mesh size etc..
Please make sure you take part!
Non-responsive content removed,
Please also participate in the USA + [redacted] failures.

With best regards

Non-responsive content removed

From: Non-responsive content removed
Sent: Friday, July 25, 2008, 10:12 AM
Non-responsive content removed
Subject: ANS: Audi CP4 pump replacement

Hello [redacted]

Initial measurements were taken in production & I'll get them by Wednesday.

There are most certainly some very evident differences (1-2 l/h) which can be explained by the testing technology.

I have considerable doubts that the pump function was not OK if it was tested at 5,000 rpm and 2,000 bar - engine speed projected or actually tested pump speed.

Mit freundlichen Grüßen / Best regards

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Robert Bosch GmbH
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www.bosch.com

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Domicile: Stuttgart, Court of Registry: Local District Court Stuttgart, Commercial Register No. 14000
Chairman of the Supervisory Board: Hermann Scholl; Management: Franz Fehrenbach, Siegfried Dais;
Bernd Bohr, Rudolf Colm, Gerhard Kümmel, Wolfgang Malchow, Peter Marks;
Volkmar Denner, Uwe Raschke, Peter Tyroller

From: Non-responsive content removed
Sent: Friday, July 25, 2008, 10:03 AM
Non-responsive content removed
Subject: Audi CP4 pump replacement

Hello Non-responsive content removed

ENTIRE PAGE CONFIDENTIAL

Initial measurements?
Included with analysis report by Wednesday.

With best regards

Non-responsive content r emoved

From: Non-responsive content removed
Sent: Friday, July 25, 2008, 9:29 AM
To: Non-responsive content removed
Subject: RE: Address for Audi CP4 Pump exchange

Please provide the vehicle number incl. the mileage of the pump replacement.
: I think this sounds like the next bomb waiting to explode if I lose significantly on flow due to mileage.
Does Bosch have a final measurement for the pump?
If yes, what does it look like?

With best regards

Non-responsive content remo ved

AUDI AG
Non-responsive conten t removed

www.audi.com

Sitz/Domicile: Ingolstadt
Registergericht/Court of Registry: Local District Court Ingolstadt
HRB Nr./Commercial Register No.: 1
Vorsitzender des Aufsichtsrats/Chairman of the Supervisory Board: Martin Winterkorn
Vorstand/Board of Management: Rupert Stadler (Vorsitzender/Chairman), Ulf Berkenhagen, Michael Dick, Frank Dreves, Peter Schwarzenbauer, Axel Strotbek, Werner Widuckel

Wichtiger Hinweis: Die vorgenannten Angaben werden jeder E-Mail automatisch hinzugefuegt und lassen keine Rueckschluesse auf den Rechtscharakter der E-Mail zu.
Important Notice: The above information is automatically added to this e-mail. This addition does not constitute a representation that the content of this e-mail is legally relevant and/or is intended to be legally binding upon AUDI AG.

From: Non-responsive content remo ved
Sent: Thursday, July 24, 2008, 11:10 PM
To: Non-responsive content removed
Subject: FW: Address for Audi CP4 Pump exchange

Hello Non-responsive content removed

brief status for both the verification vehicles, detailed analysis report by BOSCH follows:

- both pumps were opened by Bosch employees and the Mus, tappets, rollers and cams assessed - without any striking features. BOSCH has drawn up an analysis report.

- Further, both pumps were surveyed on the test bench at BOSCH

- One pump had in the operating point 5,000 rpm and 2,000 bar a flow rate of only 99 l/h (TARGET 113 l/h, plus/minus 7 l/h according to BOSCH test regulation for new pumps), according to BOSCH possible MU defect

- Not OK, according to the consultation Non-responsive content removed as recommended by BOSCH pump replaced with a new part.
- Second pump on test bench OK, re-install in vehicle

- Both vehicles shall leave tomorrow starting at 7.00 am after repeated visual check in the direction of Auburn Hills QAL stations

In case of queries, please revert.
Note: 1. Both vehicles showed oil sweat in the region of the boost pressure pipe on vehicle underside
2. One vehicle with loose precatalyst Lambda probe and missing sealing ring

Images incl. data memory excerpts will be sent tomorrow.

Regards

Non-responsive content removed

Non-responsive content removed

EA11003EN-01026[0]

ENTIRE PAGE CONFIDENTIAL

From: Non-responsive content removed
To:
CC:

Date: 7/25/2008, 9:05:26 AM
Subject: ANS: CP4 pump replacement results

Good day [redacted]

I must contact the USA and obtain feedback concerning the testing points & measured values.
If the pump is not OK, we will detect the error &, as you have proposed, replace the MU and allow the pump to continue running.

Best regards / mit freundlichen Grüßen

Non-responsive content removed

Robert Bosch GmbH
Non-responsive content removed

www.bosch.com

From: Non-responsive content removed
Sent: Friday, July 25, 2008, 9:38 AM
Non-responsive content removed
Subject: ANS: CP4 pump replacement results

Hello Non-responsive content removed

Non-responsive content removed and I have coordinated how to proceed:

ENTIRE PAGE CONFIDENTIAL

We do not want to "waste" the mileage on this pump and therefore ...

for the pump with the too low delivery rate in the FL, have the MU from the new pump built in and then test this again on the test bench.
If OK, we would like to allow the pump to run in a vehicle that is to be defined (new or already run),
if not OK we will discuss matters in detail with Bosch (regarding strainer and ? or analysis of MU at Bosch in [redacted]
Discussions concerning the Bosch analysis report in the technical meeting on Wednesday.
Decision r.e. further pit stops by [redacted] / Bosch

With best regards

[redacted]

AUDI AG
[redacted]

From: [redacted]
Sent: Thursday, July 24, 2008, 11:10 PM
[redacted]
Subject: FW: Address for Audi CP4 Pump exchange

Hello [redacted]

brief status for both the verification vehicles, detailed analysis report by BOSCH follows:

- both pumps were opened by Bosch employees and the MUs, tappets, rollers and cams assessed - without any striking features. BOSCH has drawn up an analysis report.

- Further, both pumps were surveyed on the test bench at BOSCH

- One pump had in the operating point 5,000 rpm and 2,000 bar a flow rate of only 99 l/h (TARGET 113 l/h, plus/minus 7 l/h according to BOSCH test regulation for new pumps), according to BOSCH possible MU defect

- Not OK, according to the consultation [redacted] as recommended by BOSCH pump replaced with a new part.

- Second pump on test bench OK, re-install in vehicle

- Both vehicles shall leave tomorrow starting at 7.00 am after repeated visual check in the direction of Auburn Hills QAL stations

In case of queries, please revert.

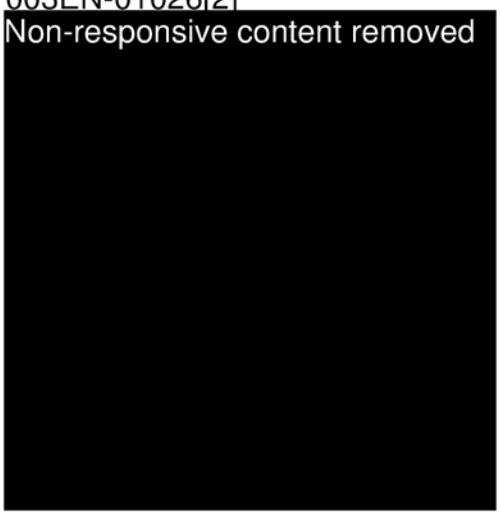
Note:
1. Both vehicles showed oil sweat in the region of the boost pressure pipe on vehicle underside
2. One vehicle with loose precatalyst Lambda probe and missing sealing ring

Images incl. data memory excerpts will be sent tomorrow.

Best Regards

EA11003EN-01026[2]

ENTIRE PAGE CONFIDENTIAL



Provisional report **"CP4 pump test campaign - USA"**

Date: 7/25/2008

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BOSCH

Customer: AUDI

Veh. AU71698026 **Mileage:** 45,475 miles = 68,058 Km

CP4.2 **MFD:** 07 11 30 **s/n:** 0625

Test process:

1. Visual findings
2. Function check on test bench

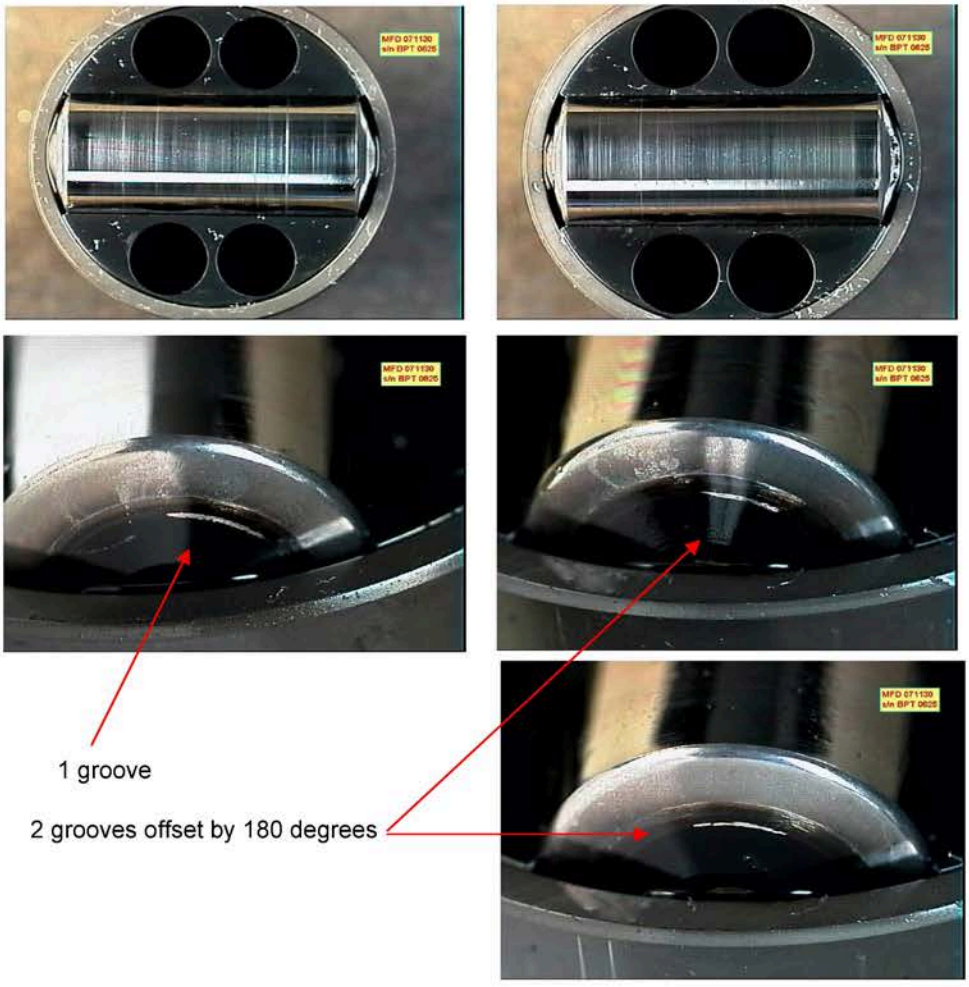
1. Result of visual findings:

Roller r&ollers have negligible run marks on the track
Roller has 2 small grooves on the front surfacee, however not across the entire circumference on the C coating
It is not a running fault as it runs to the outside diameter from the center, roller is Noguchi
Camshaft shows same running pattern on the camshaft track as the roller
MU has small, evident particles in the strainer.

Pictures:

LEFT

RIGHT



Camshaft

MU

2. Results of test bench

OK, test points within tolerances.

(Measurement data not available, probably overwritten by mistake)

Destiny of the parts:

Pump was put back in vehicle.

Provisional report **"CP4 pump test campaign - USA"**

Date: 7/25/2008

Non-responsive content re moved

Customer: AUDI

Veh. AU71698020 **Mileage:** 45,475 miles = 65,015 Km

CP4.2 **MFD:** 07 11 30 **s/n:** 0634

Test process:

1. Visual findings
2. Function check on test bench

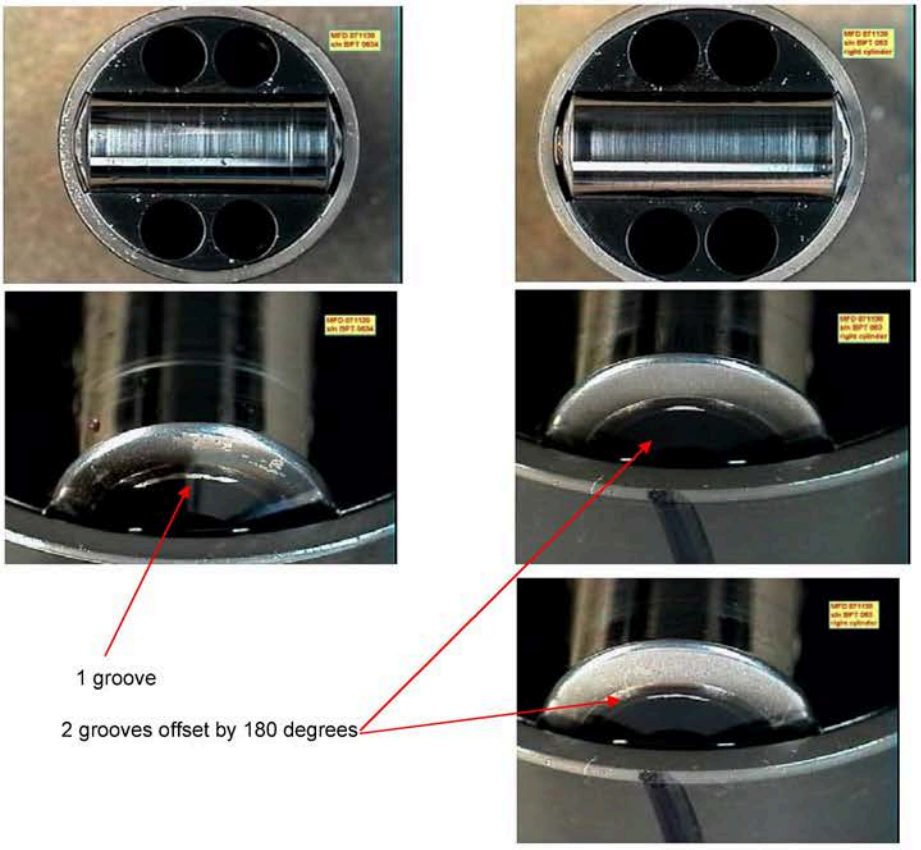
1. Result of visual findings:

Roller R&ollers have negligible run marks on the track
Roller has 2 small grooves on the front surface, however not across the entire circumference on the C coating
It is not a running fault as it runs to the outside diameter from the center, roller is Noguchi
Camshaft shows same running pattern on the camshaft track as the roller
MU has no evident particles in the strainer.

Pictures:

LEFT

RIGHT



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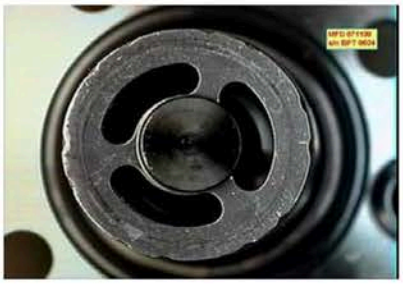


Camshaft

MU

2. Results of test bench

TEST 1

Work Order #	7348	**Test Bench**	**CA4000**	42,352mi	
Name	[redacted]	**Date**	7/25/2008		
Part Number	0445010613	**MFD/SN**	071130/0634		

Testing point	Pump speed	Current	Rail pressure	Expected Fuel delivery	Delivery Tolerance	Measured Fuel delivery	Expected Lubrf. Q	Lubrf. Q.
No.	rpm	mA	bar	l/h	l/h	l/h	l/h	l/h
1	1000	**0.4**	**2000**	34.0	> 34	38.04	> 125	180
2	3375	**1.20**	**500**	48.0	5	49.47	> 50	172
3	3375	**0.4**	**500**	113.0	7	100.95	> 30	137
4	200	**0.4**	**200**	8.7	1	8.38	> 100	195

TEST 2

Work Order #	7348	**Test Bench**	**CA4000**	42,352mi	
Name	[redacted]	**Date**	7/25/2008		
Part Number	0445010613	**MFD/SN**	071130/0634 1		

Testing point	Pump speed	Current	Rail pressure	Expected Fuel delivery	Delivery Tolerance	Measured Fuel delivery	Expected Lubrf. Q	Lubrf. Q.
No.	rpm	mA	bar	l/h	l/h	l/h	l/h	l/h
1	1000	**0.4**	**2000**	34.0	> 34	38.07	> 125	165
2	3375	**1.20**	**500**	48.0	5	48.40	> 50	155
3	3375	**0.4**	**500**	113.0	7	99.12	> 30	127
4	200	**0.4**	**200**	8.7	1	8.50	> 100	175

TEST 3

Work Order #	7348	**Test Bench**	**CA4000**	42,352mi	
Name	[redacted]	**Date**	7/28/2008		
Part Number	0445010613	**MFD/SN**	071130/0634 2		

Testing point	Pump speed	Current	Rail pressure	Expected Fuel delivery	Delivery Tolerance	Measured Fuel delivery	Expected Lubrf. Q	Lubrf. Q.
No.	rpm	mA	bar	l/h	l/h	l/h	l/h	l/h
1	1000	**0.4**	**2000**	34.0	> 34	38.01	> 125	148
2	3375	**1.20**	**500**	48.0	5	47.04	> 50	138
3	3375	**0.4**	**500**	113.0	7	116.34	> 30	99.4
4	200	**0.4**	**200**	8.7	1	8.27	> 100	161

Pump was tested twice in vehicle on 7/35/08. Both times not OK. (Delivery rate at 3,375rpm, 500bar too low).
Subsequent measurement on 07/28/2008 in vehicle, result OK.

Destiny of the parts:

Pump was sent to Fe for further testing. Was replaced on vehicle
with pump with MFD 080717, s/n 0595.

Provisional report **"CP4 pump test campaign - USA"**

Date: 7/25/2008

Non-responsive content re moved

Customer: AUDI

Veh. AU71698026 **Mileage:** 45,475 miles = 68,058 Km

CP4.2 **MFD:** 07 11 30 **s/n:** 0625

Test process:

1. Visual findings
2. Function check on test bench

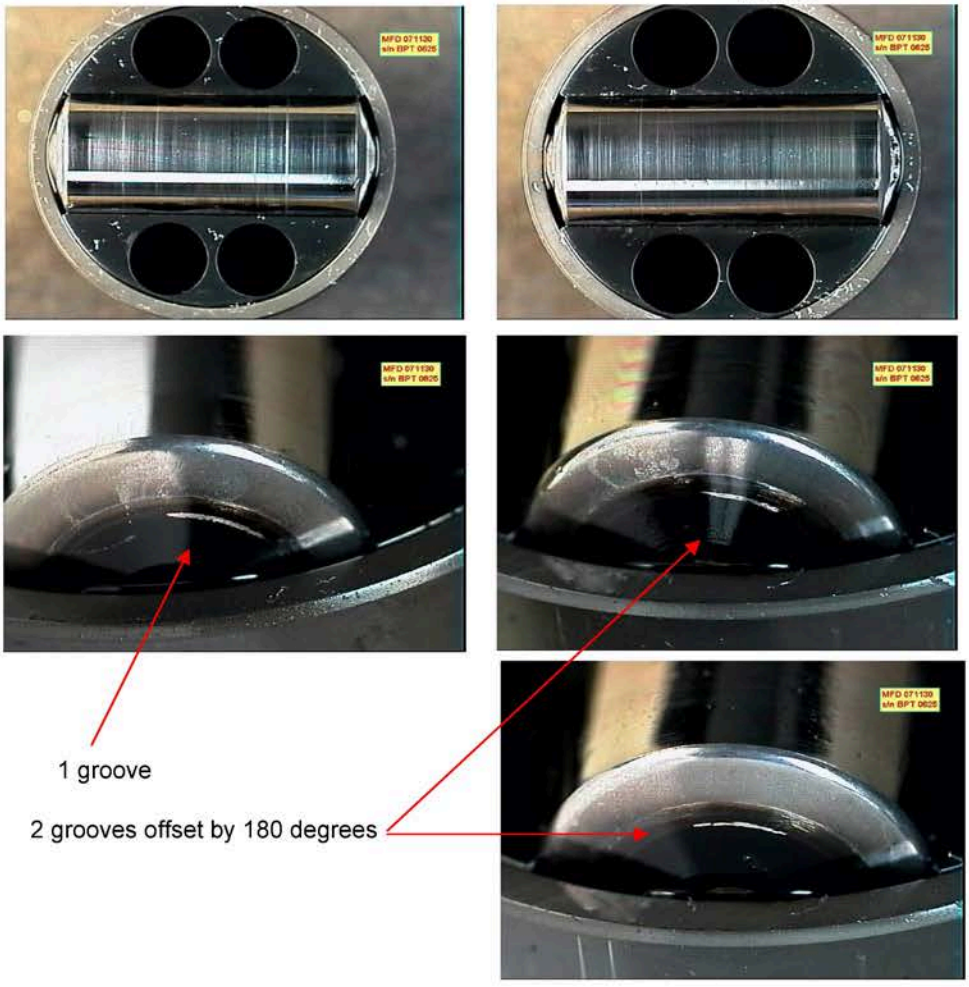
1. Result of visual findings:

Roller r&ollers have negligible run marks on the track
Roller has 2 small grooves on the front surfacee, however not across the entire circumference on the C coating
It is not a running fault as it runs to the outside diameter from the center, roller is Noguchi
Camshaft shows same running pattern on the camshaft track as the roller
MU has small, evident particles in the strainer.

Pictures:

LEFT

RIGHT



Camshaft

MU

2. Results of test bench

OK, test points within tolerances.

(Measurement data not available, probably overwritten by mistake)

Destiny of the parts:

Pump was put back in vehicle.

Provisional report **"CP4 pump test campaign - USA"**

Date: 7/25/2008

Non-responsive content re moved

Customer: AUDI

Veh. AU71698020 **Mileage:** 45,475 miles = 65,015 Km

CP4.2 **MFD:** 07 11 30 **s/n:** 0634

Test process:

1. Visual findings
2. Function check on test bench

1. Result of visual findings:

Roller R&ollers have negligible run marks on the track
Roller has 2 small grooves on the front surface, however not across the entire circumference on the C coating
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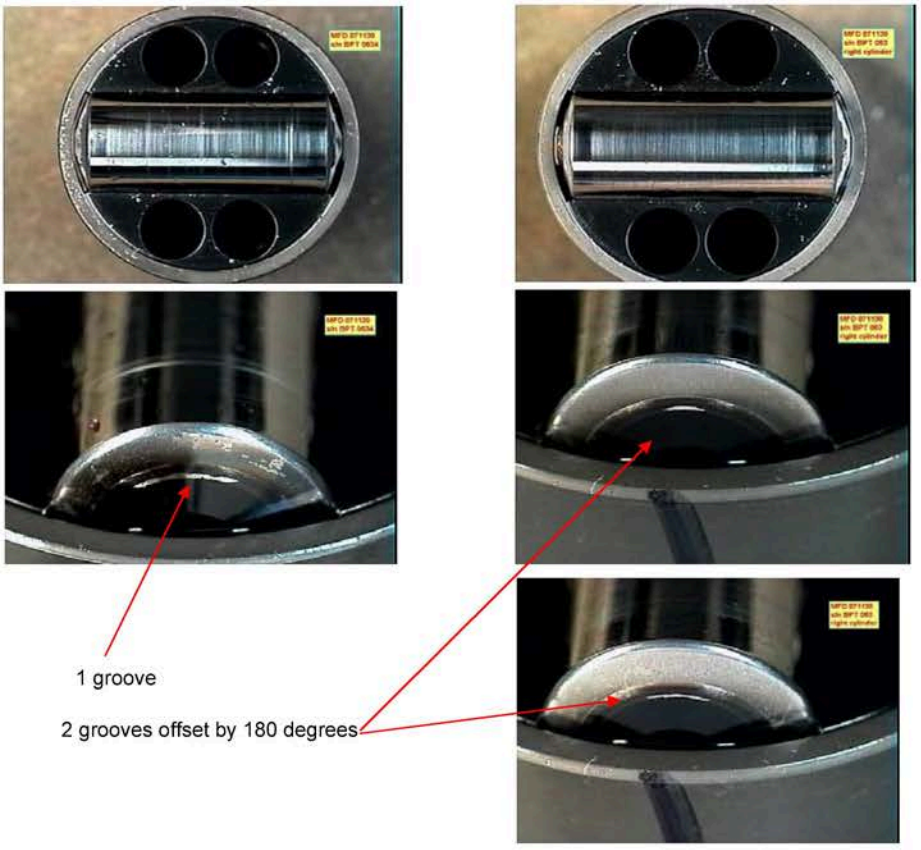
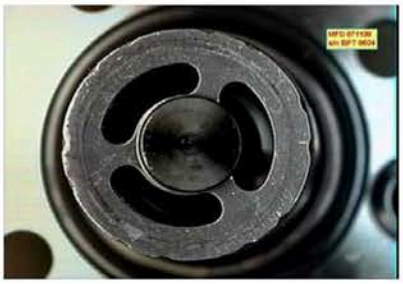
Pictures:

LEFT

RIGHT





Camshaft

MU

2. Results of test bench

TEST 1

Work Order #	7348	**Test Bench**	**CA4000**	42,352mi	
Name	[redacted]	**Date**	7/25/2008		
Part Number	0445010613	**MFD/SN**	071130/0634		

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4	200	**0.4**	**200**	8.7	1	8.38	> 100	195

TEST 2

Work Order #	7348	**Test Bench**	**CA4000**	42,352mi	
Name	[redacted]	**Date**	7/25/2008		
Part Number	0445010613	**MFD/SN**	071130/0634 1		

Testing point	Pump speed	Current	Rail pressure	Expected Fuel delivery	Delivery Tolerance	Measured Fuel delivery	Expected Lubrf. Q	Lubrf. Q.
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1	1000	**0.4**	**2000**	34.0	> 34	38.07	> 125	165
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4	200	**0.4**	**200**	8.7	1	8.50	> 100	175

TEST 3

Work Order #	7348	**Test Bench**	**CA4000**	42,352mi	
Name	[redacted]	**Date**	7/28/2008		
Part Number	0445010613	**MFD/SN**	071130/0634 2		

Testing point	Pump speed	Current	Rail pressure	Expected Fuel delivery	Delivery Tolerance	Measured Fuel delivery	Expected Lubrf. Q	Lubrf. Q.
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1	1000	**0.4**	**2000**	34.0	> 34	38.01	> 125	148
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Pump was tested twice in vehicle on 7/35/08. Both times not OK. (Delivery rate at 3,375rpm, 500bar too low).
Subsequent measurement on 07/28/2008 in vehicle, result OK.

Destiny of the parts:

Pump was sent to Fe for further testing. Was replaced on vehicle
with pump with MFD 080717, s/n 0595.

EA11003EN-01037[0]

ENTIRE PAGE CONFIDENTIAL

From: Non-responsive content removed
To:
CC:

Date: 10/13/2008, 12:34:00 PM
Subject: RE: Serious problem with vehicle 7L69D024 (3.0l 165kW/AL750-6A), failure on high-pressure fuel pump

Yes, it is typical drivetrain damage.
I have not sent you the file because the damage report included the entire history of the vehicle; and there is a lot of information there that is not intended for Bosch.
I will send you a few PDF excerpts:

7L69D024, 24.853 km, 10.10.2008

With best regards

Non-responsive content removed

From: Non-responsive content removed
Sent: Monday, October 13, 2008, 12:33 PM
Non-responsive content removed
Subject: ANS: Serious problem with vehicle 7L69D024 (3.0l 165kW/AL750-6A), failure of high-pressure fuel pump

Hello [redacted]

Do you have pictures of the MU?
In the last repeat case (Q7) the filter was blocked & but the pump was OK.

Mit freundlichen Grüßen / Best regards

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Robert Bosch GmbH
Non-responsive content removed

EA11003EN 01037[1]

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From Non-responsive content removed
Sent: Monday, October 13, 2008, 12:29 PM
Non-responsive content removed

Subject: ANS: Serious problem with vehicle 7L69D024 (3.0l 165kW/AL750-6A), failure of high-pressure fuel pump
Importance: High

Hello Non-responsive content removed

I'm afraid we have another failure with a Q verification vehicle from VW in the U.S.
It is a repeat case involving the same Touareg that already failed once at 2,700 km.
Whether this involves subsequent damage as a result of the 1st case or whether this is a new defect, unfortunately, cannot be determined.
I have already entered the case in the latest failure list (date: today).
With a pump date of manufacture of January 22, 2008, it is hardly the newest, without the measures from WK19/08.
The error memory printout is attached.
Can you please send [redacted] 1 unit of the twin pistons BIN5 pump with the new shaft position (059 130 755 AL) at your convenience?
Hello [redacted],
Please send me the failed pump SAP!
Please address it to me, or better/faster directly to Non-responsive content removed in Non-responsive content removed (see address below).
Please call me when you have received the replacement pump for installation in the U.S.

Hello [redacted]
Is it correct that this engine/vehicle already contains the new W24 tension pulley (that's what it says in my list)?

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- ---

With best regards

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ENTIRE PAGE CONFIDENTIAL

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From: Non-responsive content removed
Sent: Monday, October 13, 2008, 11:25 AM
Non-responsive content removed
Subject: Re: Serious problem with vehicle 7L69D024 (3.0l 165kW/AL750-6A), failure of high-pressure fuel pump

Hi all,

For information

With best regards

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From: Non-responsive content remove d
Sent: Monday, October 13, 2008, 11:18 AM
Non-responsive content removed
Subject: Serious problem with vehicle 7L69D024 (3.0l 165kW/AL750-6A), failure of high-pressure fuel pump

Hello,

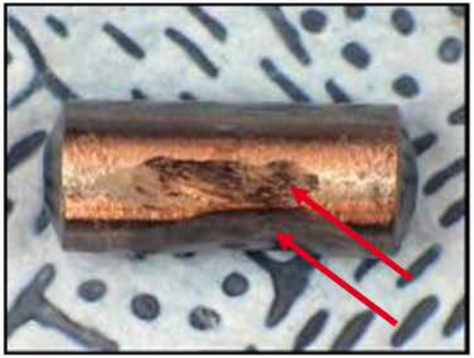
Attached please find a serious complaint from the verification run at [redacted] with a request for opinion!

Regards,
Non-responsive content rem oved

Volkswagen AG
Non-responsive content removed
VOLKSWAGEN AG

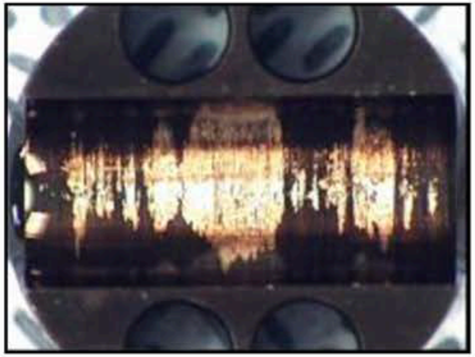
CP4 – diagnosis: VW R4 2.0l EU5 – first findings

- **Pump**: Series, CP4.1S-348-2x5,25-REC, 0 445 010 507, #190508-0741
- **Operating conditions:** Vehicle ER (3VWC781K39M[redacted]), summer drive - [redacted]
  Mileage 13,539 km, failure
- **Test:** Drivetrain damage - category 1, turned tappets as a result
- **Further work:** Due to damage, no longer possible to refer to the task force drivetrain

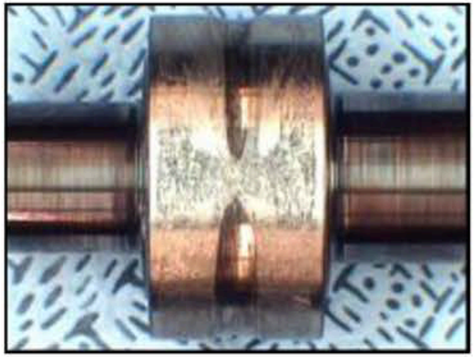


Roller with two pronounced 90° run marks on a completely abrasive worn surface

Camshaft with a completely abrasive, worn surface and a pronounced 90° wear zone



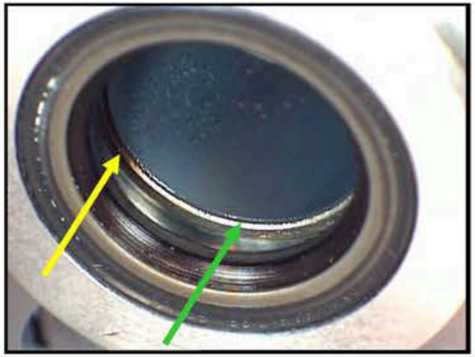
C coating wear similar to pressure profile

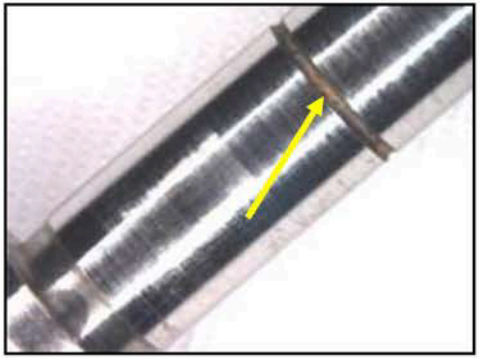


CP4 – diagnosis: VW R4 2.0l EU5 – first findings

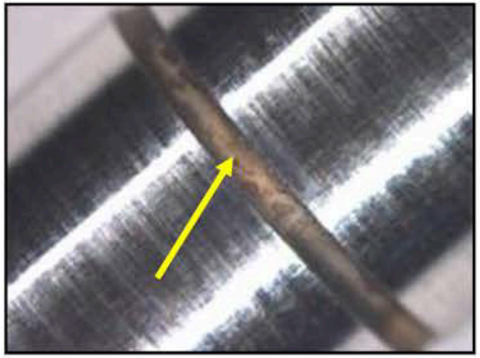
- **Pump**: Series, CP4.1S-348-2x5,25-REC, 0 445 010 507, #190508-0741
- **Operating conditions:** Vehicle ER (3VWC781K39M[redacted], summer drive - [redacted], Mileage 13,539 km, failure
- **Test:** Fuel deposits on the flange bearing and on the high-pressure pistons
- **Further work:** Coating analysis of the deposits on the flange bearing | WK 49/08

Local, brown deposits in the area between the flange bearing bushing (front surface) and shaft seal





Local, brown deposits in both low-pressure lubrication grooves (not in the two high-pressure lubrication grooves)



EA11003EN-01050[0]

ENTIRE PAGE CONFIDENTIAL

From: Non-responsive content removed
To:
CC:

Date: 12/17/2008, 10:21:58 AM
Subject: RE: complained about Audi returns

Hello Non-responsive content removed

As discussed in our phone call yesterday, here is some preliminary information from our inspection:

Result of the first findings of the two complained about Audi W19 BIN5 returns:

1) Pump "45,700mls GQ VW HPP failure"; Complaint: HPP failure
0445 010 613 080122-0898 (process 2008-CP4_0906) DNA no. 2825
- Drivetrain damage confirmed
- Adhesive wear across the entire cam track
- One RS had only medium C coating damage, tappets were finally turned by 90° (primary damage)
- Second RS completely worn, roller worn across entire circumference

Pictures: < \\bosch.com\dfsrb\dfsde\div\ds\ne5\ehp\Messdaten\Ablage1\A_Messdaten\CP4\CP4 Dauerlauf \Befundung and Analyse\06_Befundungsergebnisse\2008\2800-2849\2825-08122-0898 >

2) Pump "162,000 km US ER veh. V6TDI (W19); veh. AU716E218"; Complaint: Shavings/breakdown
0445B20169_07 782-4254 (process 2008-CP4_0897)
DNA no. 2826
- Drivetrain damage confirmed
- Strong breakouts on cam track
- Both RS with middle C layer damage and 90° turners
- Deposits (suspected corrosion) on cam track (also non-worn areas) and in IV bores / on IV
---> Assumption: failed due to water in the fuel; must be further investigated

Pictures: < \\bosch.com\dfsrb\dfsde\div\ds\ne5\ehp\Messdaten\Ablage1\A_Messdaten\CP4\CP4 Dauerlauf \Befundung and Analyse\06_Befundungsergebnisse\2008\2800-2849\2826-782-4254 >

-> I will show the pictures at the next technical meeting.

Happy holidays,

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

EA11003EN 01050[1]

Non-responsive content removed

From: Non-responsive content removed
Sent: Monday, December 08, 2008, 10:29 AM

Non-responsive content removed

Subject: complained about Audi returns

Hello [redacted]

Result of the first findings of the two complained about Audi W19 BIN5 returns:

1) Pump "45,700mls GQ VW HPP failure"; Complaint: HPP failure 0445 010 613 080122-0898 (process 2008-CP4_0906) DNA no. 2825
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Pictures: < \\bosch.com\dfsrb\dfsde\div\ds\ne5\ehp\Messdaten\Ablage1\A_Messdaten\CP4\CP4 Dauerlauf \Befundung and Analyse\06_Befundungsergebnisse\2008\2800-2849\2825-08122-0898 >

2) Pump "162,000 km US ER veh. V6TDI (W19); veh. AU716E218"; Complaint: Shavings/breakdown 0445B20169_07 782-4254 (process 2008-CP4_0897)
DNA no. 2826
- Drivetrain damage confirmed
- Strong breakouts on cam track
- Both RS with middle C layer damage and 90° turners
- Deposits (suspected corrosion) on cam track (also non-worn areas) and in IV bores / on IV ---> Assumption: failed due to water in the fuel; must be further investigated

Pictures: < \\bosch.com\dfsrb\dfsde\div\ds\ne5\ehp\Messdaten\Ablage1\A_Messdaten\CP4\CP4 Dauerlauf \Befundung and Analyse\06_Befundungsergebnisse\2008\2800-2849\2826-782-4254 >

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

ENTIRE PAGE CONFIDENTIAL

Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

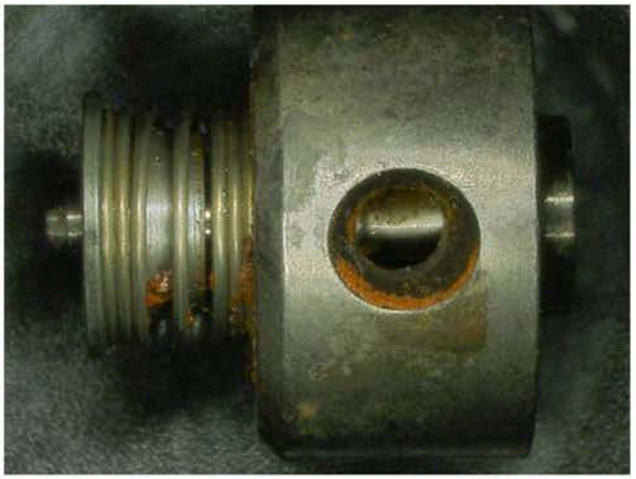

Fig. 1

CR_ARA_M_09_0001

CP4.2 HS DNA2826 left intake valve - overview 1

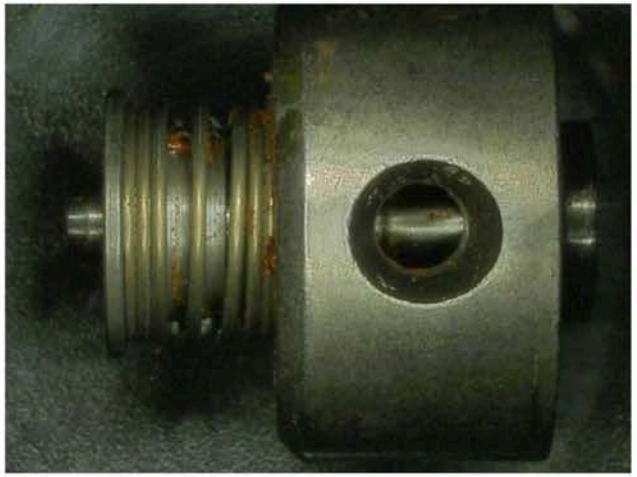

Fig. 2

CR_ARA_M_09_0002

CP4.2 HS DNA2826 left intake valve - overview 2

BOSCH CR/ARA

Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

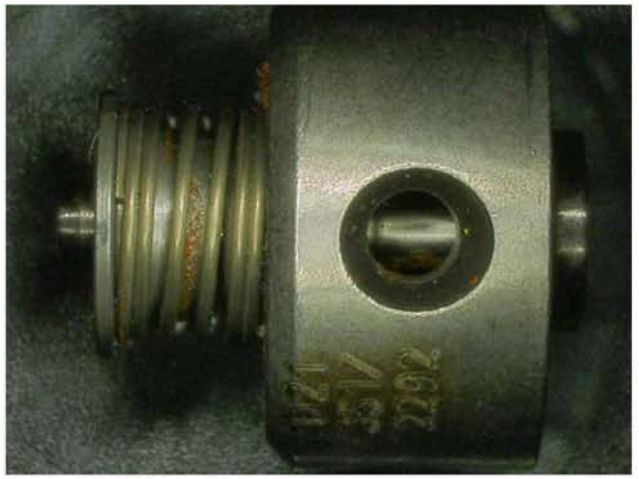

Fig. 3

CR_ARA_M_09_0003

CP4.2 HS DNA2826 left intake valve - overview 3

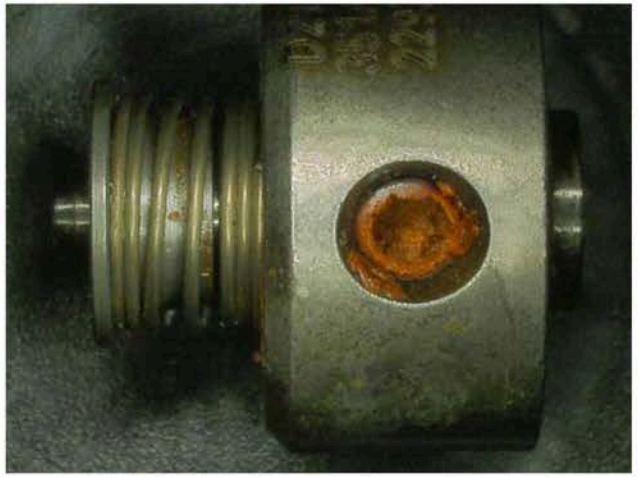

Fig. 4

CR_ARA_M_09_0004

CP4.2 HS DNA2826 left intake valve - overview 4

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Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

Fig. 5

CR_ARA_M_09_0005

CP4.2 HS DNA2826 left intake valve - detail from overview 4

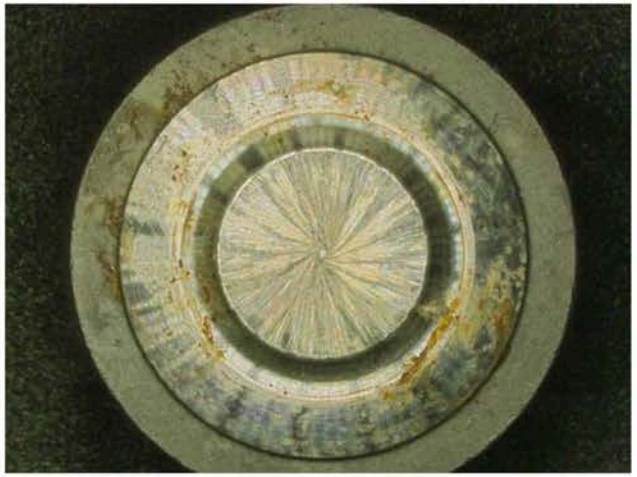

Fig. 6

CR_ARA_M_09_0006

CP4.2 HS DNA2826 left intake valve - overview 5

BOSCH CR/ARA

Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

Fig. 7

CR_ARA_M_09_0007

CP4.2 HS DNA2826 left intake valve - overview 6

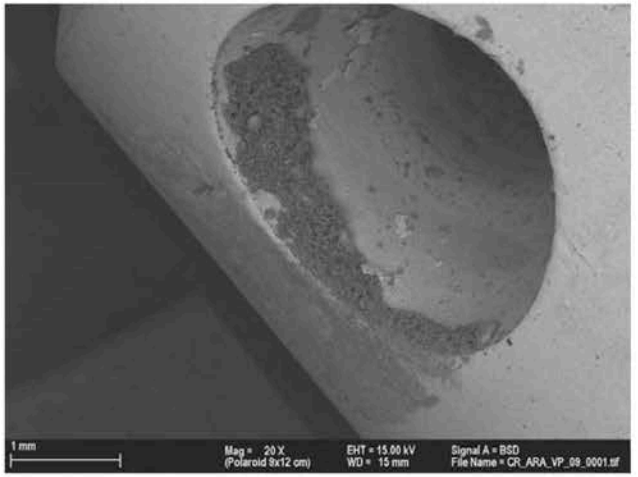

Fig. 8

CR_ARA_VP_09_0001

CP4.2 HS DNA2826 left intake valve - overview 1

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Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

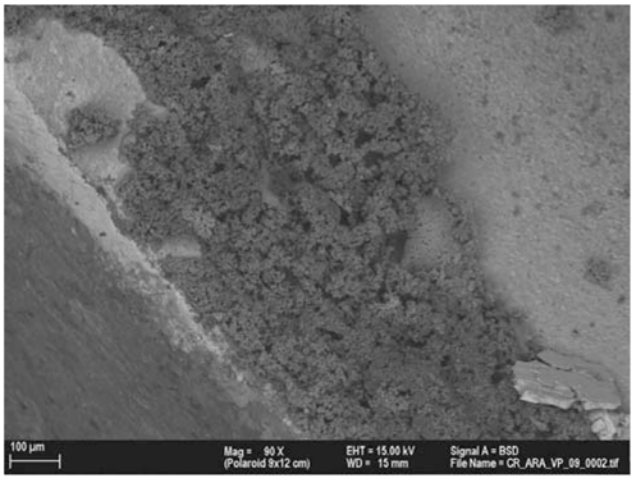

Fig. 9

CR_ARA_VP_09_0002

CP4.2 HS DNA2826 left intake valve - overview 1 detail

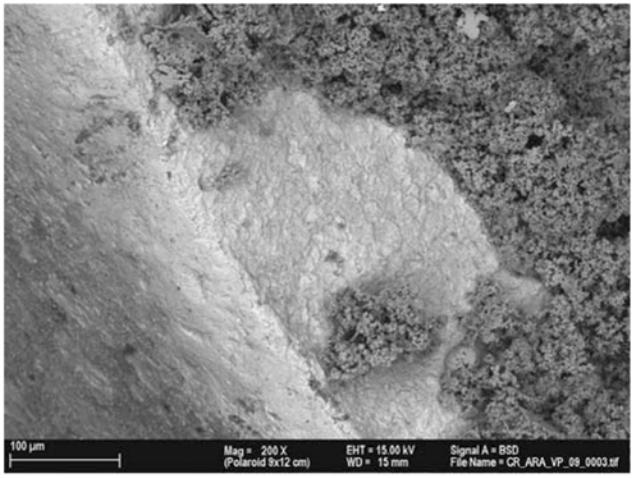

Fig. 10

CR_ARA_VP_09_0003

CP4.2 HS DNA2826 left intake valve - overview 1 detail

BOSCH CR/ARA

Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

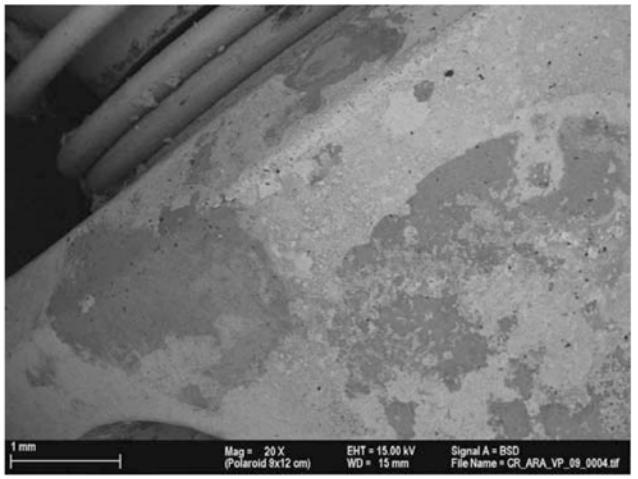

Fig. 11

CR_ARA_VP_09_0004

CP4.2 HS DNA2826 left intake valve - overview bore 1

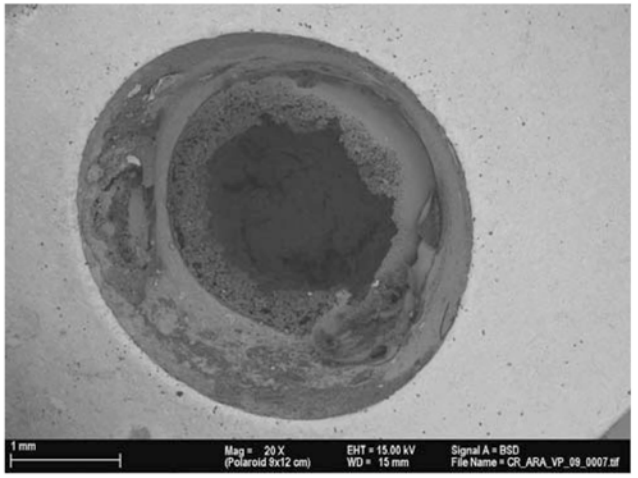

Fig. 12

CR_ARA_VP_09_0007

CP4.2 HS DNA2826 left intake valve - overview 4

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Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

Fig. 13

CR_ARA_VP_09_0008

CP4.2 HS DNA2826 left intake valve - overview 4

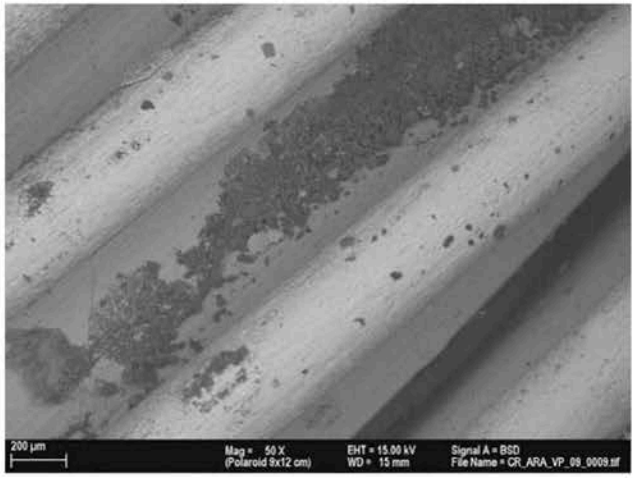

Fig. 14

CR_ARA_VP_09_0009

CP4.2 HS DNA2826 left intake valve - residue between spring coil

BOSCH CR/ARA

Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

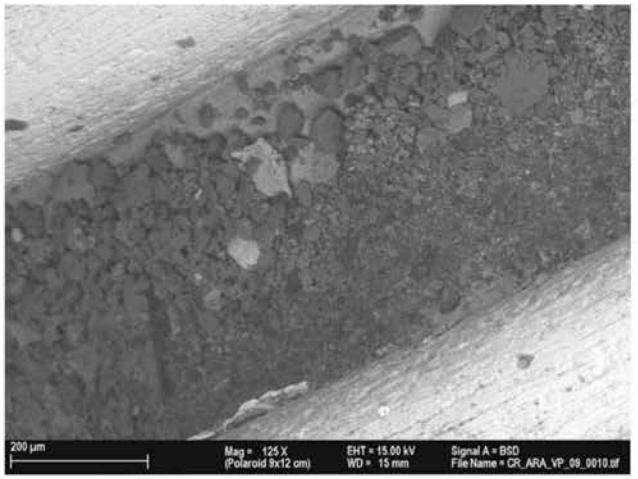

Fig. 15

CR_ARA_VP_09_0010

CP4.2 HS DNA2826 left intake valve - residue between spring coil

Fig. 16

CR_ARA_M_09_0008

CP4.2 HS DNA2826 left intake valve - overview 1 after Technovit imprint!!

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Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

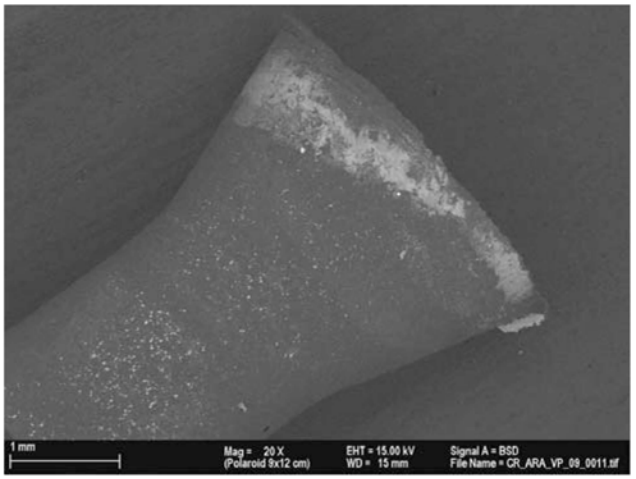

Fig. 17

CR_ARA_VP_09_0011

CP4.2 HS DNA2826 left intake valve - overview Technovit imprint bore 1!!

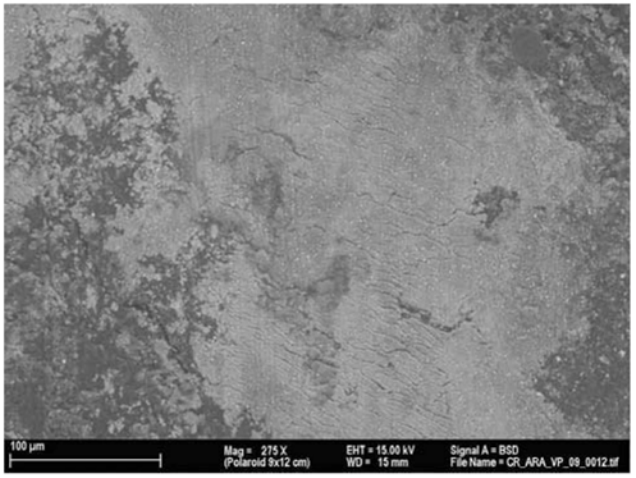

Fig. 18

CR_ARA_VP_09_0012

CP4.2 HS DNA2826 left intake valve - overview Technovit imprint bore 1!!

BOSCH CR/ARA

Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

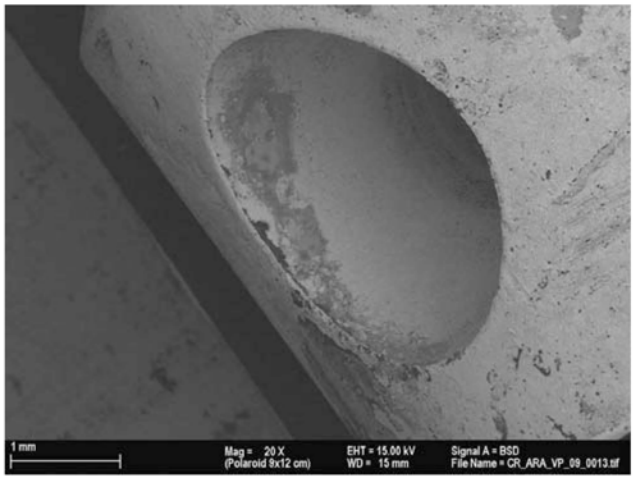

Fig. 19

CR_ARA_VP_09_0013

CP4.2 HS DNA2826 left intake valve - overview 1 after Technovit imprint!!

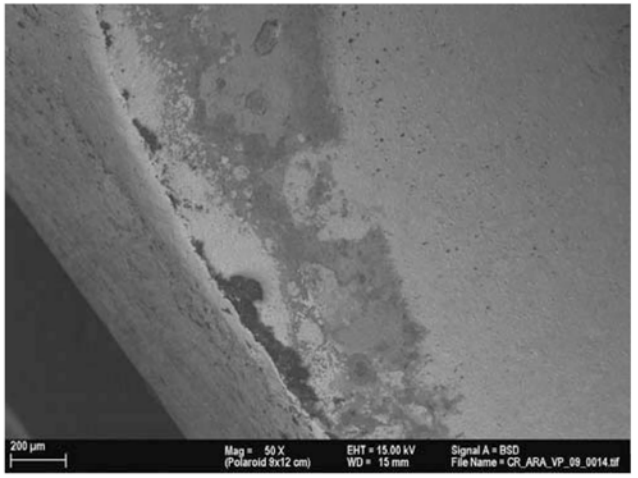

Fig. 20

CR_ARA_VP_09_0014

CP4.2 HS DNA2826 left intake valve - overview 1 after Technovit imprint!!

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Order:

CP4.2HS customer returns from Audi with unusual deposit on intake valve

Person responsible: [redacted]

Analysis no.: 2009-0018

Date of printing: 1/14/2009

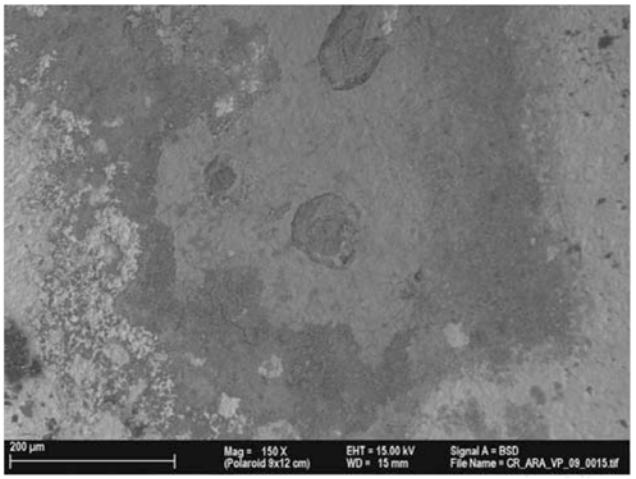

Fig. 21

CR_ARA_VP_09_0015

CP4.2 HS DNA2826 left intake valve - overview 1 after Technovit imprint!!

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CP4 drivetrain damage

2 x CP4.2 drivetrain damage cases in US vehicle endurance runs

1 x 45,700 mls in [redacted] VW endurance run (7L69D025)
Pump data: Series pump 0445 010 613; DM 22/01/2008; copy number 898
Analysis result: Drivetrain damage (cat. 2)

1 x 162,000 km in Audi endurance run (AU716E218)
Data: Sample pump 0445B20169_07, DM 782 (= February 2007); copy no. 4254
Analysis result: Drivetrain damage (category 2) with red deposits (corrosion?)

Notes:
Pumps corresponds to **old** production status -> particularly without straightedge testing

Pumps have a roller with supplier 1 -> since WK 20 2008, only supplier 2

Overview of all implemented / planned production measures on page 7/8

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CP4 drivetrain damage

1) Damage hypothesis for VW [redacted] failure (7L69D025, 45,700 mls)

Stiff right roller due to manufacturing abnormalities in combination fuel with low viscosity (lubricant film thickness is not sufficient).
Stiffness of the right roller leads to slip between rollers and cams (braking flats) and overload of C coating (main loading zone) with final turned tappet.
The right tappet damages the camshaft bearing surface and thus, the left tappet assembly.

Further analysis steps @ R.B.

Measurement of undamaged areas (right roller support, roller)	01.20.2009
Detailed microscopic analysis (adhesion of coating on right roller support)	01.23.2009

Inquiries @ Audi

Data on fuel quality (HFRR, kinematic viscosity, water) available?
Refueling data of the last locations known?
Was water found in the water separator?

ENTIRE PAGE CONFIDENTIAL

CP4 drivetrain damage

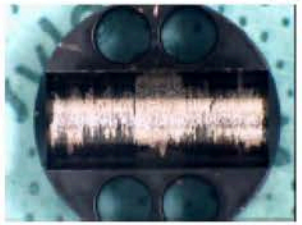
Pictures of VW GQ failure (7L69D025, 45,700 mls)

Left roller

Right roller

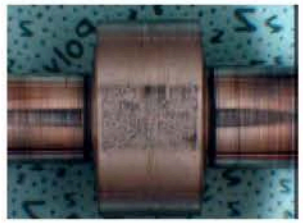
Type plate

Left roller support



Right roller support

Camshaft



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CP4 drivetrain damage

2) Damage hypothesis for Audi failure (AU716E218, 162,000 km)

Stiff rollers due to fuel with low kinematic viscosity (lubricant film thickness is not sufficient).
Stiffness of the rollers leads to slip between the rollers and cams (braking flats) and overload of C coating (main loading zone) with final turned tappets.

Further analysis steps

Analysis of the brownish deposits (corrosion?)	01.15.2009
Measurement of undamaged areas (roller support, roller)	01.20.2009
Detailed microscopic analysis (adhesion of coating on roller support)	01.23.2009

Inquiries @ Audi

Data on fuel quality (HFRR, kinematic viscosity, water) available?
Refueling data of the last locations known?
Was water found in the water separator?

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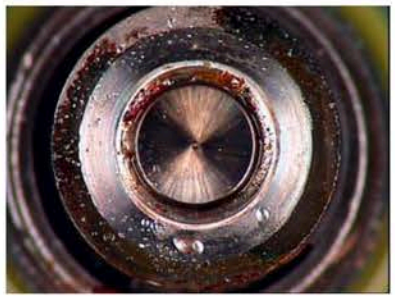
CP4 drivetrain damage

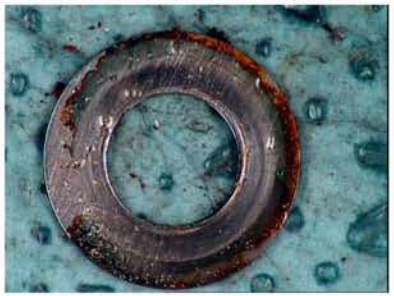
Pictures of Audi failure (AU716E218, 162,000 km, DM: February 2007)

Brownish deposits (corrosion?)

Intake valve

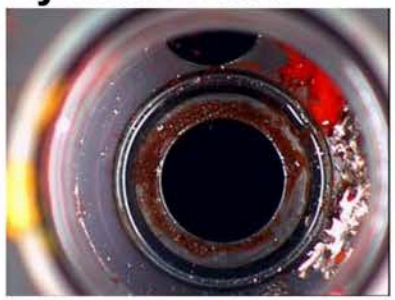


Intake valve disk



MU

Cylinder head



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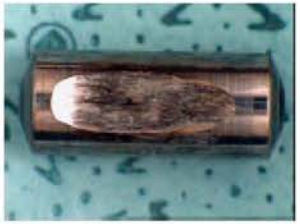
CP4 drivetrain damage

Pictures of Audi failure (AU716E218, 162,000 km, DM: February 2007)

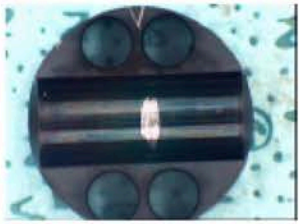
Left roller

Right roller

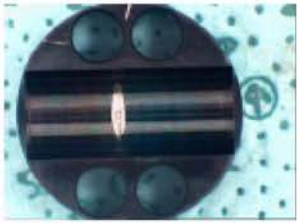


Type plate

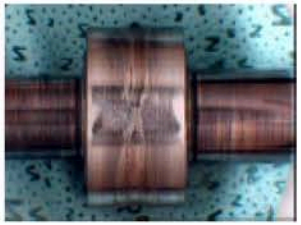
Left roller support



Right roller support



Camshaft



CP4 drivetrain damage

Implemented production measures

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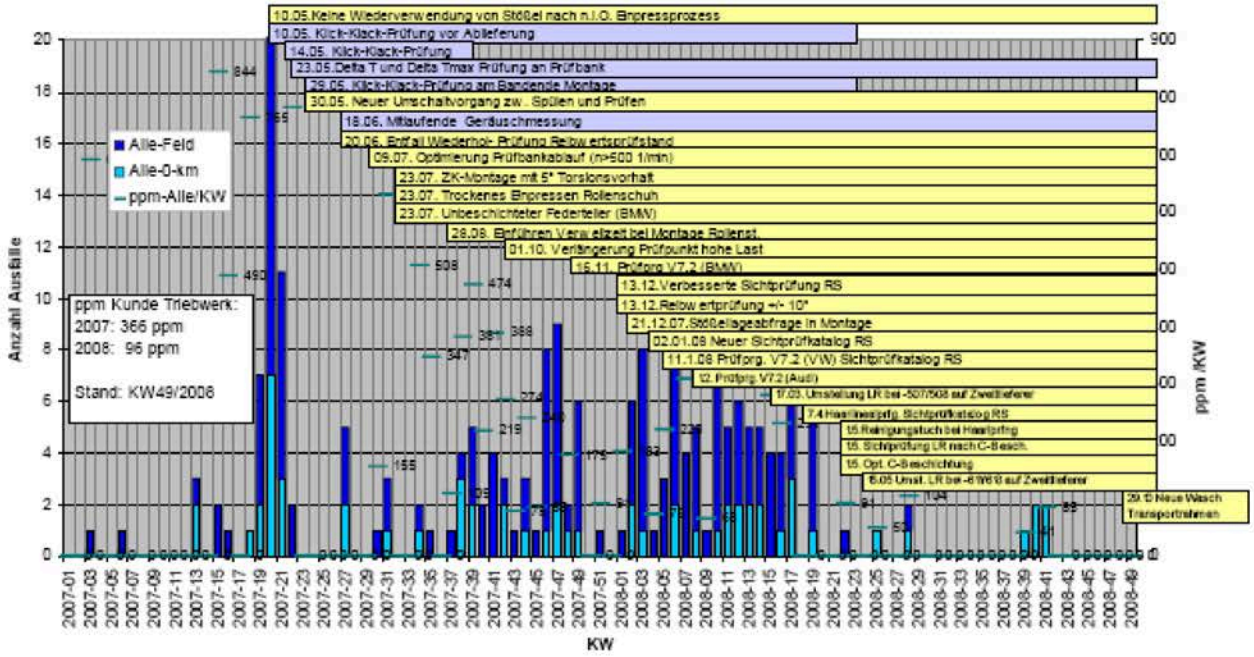

ppm customer drivetrain:
Number of failures
Status:

05.10. No reuse of tappet after not OK press-in process
10.05. Click-clack test prior to delivery
14.05. Click-clack test
05.23. Delta T and Delta Tmax test on test bench
29.05. Click-clack test at the end of assembly line
30.05. New switching step between flushing and testing
18.06. Simultaneous noise measurement
20.06. Repeat test on friction coefficient test bench dropped
09.07. Optimization of test bench sequence (n > 500 rpm)
23.07. Cylinder head assembly with 5° torsion allowance
23.07. Dry pressing in of roller support
23.07. Uncoated spring plate (BMW)
28.08. Introduction of dwell time during assembly of roller tappet.
01.10. Extension of high-load testing point
16.11. Test program V7.2 (BMW)
12.13. Friction coefficient test + / - 10°
12.13. Improved visual inspection RS
12.21.07. Tappet position query during assembly
01.02.08 New visual inspection catalog RS
11.1.08 Test program V7.2 (VW) visual inspection catalog of RS
1.2. Test program V7.2 (Audi)
17.03. Switching of roller at -507 / 508 to second source supplier
1.5. Cleaning cloth for straightedge testing
1.5. Visual inspection of roller after C coating.
1.5. Optimized C coating
05.15. Switching of roller at -611 / 613 to second source supplier
10.29 New washing transport frame
All on-field
All 0km
ppm all / WK

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CP4 drivetrain damage

Planned production measures

A) Avoidance of C coating entrainment (pressing in of roller support)

- Crash trials with roller tappets contaminated with C coating particles — D. 09.01

B) Large-scale functional testing with increased load (high rail pressure, low engine speed to increase "detection" in coordination with Audi — Target 09.01

D) Detection of metal chips with objective system — D. 09.04

C) Process to avoid fusing on the roller

New substrate holder for roller; trials have started, **long-term measure**

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EA11003EN-01055[0]

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From: Non-responsive content removed
To:
CC:

Date: 1/15/2009, 1:43:40 PM
Subject: RE: complained about Audi returns
Attachments: Kraftstoffanalyse [redacted]08 - 84.483,1-6.pdf

Hello Non-responsive content removed

First of all, the overview concerning the E218:

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58 tkm NK6 ER
The attached fuel analyses are located 32 tkm from here (water: 30 - 40 mg/kg)
8 tkm crossing
65 tkm up until HPP failure, fuel analyses being procured

On account of the HPP failure related valve timing adjustment, the engine was so damaged that the ER had to be ended.
Engine was analyzed in [redacted]. Still waiting on the analysis of the fuel filter / content

Fuel analysis attached:
1.) ultralow <15 S, [redacted], AK 5.05.08
2.) ultralow <15 S, Non-responsive content removed date?
3.) ultralow <15 S, [redacted] 06.05.08
4.) max. 500 ppm S, [redacted] 09.05.05
5.) max. 500 ppm S, [redacted] 25.04.08
6.) max. 500 ppm S, Non-responsive content removed 22.04.08

Comments:
- **The cetane numbers**
  are still to come
- **Striking features**
  less density,
  fewer total aromatic compounds,
  flash point is obviously low,
  low-boiling solvents present (there is higher-boiling gasoline in the DF),

With best regards

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AUDI AG
Non-responsive content removed

Sitz/Domicile: Ingolstadt
Registergericht/Court of Registry: Local District Court Ingolstadt
HRB Nr./Commercial Register No.: 1

EA11003EN-01055[1] **ENTIRE PAGE CONFIDENTIAL**

From: Non-responsive content removed
Sent: Thursday, January 15, 2009, 12:10 PM
Non-responsive content removed
Subject: RE: complained about Audi returns

Hello Non-responsive content removed

Thank you.

Do you know when you´ll have the fuel analyses?

I can imagine that there is more condensation in the tank & fuel system in [redacted]

Your opinion?

Mit freundlichen Grü??en / Best regards

Non-responsive content removed

Robert Bosch GmbH
Non-responsive content removed

From: Non-responsive content removed
Sent: Thursday, January 15, 2009, 9:31 AM
Non-responsive content removed
Subject: RE: complained about Audi returns

Hello Non-responsive content removed

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The fuel filter and contents will be analyzed.

Vehicle E218 is already in [redacted]
Vehicle D025 will be supplied by [redacted]

There is no “tank map” for this.
Vehicle E218 (second vehicle) was last moved in Non-responsive content removed

With best regards

Non-responsive content remove d

AUDI AG

Non-responsive conte nt removed

From: Non-responsive content removed
Sent: Wednesday, January 14, 2009, 5:20 PM
To: Non-responsive content removed
Subject: RE: complained about Audi returns

Hello Non-responsive content rem oved

Was the fuel / fuel filter analyzed in the failed USA vehicles **(7L69D025; AU716E218)?**

Was any water found in the water separator?
Was the water separator checked when maintaining the vehicles (especially the AU716E218)?

Were the vehicles filled up at different gas stations (particularly the last 10,000 km)?
Was a tank map drawn up - at least partially for the last 10 fillings?

Background:
The second pump (162,000 km) was corroded which would indicate free water.

<<Bilder_2009-0018.pdf>> <<CR_ARA_2009-0018_Deckblatt.pdf>>

Thank you.

Mit freundlichen Grüßen / Best regards

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EA11003EN-01055[3]

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Robert Bosch GmbH

EA11003EN-01057[0]

ENTIRE PAGE CONFIDENTIAL

From: Non-responsive content removed
To:
CC:
Date: 1/22/2009, 1:54:00 PM
Subject: ANS: USA failures (second batch USA
Attachments: EHC_0458_V2_ Audi, CP4, Sondermaßnahmen USA Serienanlauf,24-10-2008.ppt

Dear Non-responsive content removed

I just want to be sure for the 613 pump USA that there are **no "elevations" on the roller or the roller support**and that C2.1 coated rollers will be fitted (if Bosch is sure that that will help us and won´t just lower costs).
i.e.:

100% special test on the roller support (similar to straightedge test and visual)
100% special test on the roller after the friction coefficient check (visual)
Ensure C2.1 coating on roller
Audi is aiming to full fuel with "the best possible German"fuel (introduction in the field)

I will check out the logistics situation as soon as possible.

With best regards
Non-responsive content remov ed

From: Non-responsive content removed
Sent: Thursday, January 22, 2009, 1:07 PM
Non-responsive content removed
Subject: ANS: USA failures (second batch USA

Hello

We had proposed for the batch the measures listed in the slide -> however a much reduced quantity of 150 pumps in the first batch vs > 1000 pumps in the second batch)

But:
-> The roller support with an opt. coating system has since been released& and therefore in series production.
-> We have Güntert rollers with C2.1 in series production (& fitted to first batch still via change order / special approval.

We will discuss / propose / authorize the testing point on Monday - if you / Audi require this - however first **"only"** for 611 pump & only for the February (~10,000 units). Then we will assess to see how practical this is.

In any case, the additional point will cost us 25 s timing -> if the test point becomes long-term, we will have to compensate
for this -> i.e. omit other test points (starting point, ...).
(I must initiate a special approval process for the additional test point)

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Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Robert Bosch GmbH

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From: Non-responsive content removed
Sent: Thursday, January 22, 2009, 12:18 PM
To: Non-responsive content removed
Subject: ANS: USA failures (second batch USA

Hello Non-responsive content removed

What would you consider to be special measures?
Try just to act as if there was no deadline.

With best regards

Non-responsive content removed

From: Non-responsive content removed
Sent: Thursday, January 22, 2009, 12:10 PM
Non-responsive content removed
Subject: ANS: USA failures (second batch USA

Hello Non-responsive content removed

Thank you.

We also consider the filter to be surprisingly clean.

Comment regarding USA batch:

No special measures were built into the first batch.
If the engines were already fitted in WK 6 & and pumps would have to be available, we would not use any special measures in the second batch (especially for > 1,000 pumps)

-> i.e. the second batch is analog to the first one!

Mit freundlichen Grüßen / Best regards

EA11003EN-01057[2]

ENTIRE PAGE CONFIDENTIAL

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Robert Bosch GmbH

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Domicile: Stuttgart, Court of Registry: Local District Court Stuttgart, Commercial Register No. 14000;
Chairman of the Supervisory Board: Hermann Scholl; Management Franz Fehrenbach, Siegfried Dais;
Bernd Bohr, Rudolf Colm, Volkmar Denner, Gerhard Kümmel, Wolfgang Malchow, Peter Marks,
Peter Tyroller; Uwe Raschke

From: Non-responsive content removed
Sent: Thursday, January 22, 2009, 11:14 AM
Non-responsive content removed
Subject: ANS: USA failures (second batch USA

Hello Non-responsive content remove d

Water separator:
There is a space beneath the paper filter insert in the filter housing in which water accumulates.
When replacing, the paper filter is dismantled and there remaining volume of fuel / (water) drained out, and then a new filter is inserted.

This system works
(See striking features due to frozen water during the winter testing the USA)
and is also in use in Europe.
Differences in the USA: Replacement interval is 30 tkm (in EU for EN590 60tkm)

In the E218, the filter had not been changed over 160 tkm before the HPP failed!
The filter and fuel are visually surprisingly clean!

Regarding the second batch:

Decision will be reached tomorrow:
A total of just under 1,000 Q7 + Touareg were built as of WK 06.
[redacted] is verifying the pumps.
We are assuming that the same measures were used as with the first batch.
Please provide information if there are any problems with this!

With best regards

Non-responsive content removed

EA11003EN-01057[3]

ENTIRE PAGE CONFIDENTIAL

Non-responsive content removed

From Non-responsive content removed
Sent: Wednesday, January 21, 2009, 1:08 PM
Non-responsive content removed
Subject: ANS: USA failures (second batch USA

Hello Non-responsive content removed

Thank you

So how does the water separator work?

Has water been found in this type of filter before or checked to see if the water is being separated?

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Robert Bosch GmbH
Non-responsive content removed

From: Non-responsive content removed
Sent: Wednesday, January 21, 2009, 12:17 PM
Non-responsive content removed

ENTIRE PAGE CONFIDENTIAL

Subject:ANS: USA failures (second batch USA

Hello [redacted]

We now have the fuel sample from the Q7 **E218**:

No striking features: Filter clean, fuel visually clean without water ... see attachment
We will send you a sample.

The Touareg is on its way to [redacted]

Regarding the fuel samples:
Further analysis has been requested including a sample for Bosch. Deadline still to be decided

With best regards

[redacted]

From [redacted]
Sent: Tuesday, January 20, 2009, 8:48 AM
[redacted]
Subject:USA failures (second batch USA

Hello [redacted]

When will we have the results for the viscosity of the Alaska fuel?
Were you already able to see if water was in the filters (water separator)?

[redacted] indicated yesterday that a second batch was set up for the USA.

How big is this second batch (units) & by when do you require the pumps to fit in the engines?

Background:
Assess to see if special measures are required for installation - which were intended for the first batch.

ENTIRE PAGE CONFIDENTIAL

Thank you.

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Robert Bosch GmbH

Non-responsive content removed

From: Non-responsive content removed
Sent: Thursday, January 15, 2009, 2:00 PM
Non-responsive content removed
Subject: ANS: Analysis report 2009-0018 CP4.2HS customer returns from Audi with unusual deposit on the intake valve

Hello Non-responsive content removed

Here is the complete set of slides.

<<EHC_0545_V2_[redacted], Audi, CP4 Triebwerkschaden, 15-01-2009.pdf>>

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Robert Bosch GmbH

Non-responsive content removed

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From: Non-responsive content removed
Sent: Thursday, January 15, 2009, 1:55 PM
Non-responsive content removed
Subject: ANS: Analysis report 2009-0018 CP4.2HS customer returns from Audi with unusual deposit on the intake valve

Hello Non-responsive content removed

Here is an update on the 2 x drivetrain damage.

< File: EHC_0545_V2_ Audi, CP4 Triebwerkschaden, 15-01-2009.pdf >>

To underpin the hypotheses, the analysis of the fuels as well as information as to whether any water was found in the filter (water separator) would be helpful.
I have asked Non-responsive content removed for this information.

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Robert Bosch GmbH
Non-responsive content removed

From: Non-responsive content removed
Sent: Wednesday, January 14, 2009, 5:24 PM
Non-responsive content removed
Subject: Re: Analysis report 2009-0018 CP4.2HS customer returns from Audi with unusual deposit on the intake valve
Importance: High

Hello Non-responsive content removed

Here is the current status slide concerning the two USA failures.

< File: EHC_0545_ Audi, CP4 Triebwerkschaden, 13-01-2009.pdf >>

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Robert Bosch GmbH
Non-responsive content removed

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Non-responsive content removed

From: Non-responsive content removed
Sent: Wednesday, January 14, 2009, 4:44 PM
Non-responsive content removed
Subject: Re: Analysis report 2009-0018 CP4.2HS customer returns from Audi with unusual deposit on the intake valve
Importance: High

Hello Non-responsive content removed

The red-colored coverings are actually corrosion!

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Robert Bosch GmbH
Non-responsive content removed

From: Non-responsive content removed
Sent: Wednesday, January 14, 2009, 4:30 PM
Non-responsive content removed
Subject: Analysis report 2009-0018 CP4.2HS customer returns from Audi with unusual deposit on the intake valve
Importance: High

Dear Non-responsive content removed

EA11003EN-01057[8]

ENTIRE PAGE CONFIDENTIAL

Here is the interim report concerning the analyses (SEM, EDS and FTIR).

< File: CR_ARA_2009-0018_1 Seite.pdf >>

< File: Bilder_2009-0018.pdf >>

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Audi CP4.2 start-up in the U.S.

Audi requests special measures for 150 0 445 010 613 pumps for the U.S. start-up

Special approval for 240 pumps

Measures

- RS from optimized C coating plant
- RS & roller cleaning with hydrocarbons
  -> Objective: avoid impact of washing residues on friction coefficient test
- Friction coefficient test for components with BDF650
  -> Tightened friction coefficient test (selection of lowest friction values...)
- Objective: Visual inspection RS with microscope before press-in process (availability of visual inspection bench)
  -> Tightened visual inspection
- Selection/installation of tappet assembly with pressing-in force in upper range
- Photographic documentation of roller after friction coefficient test of tappet assembly & evaluation in accordance with visual inspection catalog -> Additional visual inspection
- Reduce inspection speed (800rpm@2,000 bar, additional testing point)
  -> Increased load
- 100% Güntert roller with C2.1 on the roller end

Trial of measures on 10 pumps with subsequent diagnosis.

Non-responsive content removed [redacted]

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EA11003EN-01063[0]

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Fr[illegible]
To:
CC:"

Date: 3/26/2009, 3:14:00 PM
Subject: Re: Documents for the drivetrain telco 03/26/2009
Attachments: 9830100_PB_Status.pdf

... so that you can see what kind of metal splashes / fusing we are dealing with (were taken from the straightedge test).
Note: BDF650 is a very poorly lubricating diesel fuel (boundary diesel fuel with HFRR value 650 µm)

With best regards

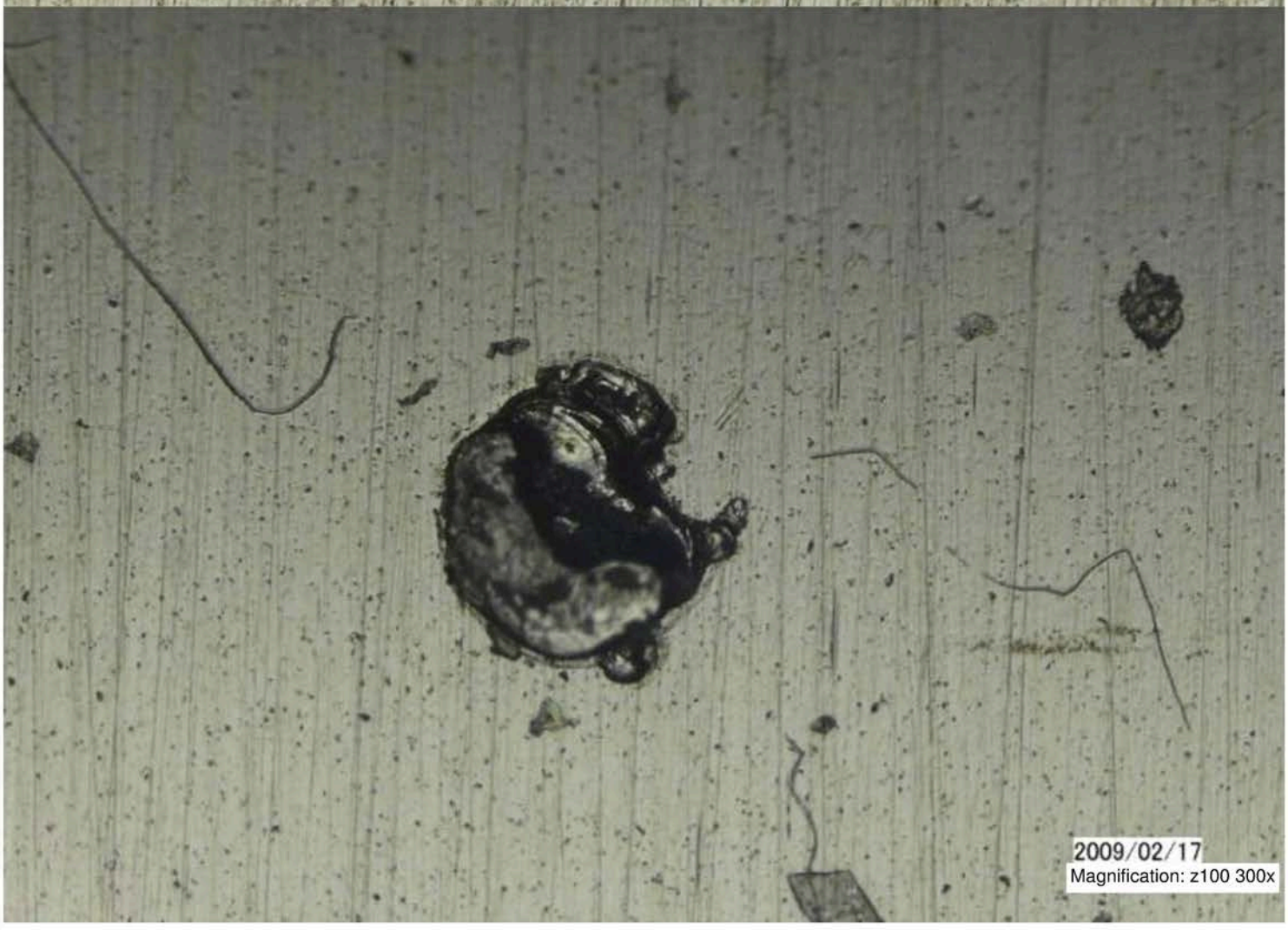
Non-responsive content re moved

From: Non-responsive content removed
Sent: Thursday, March 26, 2009 12:45 PM

Non-responsive content removed

Hello,

Here are the documents for today´s drivetrain telco
1) Results of provocation endurance runs



ENTIRE PAGE CONFIDENTIAL

Mit freundlichen Grüßen / Best regards

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ENTIRE PAGE CONFIDENTIAL

CP4 testing - Audi

Status of challenge endurance runs “drivetrain damage”

Constraints:
Program ER, inlet temperature 90°C, fuel BDF650, set running time 100h
basic pump: 0445 010 613 (W19 BIN5/EU6)

1st endurance run:

Pump in series state - Result: 100h running time without striking features; visual findings OK

2nd endurance run:

Series pump redesigned on tappet with borderline frictional coefficients

Result: 100h running time without striking features; visual findings OK

3rd endurance run:

Series pump redesigned on tappet with fusing or metal splashes on roller support / roller

Result: after 1 h running time - failure with drivetrain damage

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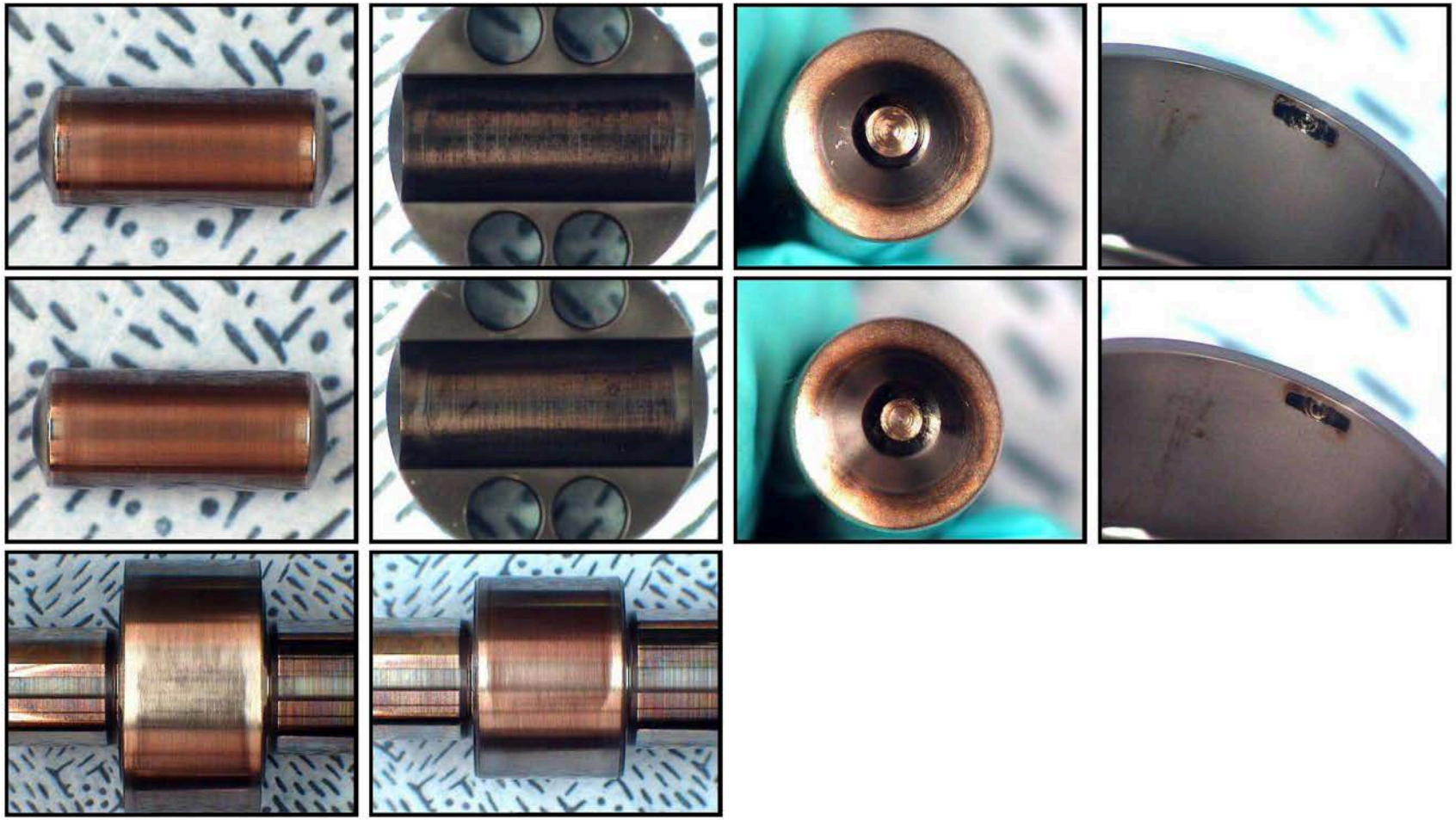
CP4 testing - Audi

1st endurance run: Pump in series state



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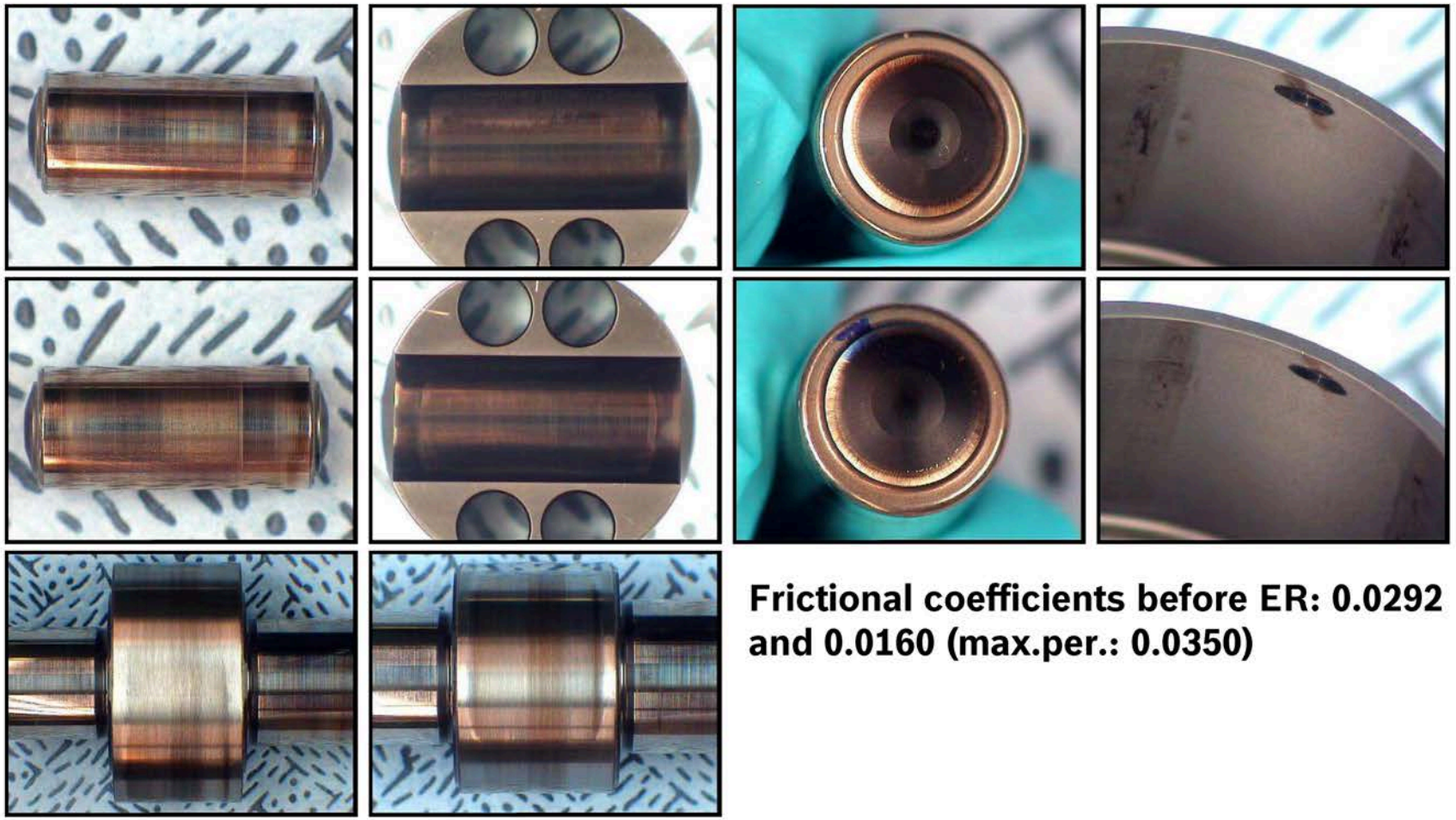
CP4 testing - Audi

2nd endurance run: Tappet with borderline frictional coefficients



Frictional coefficients before ER: 0.0292 and 0.0160 (max.per.: 0.0350)

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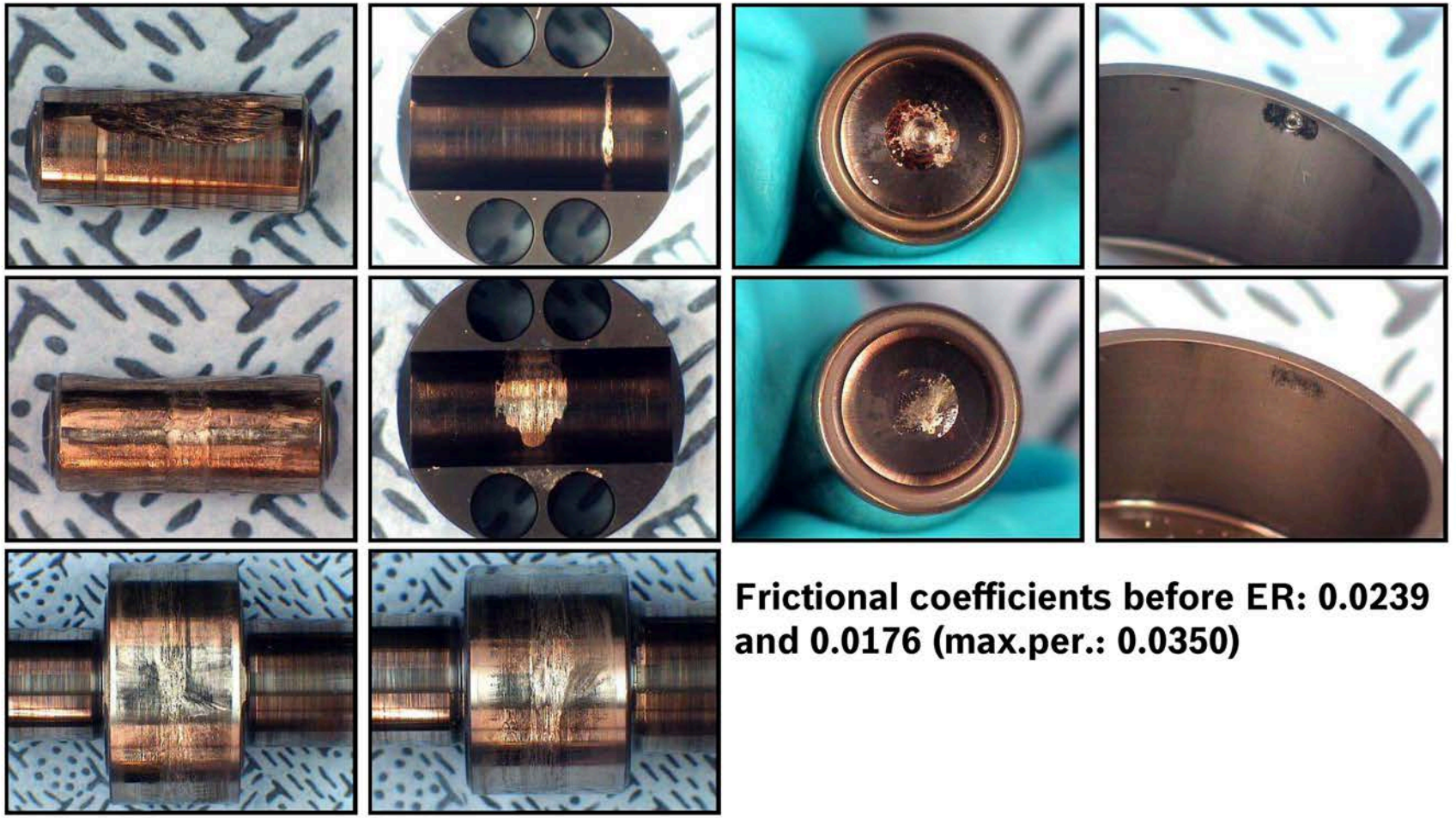
CP4 testing - Audi

3rd endurance run: Tappet with fusing / metal splashes on roller supports / rollers



Frictional coefficients before ER: 0.0239 and 0.0176 (max.per.: 0.0350)

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Pump complaint from veh. endurance run (Q verification USA)

Situation:

- CP4.1 pt no. 0 445 010 508 DM 290109, SN 0425
- Mileage 83,726 km
- Engine no. CBE000155 BIN5
- Vehicle: AU35308050
- Failure location: USA

Fault pattern:

- Drivetrain damage Considerable wear in the center of the cam track through perpendicular roller as a result of sluggish roller, respective deep wear track on the roller. Wear in the middle of the running surface on the roller support.
  There are numerous chips on the MU strainer, OV strainer, in the CH intake valve compartment, in the OV and MU bores and in the bearings and on the shaft seal.
- MU fastening screw missing upon delivery -> probably dismantled by the customer

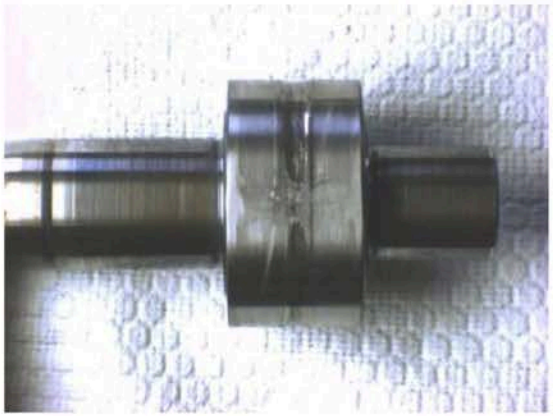
Further work:

- SEM analysis on roller and roller support for further clarification of the cause of failure
- Fuel analysis?

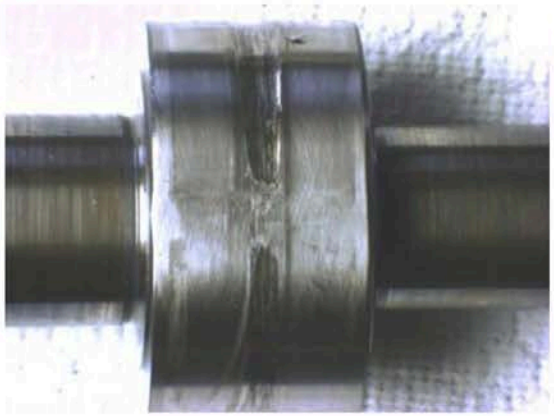
| VW

BOSCH

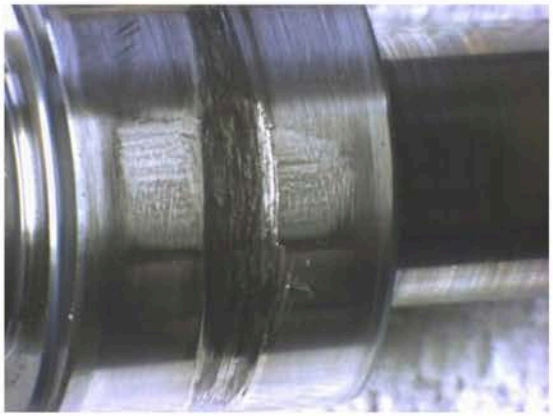
First findings r.e. VW damage case from Q verification ER USA



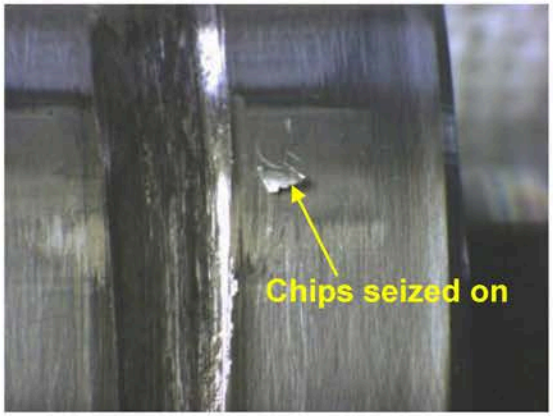
Camshaft



Camshaft BDC

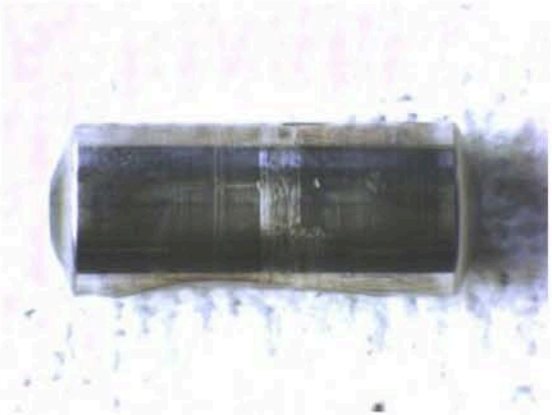


Camshaft TDC



Camshaft TDC

Roller running surface



Roller running surface turned 180°

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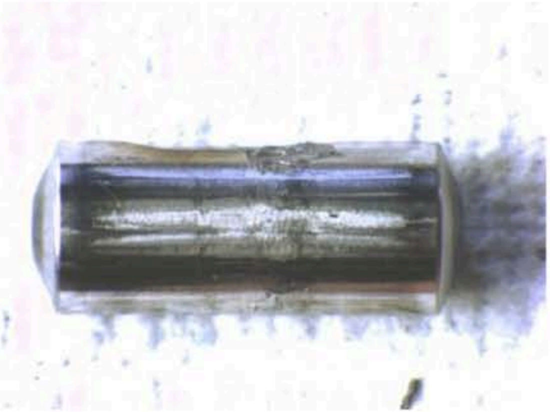
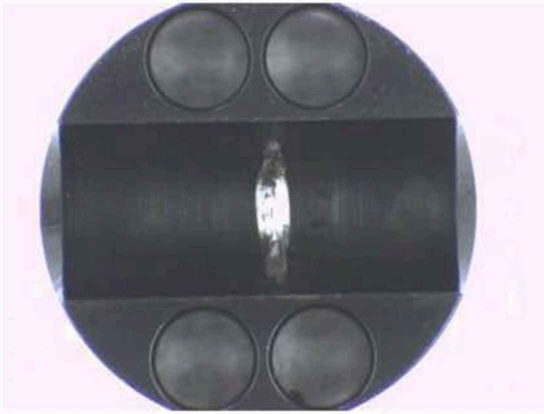
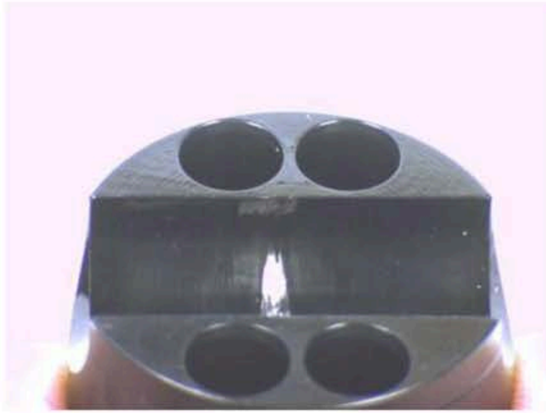
ENTIRE PAGE CONFIDENTIAL

First findings r.e. VW damage case from Q verification ER USA



Roller running surface

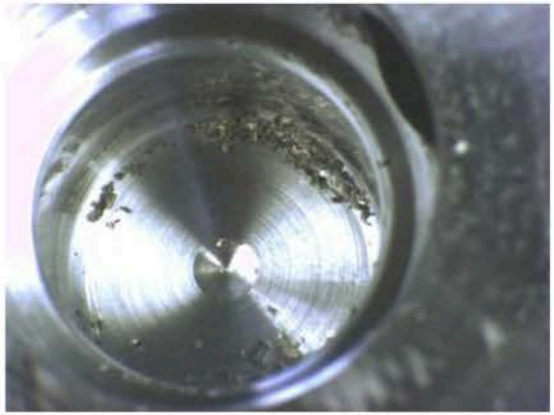




Roller support running surface

CH intake valve compartment

MU strainer



MU bore

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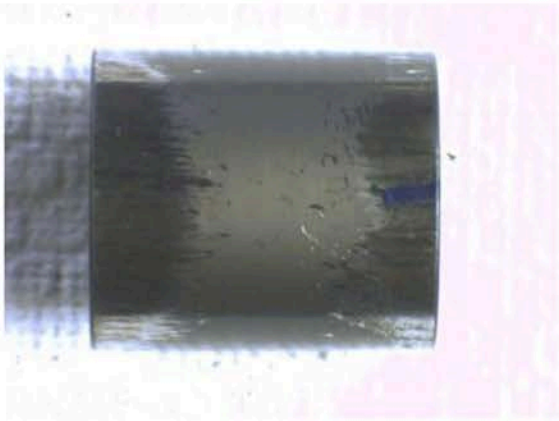
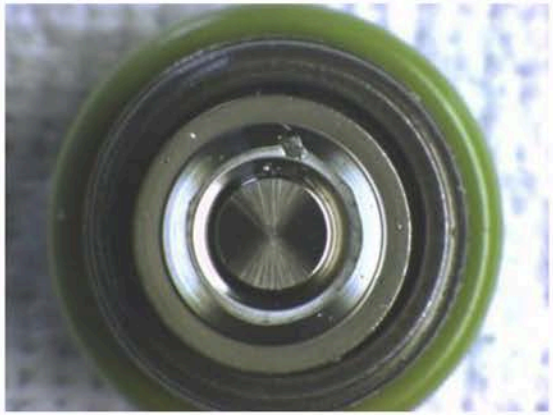
First findings re VW damage case from Q verification ER USA



Tappet body



Intake valve

Intake valve sealing disk

Piston base

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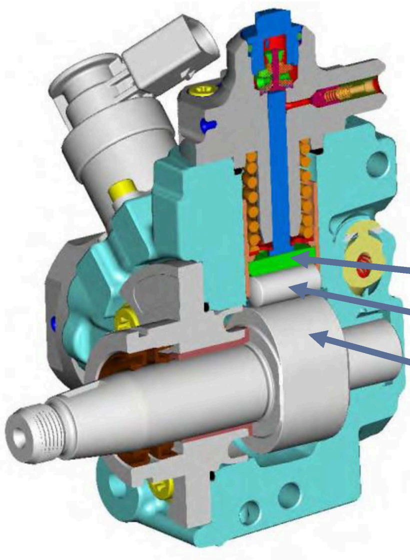
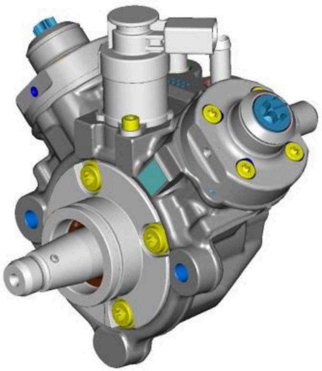
CP4 – Drive Train Failures – Analysis

Problem Description



- In platform testing of B-Sample CP4.1 and CP4.2 [pumps], high failure rate of ~ 20% due to rolling wear and/or sliding wear on
  - roller shoe
  - roller
  - cam shaft
- Drive train failures for all pump types, sample versions, and endurance testing programs



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Causes of Sliding Wear on Roller and Cam Lobe

It was not possible to identify geometric causes for pure sliding wear on the roller and cam lobe.

- ➔ Distinguishing characteristics of failures due solely to sliding wear on the roller and cam lobe as opposed to failures with rolling wear (roller or cam shaft) could not be found.
- ➔ All failures due solely to sliding wear also exhibit the characteristics that were found for rolling wear.
- ➔ In one case there is an indication that the friction coefficient may be the cause of failure; in the other cases friction coefficient testing at the time of assembly had not yet been implemented.

Hypothesis

- ➔ The cause of roller standstill and the resulting failure due to sliding wear on the roller and the cam lobe is an increased friction coefficient of the roller in the roller shoe.

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EA11003EN-01192[0]

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From: Non-responsive content removed
To:
CC:
Date: 07.26.2011 4:47:14 PM
Subject:
Attachments: 2011-CP4_0508_Bericht_gez_31514.pdf
2011-CP4_0505_Bericht_gez_31512.pdf
2011-CP4_0507_Bericht_gez_31513.pdf
Pages from 1903_EHC1_La 117. PG VW R4.pdf

Hello Mr. Non-responsive content removed
Please find attached the reports and additional page from the presentation in the project meeting as requested. The result, in my view, is positive.
Please also provide info on part disposition. Do you want the pumps in WOB or should we scrap them as standard?

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

From: Non-responsive content removed
Sent: Friday, July 22, 2011, 3:25 PM
To: Non-responsive content removed
Cc:
Subject: ANS: HPP from endurance run on the findings

Hello Mr. Non-responsive content removed

Here is the story of the MNS HPP (Q verification run failure at 31,874 km)

During yesterday's shift run traveling on the freeway at approx. 120 km/h, there was a performance dropout of the engine.
No fuel intake possible, preheat light started flashing in the station wagon, when the vehicle came to a standstill the engine stopped.
The vehicle could not be restarted and had to be towed to the station.

3 static error memory entries in CU01:
"P0087 Fuel rail / system pressure too low
0110 0001 upper limit value exceeded"
Diagram readout of the MWB engine and transmission attached.

ENTIRE PAGE CONFIDENTIAL

A fuel sample was taken from the vehicle and examined with the "fuel identification device DMP 02". (Unfortunately this device only outputs information about the type of fuel, not the quality.)
Result: 100% diesel (see attached photo "diesel sample")

The analysis approached used was to examine the HPP, in which some shavings were found (see photos).
HPP parts data:
805 010 511 0, Bosch 1000, 1027, 02/53R/1S4PC/RC, A557 031 L30, 01 21 80 80, 1540TPB.

Crafter and RPU HPP supply with Non-responsive content removed **test fuel. Low pressure circuits with both series.**

We will try to complete the additional information (questionnaire) you requested soon and, if successful, would pass this onto you in a findings meeting.

Please send the results of the [redacted] **HPP analysis to me and** Non-responsive content removed **in advance. I will not be able to find out the result in PM 117 because of plant holiday.**

Thank you

Best regards

Non-responsive content removed

From: Non-responsive content removed
Sent: Friday, July 22, 2011, 1:57 PM
To: Non-responsive content removed
Subject: Re: HPP from endurance run on the findings

Hello Non-responsive content removed

Here are the questions fr Non-responsive content removed

With best wishes

Non-responsive content removed

From: Non-responsive content removed
Sent: Thursday, July 21, 2011, 4:53 PM
To: Non-responsive content removed

EA11003EN-01192[2]

ENTIRE PAGE CONFIDENTIAL

Subject: Re: HPP from endurance run on the findings

Hi all,

If I am reading it right, are the bottom two the failures? Please answer my questions as far as you can, thank you. Would be very helpful in the findings. Thank you.

Mit freundlichen Grüßen / Best regards

Non-responsive content removed

Description:
cid:b28ce4b8-b627-448e-aecd-19b7a229ed22

From: Non-responsive content removed
Sent: Thursday, July 21, 2011, 3:16 PM
To: Non-responsive content removed
Cc:
Subject: HPP from endurance run on the findings

Hello Non-responsive content removed

I have received the three high-pressure fuel pumps. They will go to Stuttgart tomorrow on an application vehicle.
We have received the following info on the HPPs:

1. 03L 130 755 A no info on the HPP ;-(
   08 081210
   BPT 0451
2. 03L 130 755 AB from VN 817 1 0360 with 89,297km
   02 211010
   BPT 0249
2. 03L 130 755 AB from VN 831 9 0143 with 143,821km (EWP)
   08 100810
   BPT 0022

Can you please send us the missing info about HPP no. 1!

Non-responsive content removed, please enter the HPPs in the findings list. The HPPs are in the Passat (NMS) that is going from BS to Fe tomorrow.
Please take the parts out of the trunk on Monday and give them to Mr. Non-responsive content removed.

Thanks for your efforts!

Non-responsive content removed

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www.bosch.com

[redacted]

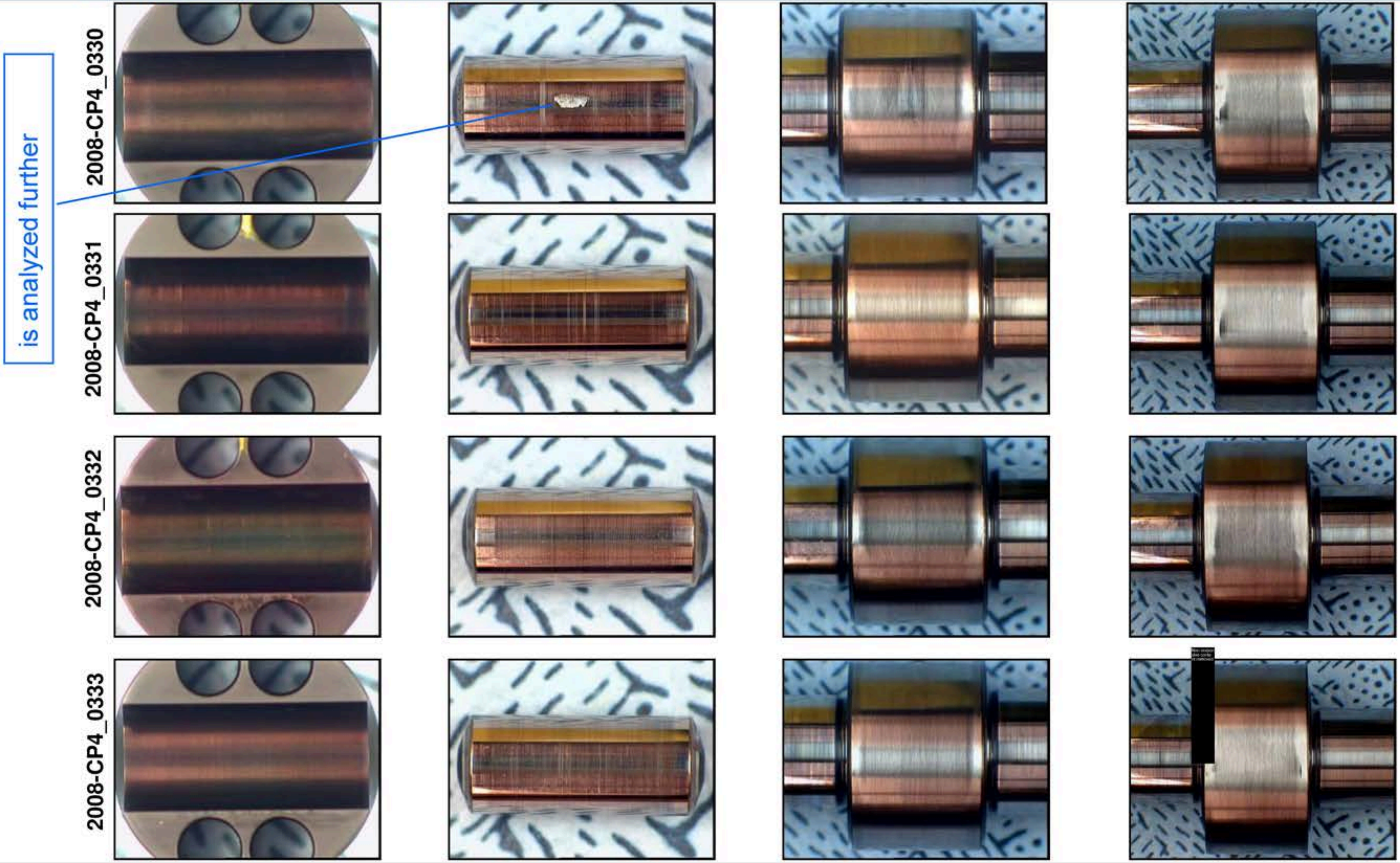
Domicile: Stuttgart, Court of Registry: Local District Court Stuttgart, Commercial Register No. 14000;
Chairman of the Supervisory Board: Hermann Scholl; Management: Franz Fehrenbach, Siegfried Dais;
Stefan Asenkerschbaumer, Bernd Bohr, Rudolf Colm, Volkmar Denner, Wolfgang Malchow, Peter Marks, Uwe Raschke, Wolf-Henning Scheider,
Peter Tyroller

< OLE object: Picture (Enhanced Metafile) >>

Diagnostics for DL end pumps R4 2.0l BIN5 – received on 15/04/2007

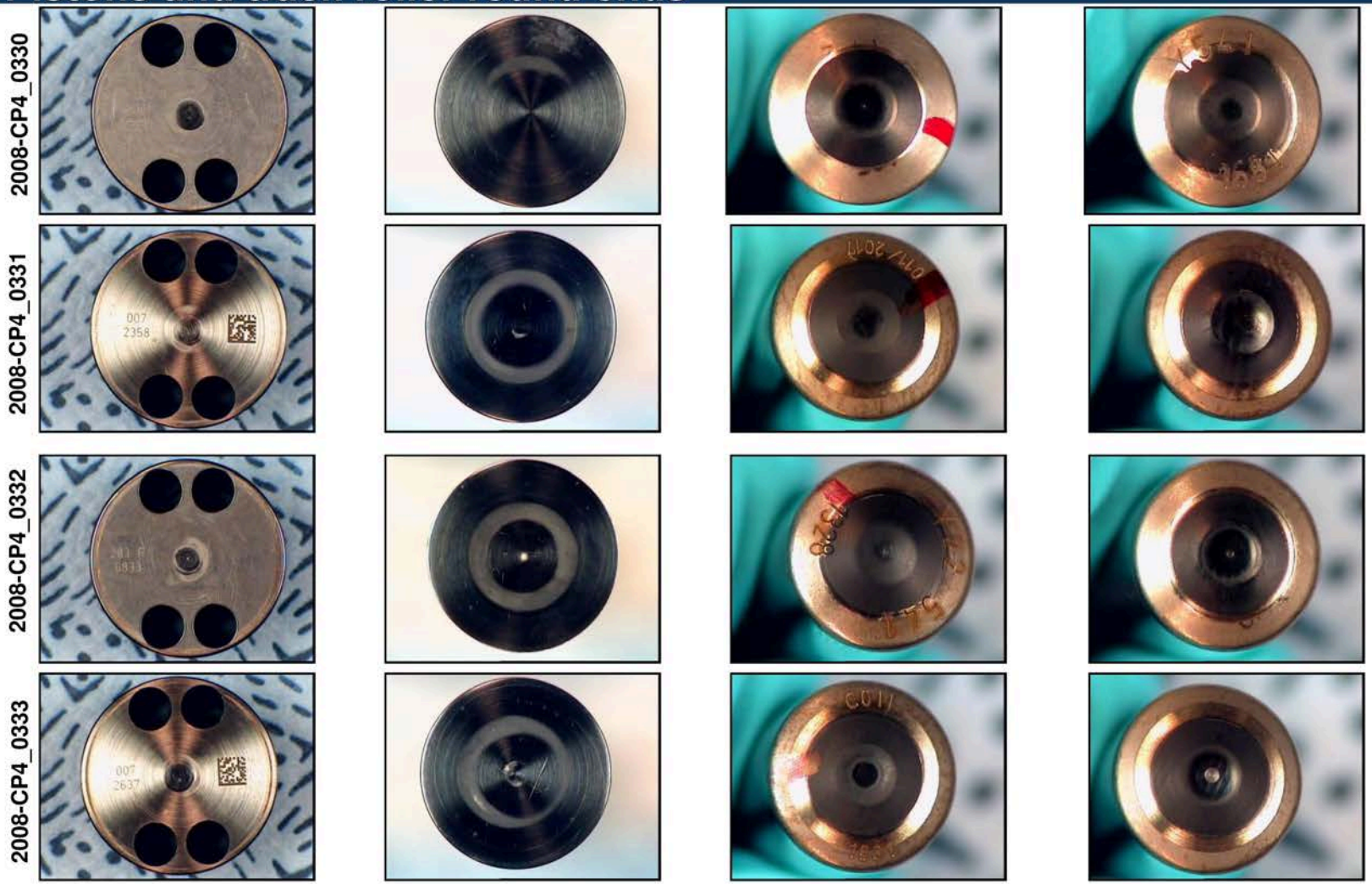
- 2008-CP4_0330 / pump #689-4147 / 0445B21060_06 V125
  - Type of application: USA field; engine 3LDB17284
  - Vehicle VW351780082
  - 102,251 km
- 2008-CP4_0331 / pump #692-4343 / 0445B21060_11 V130
  - Type of application: USA field; engine 3LDP18102
  - Vehicle VW351780088
  - 117,627 km
- 2008-CP4_0332 / pump #689-4943 / 0445B21060_05 V125
  - Type of application: USA field; engine 3LDB17267
  - Vehicle VW351780089
  - 114,225 km
- 2008-CP4_0333 / pump #692-4338 / 0445B21060_11 V130
  - Type of application: USA field; engine 3LDP18095
  - Vehicle VW351780092
  - 159,350 km

CP4 – diagnostics for VW R4 2.0 BIN5
Drive device after tests



CP4 – diagnostics for VW PA 2.0 BIN5

Pistons and track roller round ends



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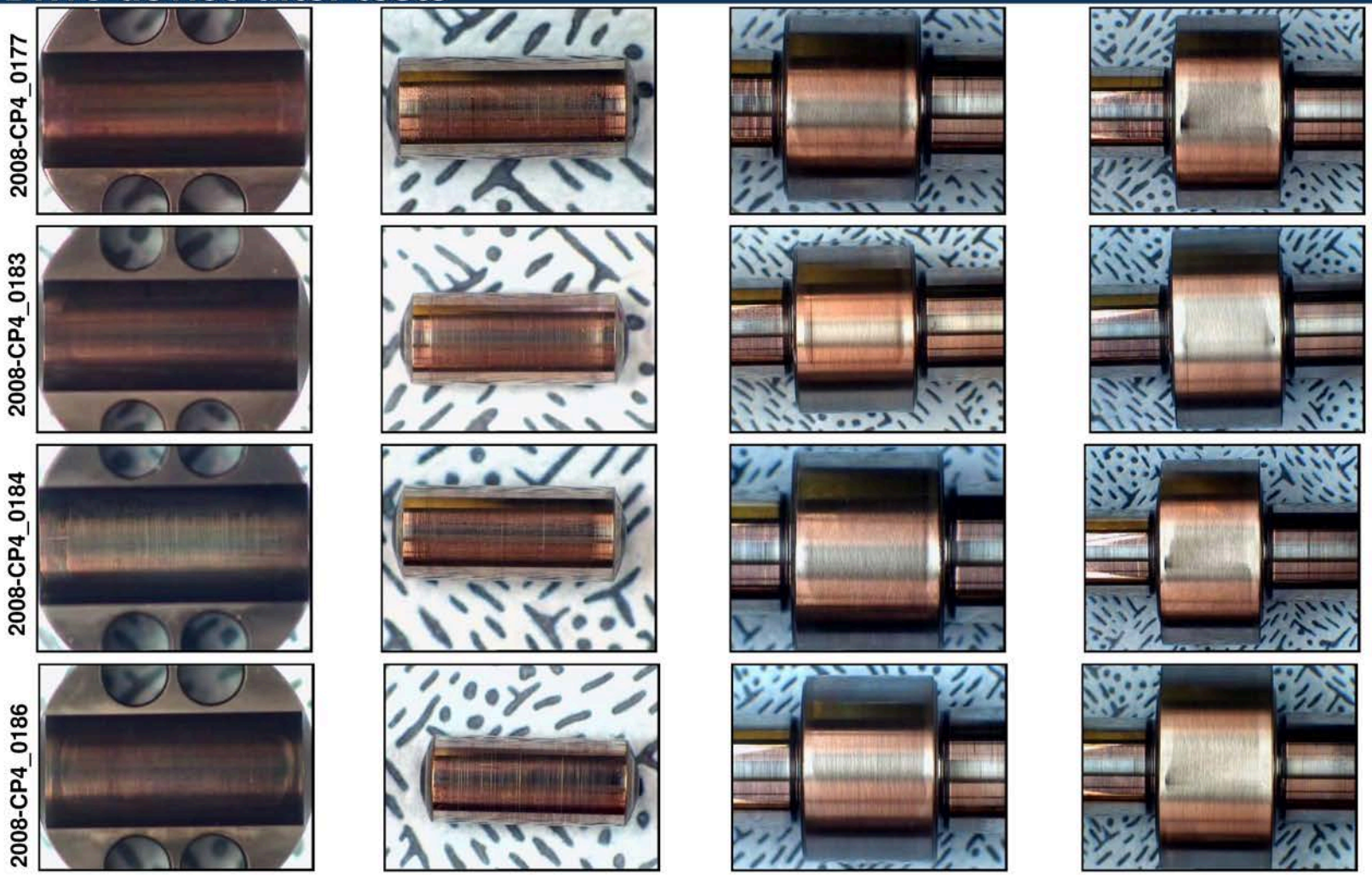
Diagnostics for DL end pumps R4 2.0l BIN5 – received on 29/01/07

- 2008-CP4_0177 / pump #688-4786 / 0445B21060_05
  - Type of application:WL1+KL4; engine: 03LD/17263;
  - Vehicle/Pst: VW315780090
  - 98,820 km
- 2008-CP4_0183 / pump #090707-0453 / 0445010508
  - Engine: CBE0000544
  - 981h
- 2008-CP4_0184 / pump #689-4148 / 0445B21060_06
  - Type of application: WL1 + KL4 + Winnipeg;
  - Engine: O3LD/17088
  - 100,026 km
- 2008-CP4_0186 / pump #692-4335 / 0445B21060_11
  - Type of application: QS-DL 1/3 Mix
  - Engine: O3LD/18097
  - 126,398 km

CP4 – diagnostics for VW PA 2.0 BIN5

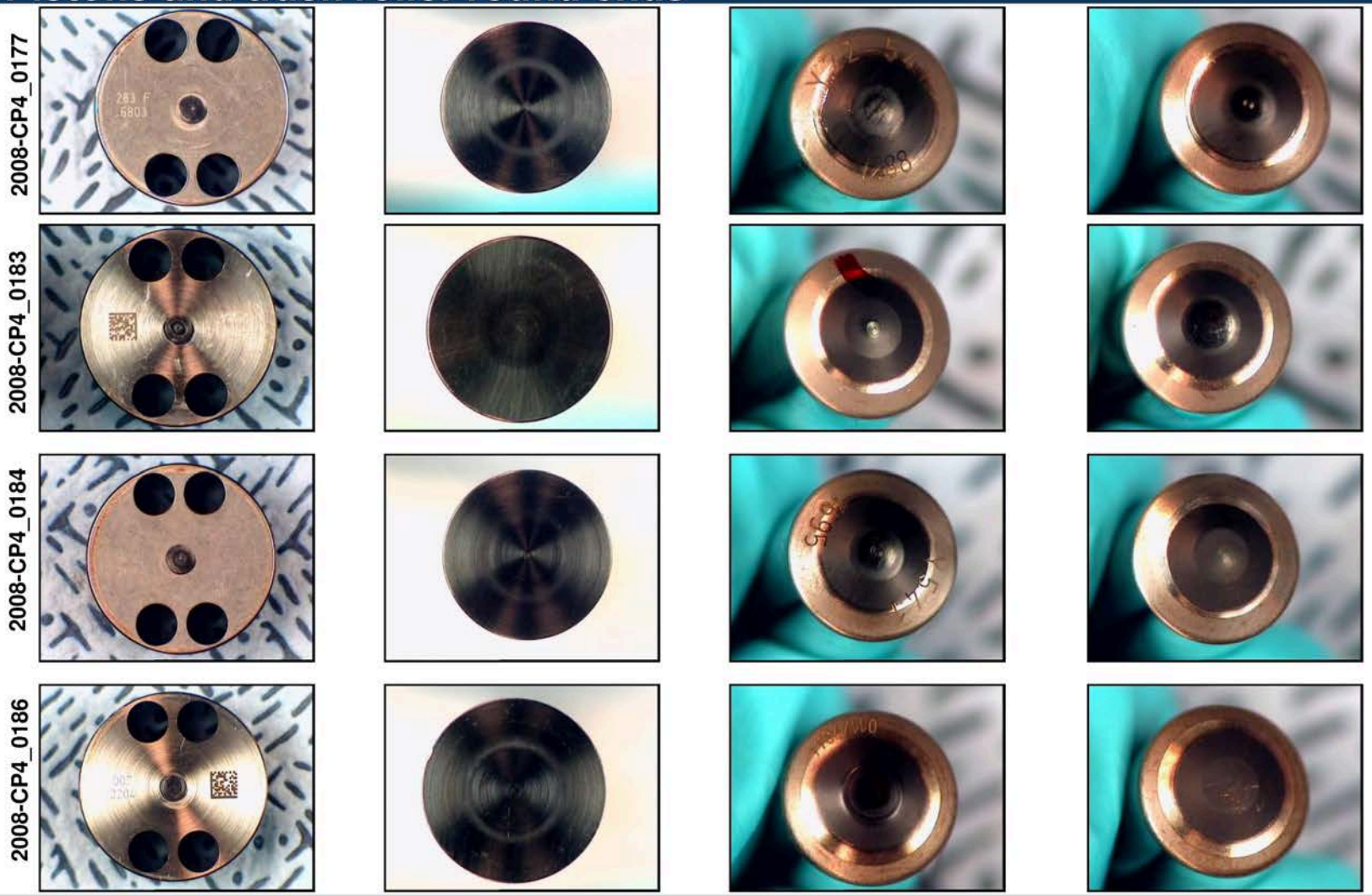
Drive device after tests



CP4 – diagnostics for VW PA 2.0 BIN5

ENTIRE PAGE CONFIDENTIAL

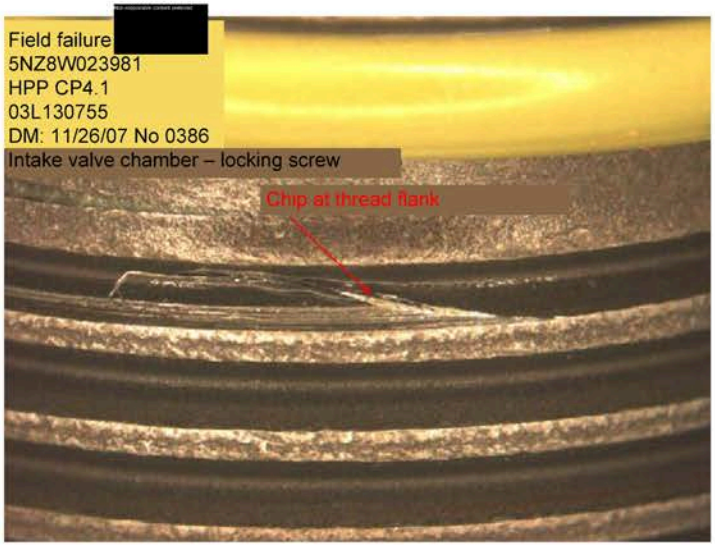
Pistons and track roller round ends



Chip at locking screw

Process:

- Failed pump disassembled and examined by VW.
  Result:
  1.) Chips in the intake valve (IV) area
  2.) Chip at the locking screw (see figure)



Situation in relation to the striking feature, point 2.)

- Striking feature known and countermeasures initiated
- The screw connection may cause chips to form.
  Cause: Thread geometry of the cylinder head (limited by its construction)
- A series of tests was conducted on cylinder heads (CH) with different thread geometries. Result:
  A variant that can be used to prevent the formation of chips on the locking screw was identified. This variant is within the valid specification.

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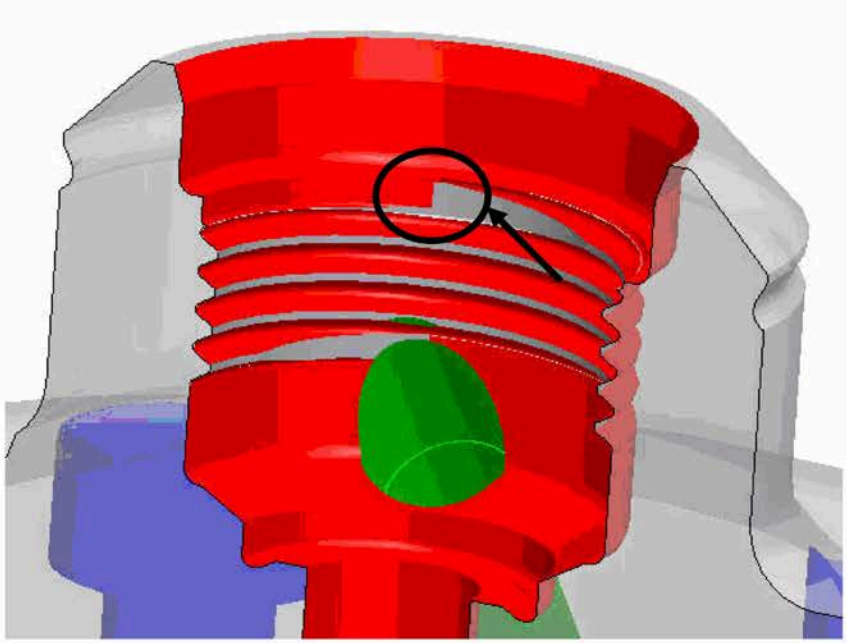
Formation of a chip:

- When assembling the locking screw, an indentation/chip forms in the thread of the locking screw. This is produced by the thread end of the inner thread at the cylinder head.
- The chip always forms at the locking screw because this is the softer material.



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Effects of a chip:

- The chip can only be formed if the axial force is sufficient (i.e. at the end of the bolting procedure). In the assembled state, the chip always remains above the intake valve thread.
- In order to access the intake valve, it would have to migrate downwards through the thread pitch (approx. 4 rotations at 75µm, which is the greatest possible thread clearance) against the fuel flow. Since this can be ruled out, disassembly is the only risk that remains.
- During disassembly, the chip may be loosen from the locking screw, drop into the cylinder head or intake valve and become entangled there, where it remains and causes damage during reassembly.

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Chip at locking screw

Further planned measures:

Conduct a series of tests on CHs manufactured under series production conditions with an optimized thread geometry (-> proof of effectiveness).

- Production of approx. 2,800 CHs with an optimized thread runout. D : 2/29/2008
- Conduct a series of "locking" tests to verify that the measure is effective. D: 3/7/2008
- Change over the series to an optimized thread runout. D: under review

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Measures relating to multiple screw locking at the CH:

- Measure the plastic screw formation. D: 2/29/2008
- DNA: No reworking of CHs whose locking screw needs to be disassembled. D: Done

Proposal for an additional pump failure process:

Material analysis of the chips found in the IV area. Verification of the origin of the chips.

EA11003EN-01302[0]

From: Non-responsive content removed
To:
CC:

Date: 9/26/2008, 5:59:36 PM
Subject: Formatted documents from zero-error meeting 09/24/2008
Attachments: 0-FG 2008-09-24 - Zusammenfassung für [redacted].pdf

Good evening [redacted]

As you requested, here is a formatted set of slides with the information from the zero-error meeting. The documents shown on Wednesday contain the latest data.
<<0-FG 2008-09-24 - Zusammenfassung für [redacted].pdf>>
The measure shown in the flag graph, “Opt. C coating”
is a measure to avoid influence of the shielding plates during C coating of the roller support.

Also see first version.

<>

Best regards / mit freundlichen Grüßen

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Robert Bosch GmbH
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Measures (continued)

C coating measures being tested:
Roller support (RS)
2. Reduce influence of shielding plates, attempt with batch of 2880 RS; if result is positive, Audi approves of conversion of C coating process;
   Result: The result of the full batch with 2880 units showed only one case of metal spatters; this is a significant improvement compared to the test batch; the C coating method will be adopted in the series RS;
   Introduction date roller support: 5/1/2008;
   Introduction date product CP4.1/CP4.2: from 05/05/2008

C coating measures being tested:
Roller:
Optimized holder model for roller to prevent fusing
D: Schedule 04/23/2008 - done (see attachment)

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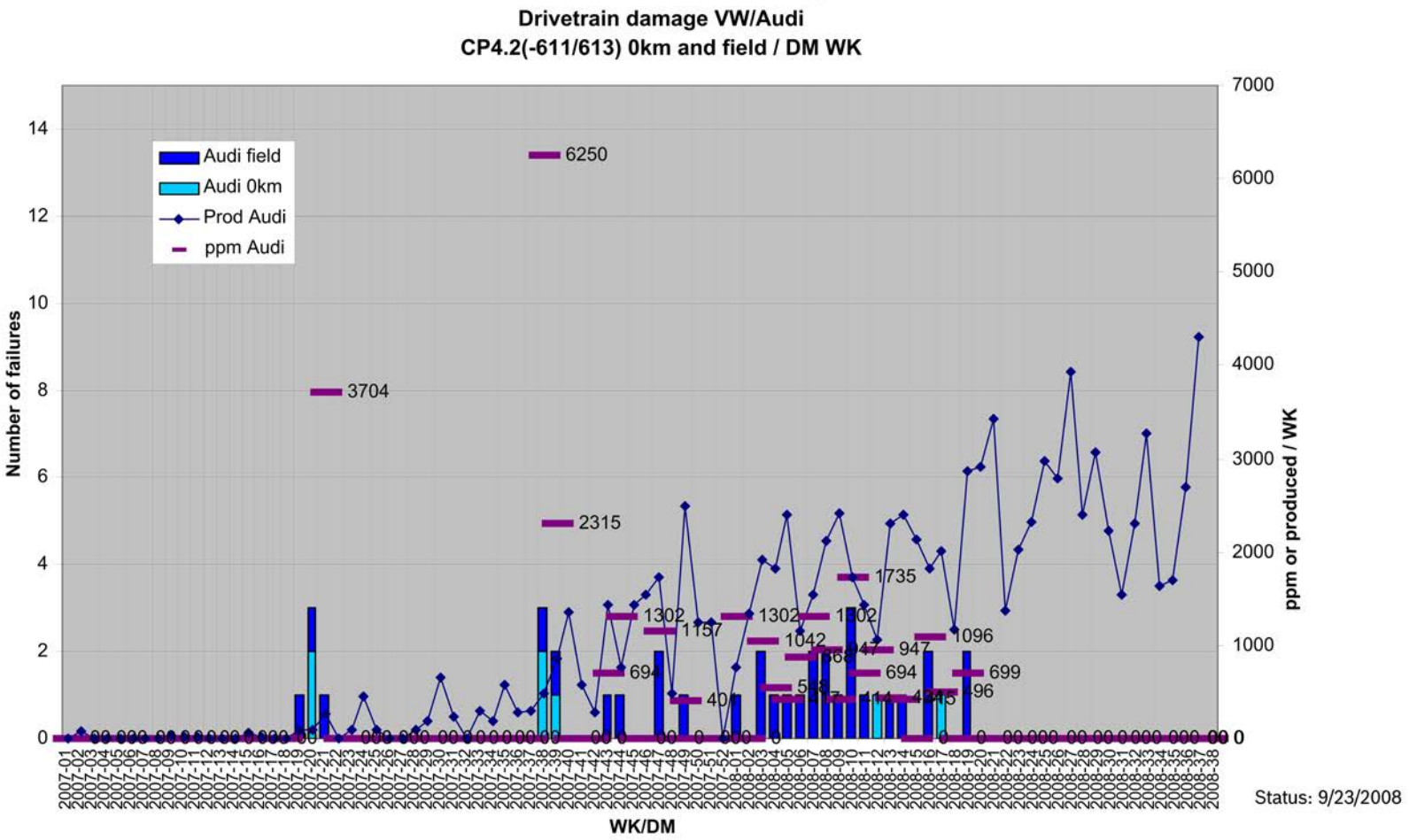
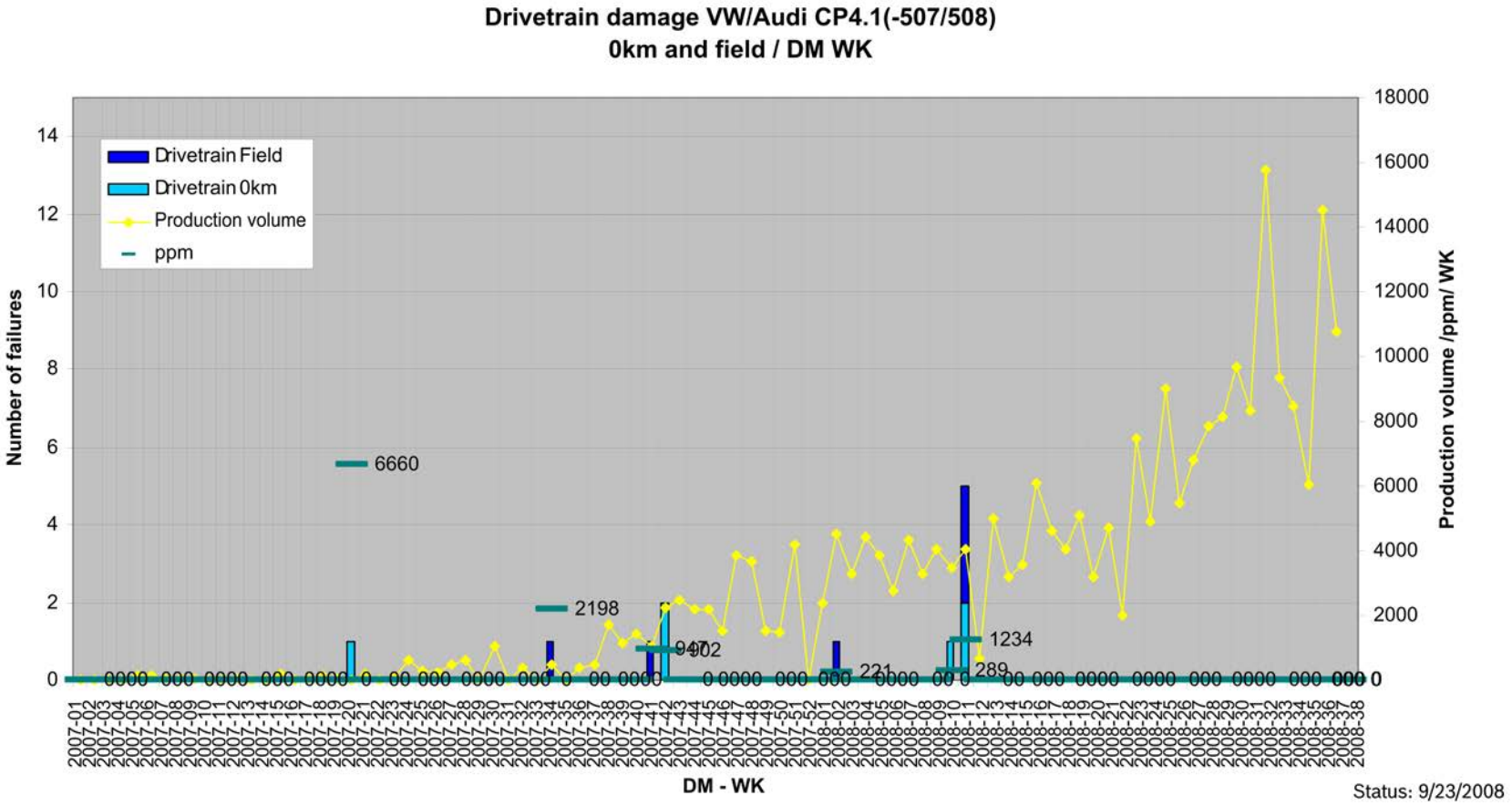
Failures with drivetrain damage - audi/VW CP4.2



Failures with drivetrain damage - Audi/VW CP4.1



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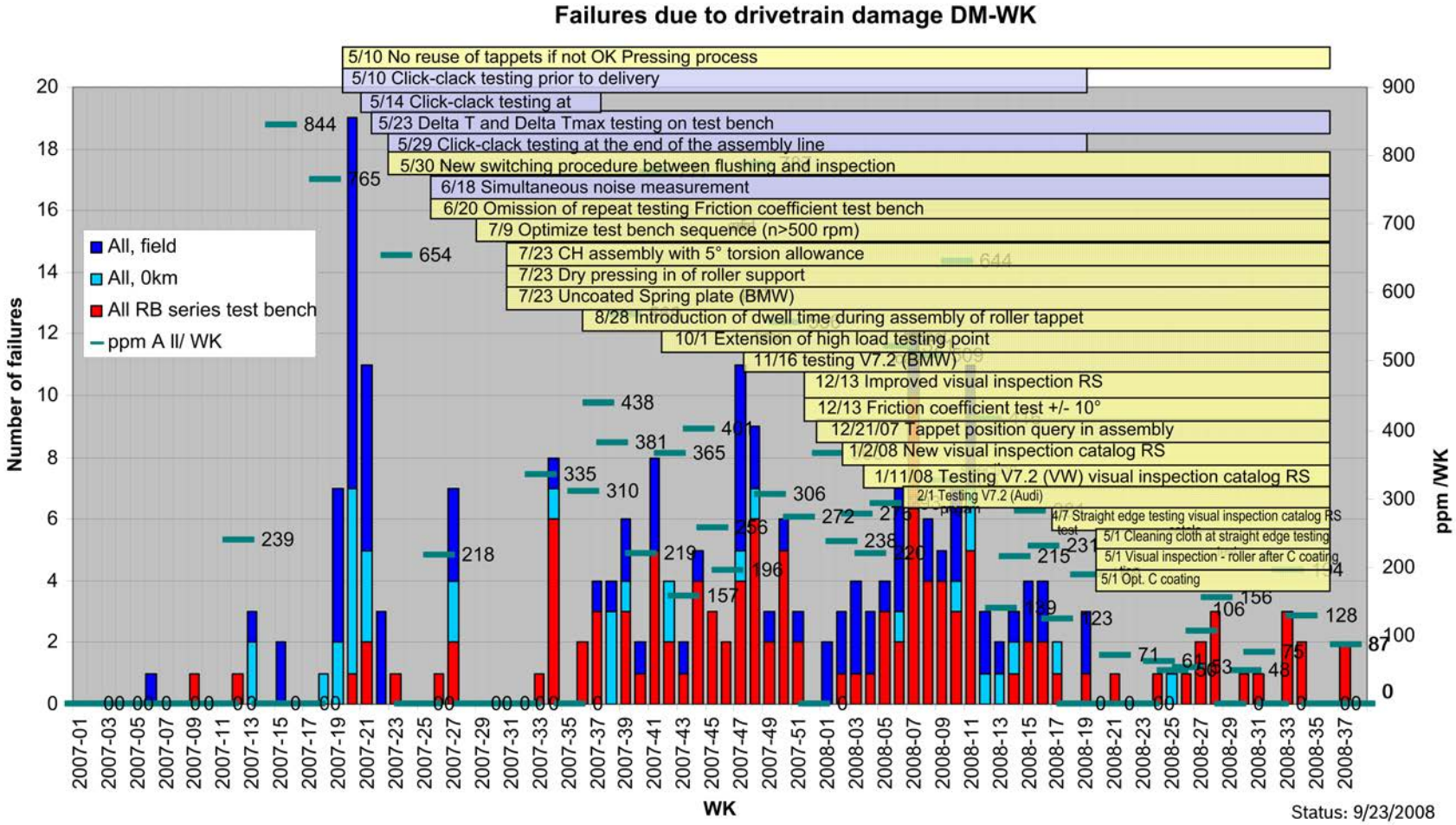
Failures with drivetrain damages - all customer CP4.x



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Drivetrain damage comparison Audi CP4.2

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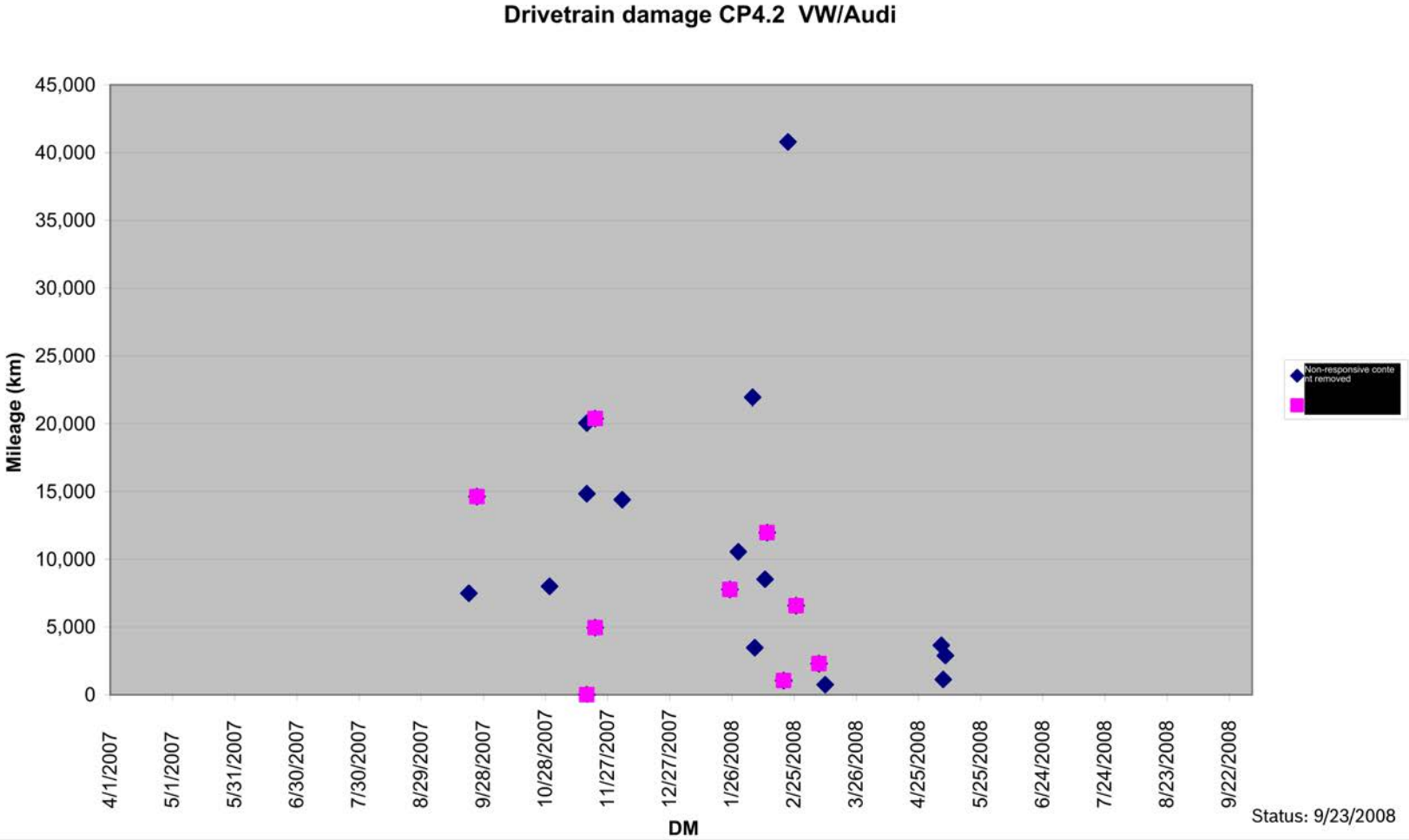

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Status drivetrain damages

- No failure with VW/Audi CP4.2 since DM WK20/2008
- No failure with VW/Audi CP4.1 since DM WK12/2008
- No failure with all CP4 series customers since DM WK20/2008
- The comparison of failures from Non-responsive content removed and Non-responsive content removed by date of manufacture and mileage does not show any striking features

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Activities to reduce drivetrain damage

Production activities to reduce drivetrain failures

1) Metal splashes on roller support (RS)

1.1) Avoidance of metal splashes

Graphite/boron nitride covering on holders in C layer coating system

• Test new plant	(done)
• 2-day production/large-scale test planned	Date under discussion
• After positive test, planned implementation	Date under discussion

1.2) Recognizing metal splashes

• Feasibility study: objective measurement procedures	(done)
• Two quotations for camera monitoring in progress, major trial under series conditions required for evaluation purposes (avoidance of pseudo scrap)	
• Ordering of preferred solution for 1st line in [redacted] planned by Implementation then scheduled for 09/04	WK44
• 2 visual inspections used at present (after finishing or frictional coefficient test)	

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Activities to reduce drivetrain damage

Production activities to reduce drivetrain failures

3) Avoidance of C layer removal during washing/ transport, RS

New washing/ transport frames

- First 100 (done)
- Complete conversion WK 42

3.1) Avoidance of C layer removal during pressing RS in tappet body TB

- Flaking C layer particles from the RS are transferred during frictional coefficient measurement and can lead to preliminary damage. The following potential remediation measures are currently being assessed:
  - Optimization of C layer adhesion
  - Avoidance of C coating

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Activities to reduce drivetrain damage

Production activities to reduce drivetrain failures

Schedule of activities: C particle removal of roller support

1.	Examine a batch of roller supports (480) before Press-in process ➔ Striking features, flaking, peculiarities under microscope	WK 40
2.	Feasibility study for “brushing” RS surface (after C coating)	WK 44
3.	Carry out analysis of identified C layer bulges. of an FIP cross-section	WK 43
4.	Change RS holding tool when pressing into tappet body ➔ Smaller support surface, better coverage	WK 48
5.	Feasibility study for elimination of coating on RS surface	WK 48

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Activities to reduce drivetrain damage

Production activities to reduce drivetrain failures

4) Avoiding "fusing" on roller.

Currently there are two solution approaches being considered:

- a) Improv ment of roller contact through resilient contact plate
- b) direct alignment of the rollers ("stack of wood") for improved contact
- b) is favored and prioritized; if effect is positive implementation by WK48

- Currently there are 2 x straightedge tests used to positive effect, since the 2nd test has not yet found any faulty parts.

5) Change to construction layout

- Change coating system of roller end from C3 to C2 (test W24 D4, VW package 3)
- Improve tight fit for the roller support/tappet body press assembly R.B. internal test WK 43

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Activities to reduce drivetrain damage

Development activities to reduce drivetrain failures

(Focus: export countries of [redacted])

Failure hypothesis:

Drivetrain damage due to combinations of stiff cam roller (slippage in production prior to introduction of the straightedge test, etc. 1.05.2008) + country-specific special features (fuel, transport, commissioning)

KT analysis with key question

- Why is the failure rate in [redacted] higher compared to [redacted]?
- Why is CP4.2 affected more than CP4.1 (production plant, components,...)?

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Activities to reduce drivetrain damage

Investigation in relation to fuels & Fuel peculiarities in [redacted] **markets**

1) Free water:

Estimation: unlikely; however, 1 pump found with visible corrosion

1.1) Action: Replication attempt with sloshing water

Result: no drivetrain damage, slight traces of tarnishing in housing

1.2) Action: Reproduction attempt with continuous water entry (30% water)

Result: drivetrain damage after a few minutes

1.3) Action: WCF test with 1% water & subsequent continuation with EN590

Result: Pitting on the roller -> likely drivetrain damage in case of continued operation

Conclusion: Free water can cause drivetrain damage.

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Activities to reduce drivetrain damage

Investigation in relation to fuels & Fuel peculiarities in [redacted] markets

2) Fuel from [redacted]

Estimation: probably in combination with other influencing factors

2.1) Action: Carry out research of fuel peculiarities in [redacted]

Result: Use of ethanol fuels in [redacted], to date exclusively in bus area with oil-lubricated pump drivetrains

2.2) Action: Obtain fuel samples from failure map **D. 10/24/08 R:** [redacted]

Result: t.b.d.

2.3) Action: Analyze fuels from failed pumps **D: Ongoing R:** [redacted]

Result: No striking features to date

2.4) Action: Analysis of fuel deposits **D. 10/13/2008** [redacted]

Result: One noteworthy pump. Rust, products of fuel aging & traces of chlorine and silicone oxide. The source of the corrosion medium (likely with chlorine) could not be determined. Additional failed pumps are being examined.

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Activities to reduce drivetrain damage

Investigation in relation to fuels & Fuel peculiarities in [redacted] markets

3) Fuel from [redacted]

Estimation: probably in combination with other influencing factors

3.1) Action: Research peculiarities of fuel in [redacted] **D: 10/20/08 R: [redacted]**

Result: t.b.d.

3.2) Action: Endurance run with non-OK roller & GDK650

Result: Failure after 35 hours with final turned tappet

3.3) Action: additional endurance runs with production abnormalities (priority A, see ER overview)

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Activities to reduce drivetrain damage

Examine influence on operating conditions

4) Air in fuel

Estimation: unlikely; however, air was found in the pump intake for a leased Q7.

4.1) Action: Replication test with high air proportion

Result: no drivetrain damage, but high degree of foam formation

4.2) Action: Research with Audi series electric fuel pump & filter

Result: Inline EFP can take in air via the filter

Recommendation: Verify LPC layout design with borderline components.

V. Audi Non-responsive content removed

4.3) Action: Endurance run with defined air entry (priority B, see ER verview)

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Activities to reduce drivetrain damage

Examine influence on operating conditions

5) Belt tension too low (not OK)

Estimation: unlikely; however, in two US Q7s that experienced failure incidents, W19 tension pulleys were found instead of W24 tension pulleys

4.1) Action: Simulation with low belt tension

Result: Impermissibly high rotary drive oscillations can result in impermissibly high slippage between cam & roller (-> braking flats)

4.2) Action: Measurement of rotary drive oscillations with min. tension pulley on engine, determine worst case conditions & then with worst case engine endurance run conditions

Result: Measurements do not show any impermissibly high rotary drive oscillations
Engine endurance run without striking feature

4.3) Action: Diagnosis of pump for “rotary drive oscillations” **D: 10/17/08 R:** [redacted]

Conclusion:

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Production period			Jan 07	Feb 07	Mar 07	Apr 07	May 07	Jun 07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08
CP4.1 Volkswagen 0 445 010 507/...508																										
Production volume	Plant																									
	[redacted]		0	100	0	168	246	384	864	1317	2880	4800	5376	4800	6240	2304	3264	1344	1920	7104	0 3745	0 11808	0 16512			
			0	100	0	168	246	384	864	1317	2880	4800	5376	4800	6240	2304	3264	1344	1920	7104	3745	11808	16512	0	0	0
Errors	Drivetrain damage / Turned tappet	0km					1					2					1									
		Field																								
	Particles IV Non-starter	0km																								
		Field																								
	Particles NRV Non-starter	0km																								
		Field																								
	MU O-ring damaged	0km																								
		Field										1														
	Shaft seal leaking	0km										1														
		Field										1														
	Crack on cylinder head	0km																								
		Field																								
	Tappet spring broken	0km																								
		Field																								
	CH HP connector thread damaged	0km																								
		Field																								
	Assembly error (Handling error: Tension pin [redacted] missing)	0km																								
		Field																								
	[redacted] pressure retaining test not OK, RB OK according to spec.	0km	1						1	2	1	3	7													
		Field																								
	OK according to specification	0km				1	1																			
		Field									1	1														
	Prefinding EAD1 (ignored in the overall ppm view)	0km							1																	
		Field								1																
	Customer error	0km																								
		Field																								
	t.b.d.	0km																								
		Field																								

Production period			Jan 07	Feb 07	Mar 07	Apr 07	May 07	Jun 07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08
CP4.1 AUDI 0 445 010 507																										
Production volume	Plant																									
	[redacted]		0	55	0	0	54	698	112	384	288	1728	7680	4391	8448	11328	9504	16229	17861	21984	27628	21696	33120			
Errors	Drivetrain damage / Turned tappet	0km															3									
		Field													1		2									
	Particles IV Non-starter	0km									1	2	1		1			2		1	1	1				
		Field									1															
	Particles NRV Non-starter	0km																								
		Field																								
	MU O-ring damaged	0km										5														
		Field										1														
	Shaft seal leaking	0km																								
		Field																								
	Crack on cylinder head	0km																								
		Field																								
	Tappet spring broken	0km																								
		Field															1									
	CH HP connector thread damaged	0km																			1	1	1			
		Field																								
	Assembly error (Handling error: Tension pin missing)	0km																	1							
		Field																								
	OK according to specification	0km																			1					
		Field											1													
	Customer error	0km											2							3						
		Field																								
	t.b.d.	0km																				1				
		Field																								

Production period			Jan 07	Feb 07	Mar 07	Apr 07	May 07	Jun 07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08
CP4.2 AUDI 0 445 010 611																										
Production volume	Plant																									
	[redacted]		72	0	45	90	450	450	378	1344	2016	3456	6336	4512	6624	7872	6624	8064	9600	12096	10472	9312	16901			
Errors	Drivetrain damage / Turned tappet	0km					2				3						1	1			1					
		Field					1					1			2	1	3	1								
	Particles IV Non-starter	0km																								
		Field																								
	Particles NRV Non-starter	0km								1																
		Field																								
	MU O-ring damaged	0km																								
		Field																								
	Shaft seal leaking	0km																								
		Field																								
	Crack on cylinder head	0km																								
		Field									1		1			2										
	Tappet spring broken	0km																								
		Field																								
	CH HP connector thread damaged	0km																					1			
		Field																								
	Assembly error (Handling error: Tension pin missing)	0km																								
		Field																								
	OK according to specification	0km									1								1							
		Field										1						1		1						
	Customer error	0km																								
		Field													1											
	t.b.d.	0km																					1			
		Field					1																			

Paynter Chart 0km and field failures CP4.1 for all plants (VW and AUDI), FeP (series)

IQIS GA20/21/40

Status: 10/20/2008 - Ca

Production period		Jan-Jun/07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	No of units 01/07 - 12/08	PPM total	No of units 01/08 - 12/08	PPM 2008
Total supply Qty to		1,705	976	1701	3168	6528	13056	9191	14688	13632	12768	17573	19781	29088	31373	33504	49632	0	0	0	258,364		222,039	
Drivetrain damage / turned tappet	0km	1				2					4										7	27	4	18
	Field	0							1		2										3	12	3	14
Particles IV Non-starter	0km	0			1	2	1		1			2		1	1	1					10	39	6	27
	Field	0			1																1	4	0	0
Particles NRV Non-starter	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
MU O-ring damaged	0km	0				5															5	19	0	0
	Field	0				2															2	8	0	0
Shaft seal leaking	0km	0				1															1	4	0	0
	Field	0				1															1	4	0	0
Crack on cylinder head	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
Tappet spring broken	0km	0																			0	0	0	0
	Field	0									1										1	4	1	5
CH HP connector thread damaged	0km	0													1	1	1				3	12	3	14
	Field	0																			0	0	0	0
Assembly error (Handling error: tension pin missing)	0km	0											1								1	4	1	5
	Field	0																			0	0	0	0
Chemnitz pressure retaining test not OK, RB OK according to spec.	0km	1	1	2	1	3	7														15	58	0	0
	Field	0																			0	0	0	0
OK according to specification	0km	2													1						3	12	1	5
	Field	0			1	1	1														3	12	0	0
Prefinding EAD1 (not considered in the overall ppm view)	0km	0	1																		1	4	0	0
	Field	0		1																	1	4	0	0
Customer error	0km	0					2							3							5	19	3	14
	Field	0																			0	0	0	0
t.b.d.	0km	0														1					1	4	1	5
	Field	0																			0	0	0	0
Total all complaints	0km	4	1	2	2	13	10	0	1	0	4	2	1	4	3	3	1	0	0	0	51		19	
	Field	0	0	0	2	4	1	0	1	0	3	0	0	0	0	0	0	0	0	0	11		4	
total ppm-quota	ppm 0km	2,346	1,025	1,176	631	1,991	766	0	68	0	313	114	51	138	96	90	20	0	0	0		197		86
	ppm field	0	0	0	631	613	77	0	68	0	235	0	0	0	0	0	0	0	0	0		43		18
Total acknowledged complaints	0km	1	0	0	1	10	1	0	1	0	4	2	1	1	2	2	1	0	0	0	27		14	
	Field	0	0	0	1	3	0	0	1	0	3	0	0	0	0	0	0	0	0	0	8		4	
accepted ppm quota	ppm 0km	587	0	0	316	1,532	77	0	68	0	313	114	51	34	64	60	20	0	0	0		105		63
	ppm field	0	0	0	316	460	0	0	68	0	235	0	0	0	0	0	0	0	0	0		31		18

accepted complaints
new

Paynter Chart 0km and field failures CP4.1 for Chemnitz and Salzgitter plants (VW), FeP (Series)

IQIS GA20/21/40

Status: 10/20/2008 - Ca

Production period		Jan-Jun/07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	No of units 01/07 - 12/08	PPM total	No of units 01/08 - 12/08	PPM 2008
Supply Qty (..507/508) [redacted]		898	864	1,317	2,880	4,800	5,376	4,800	6,240	2,304	3,264	1,344	1,920	7,104	3,745	11,808	16,512	0	0	0	43,111		54,241	
Drivetrain damage / Turned tappet	0km	1				2					1										3	70	1	18
	Field	0																			0	0	0	0
Particles IV Non-starter	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
Particles NRV Non-starter	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
MU O-ring damaged	0km	0																			0	0	0	0
	Field	0				1															1	23	0	0
Shaft seal leaking	0km	0				1															1	23	0	0
	Field	0				1															1	23	0	0
Chemnitz pressure retaining test not OK, RB OK according to spec.	0km	1	1	2	1	3	7														15	348	0	0
	Field	0																			0	0	0	0
OK according to specification	0km	2																			2	46	0	0
	Field	0			1	1															2	46	0	0
Prefinding EAD1 (ignored in the overall ppm view)	0km	0	1																		1	23	0	0
	Field	0		1																	1	23	0	0
Customer error	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
t.b.d.	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
Total all complaints	0km	4	1	2	1	6	7	0	0	0	1	0	0	0	0	0	0	0	0	0	22		1	
	Field	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4		0	
total ppm-quota	ppm 0km	4,454	1,157	1,519	347	1,250	1,302	0	0	0	306	0	0	0	0	0	0	0	0	0		510		18
	ppm field	0	0	0	347	625	0	0	0	0	0	0	0	0	0	0	0	0	0	0		93		0
Total acknowledged complaints	0km	1	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5		1	
	Field	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2		0	
accepted ppm quota	ppm 0km	1,114	0	0	0	625	0	0	0	0	306	0	0	0	0	0	0	0	0	0		116		18
	ppm field	0	0	0	0	417	0	0	0	0	0	0	0	0	0	0	0	0	0	0		46		0

accepted complaints
new

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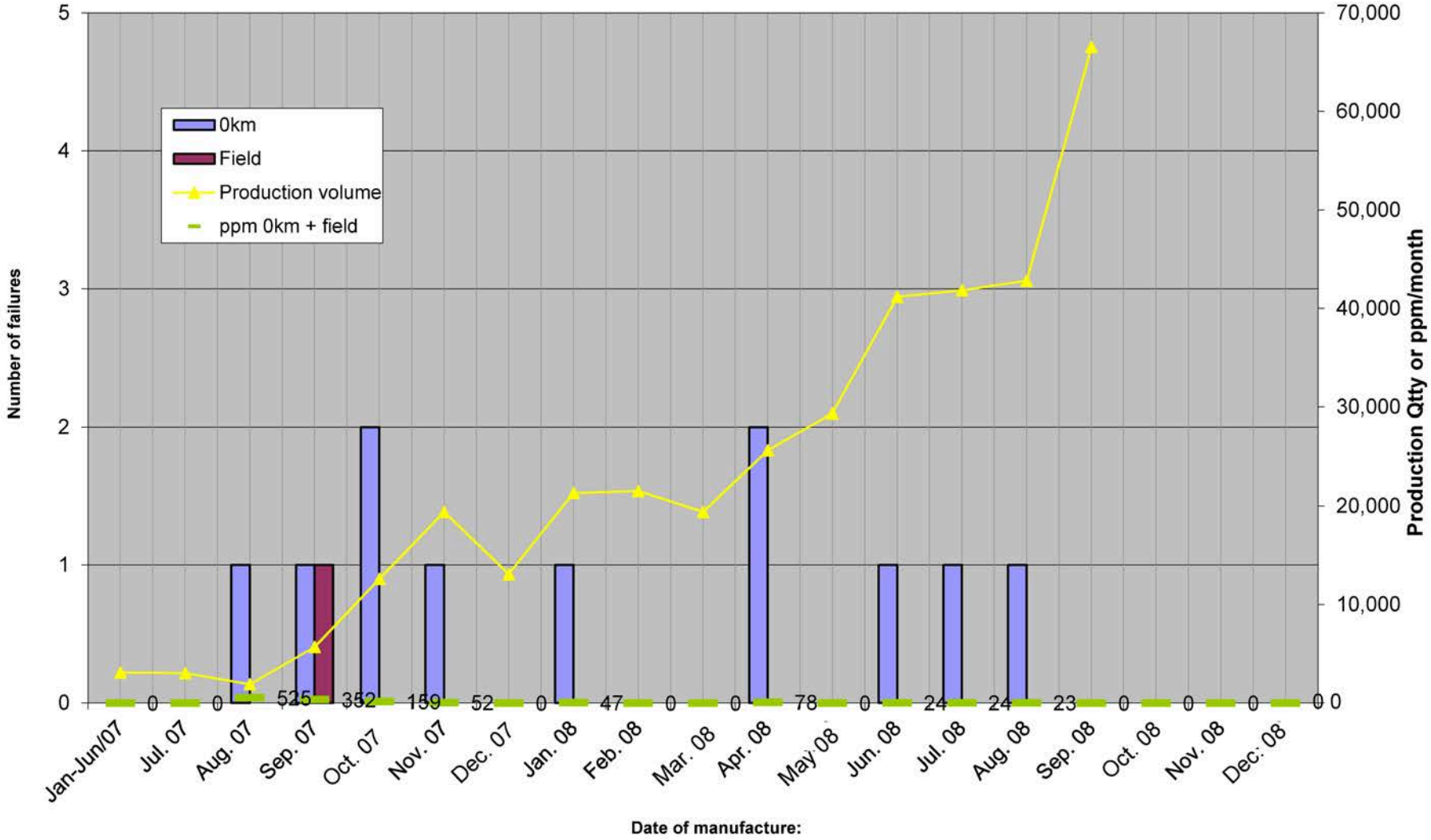
EA11003EN-01308[3]

Non-starter
CP4.1, CP4.2, all plants (VW and AUDI)



EA11003EN-01308[4]

ENTIRE PAGE CONFIDENTIAL

Paynter Chart 0km and field failures CP4.1 and CP4.2 for all plants (VW and AUDI), FeP (series)

IQIS GA20/21/40

Status: 10/20/2008 - [redacted]

Production period		Jan-Jun/07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	No of units 01/07 - 12/08	PPM total	No of units 01/08 - 12/08	PPM 2008
Production volume (..507/508/611)		3,084	3,023	1,905	5,678	12,594	19,392	13,073	21,312	21,504	19,392	25,637	29,381	41,184	41,845	42,816	66,533	0	0	0	368,353		309,604	
Drivetrain damage / turned tappet	0km	3			3	2					5	1			1						15	41	7	23
	Field	1				1			3	1	5	1									12	33	10	32
Particles IV Non-starter	0km	0			1	2	1		1			2		1	1	1					10	27	6	19
	Field	0			1																1	3	0	0
Particles NRV Non-starter	0km	0		1																	1	3	0	0
	Field	0																			0	0	0	0
MU O-ring damaged	0km	0				5															5	14	0	0
	Field	0				2															2	5	0	0
Crack on cylinder head	0km	0																			0	0	0	0
	Field	0			1		1			2											4	11	2	6
Shaft seal leaking	0km	0				1															1	3	0	0
	Field	0				1															1	3	0	0
Tappet spring broken	0km	0																			0	0	0	0
	Field	0									1										1	3	1	3
CH HP connector thread damaged	0km	0													1	1	2				4	11	4	13
	Field	0																			0	0	0	0
Assembly error (Handling error: tension pin missing)	0km	0											1								1	3	1	3
	Field	0																			0	0	0	0
[redacted] pressure retaining test not OK, RB OK according to spec.	0km	1	1	2	1	3	7														15	41	0	0
	Field	0																			0	0	0	0
OK according to specification	0km	2			1								1		1						5	14	2	6
	Field	0			1	2	1					1		1							6	16	2	6
Prefinding EAD1 (ignored in the overall ppm view)	0km	0	1																		1	3	0	0
	Field	0		1																	1	3	0	0
Customer error	0km	0					2							3							5	14	3	10
	Field	0							1												1	3	1	3
t.b.d.	0km	0														1	1				2	5	2	6
	Field	1																			1	3	0	0
Total all complaints	0km	6	1	3	6	13	10	0	1	0	5	3	2	4	4	3	3	0	0	0	64		25	
	Field	2	0	0	3	6	2	0	4	3	6	2	0	1	0	0	0	0	0	0	29		16	
total ppm-quota	ppm 0km	1,946	331	1,575	1,057	1,032	516	0	47	0	258	117	68	97	96	70	45	0	0	0		174		81
	ppm field	649	0	0	528	476	103	0	188	140	309	78	0	24	0	0	0	0	0	0		79		52
Total acknowledged complaints	0km	3	0	1	4	10	1	0	1	0	5	3	1	1	3	2	2	0	0	0	37		18	
	Field	1	0	0	2	4	1	0	3	3	6	1	0	0	0	0	0	0	0	0	21		13	
accepted ppm quota	ppm 0km	973	0	525	704	794	52	0	47	0	258	117	34	24	72	47	30	0	0	0		**100**		**58**
	ppm field	324	0	0	352	318	52	0	141	140	309	39	0	0	0	0	0	0	0	0		**57**		**42**
total non-starter complaints	0km	0	0	1	1	2	1	0	1	0	0	2	0	1	1	1	0	0	0	0	**11**		**6**	
	Field	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**		**0**	
PPM quota non-starter	ppm 0km	0	0	525	176	159	52	0	47	0	0	78	0	24	24	23	0	0	0	0	11	**30**	6	**19**
	ppm field	0	0	0	176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**3**	0	**0**
	ppm 0km+field	0	0	525	352	159	52	0	47	0	0	78	0	24	24	23	0	0	0	0	12	**33**	6	**19**

accepted complaints

new

0	0	528	159	0	0	0	0	258			41 #DIV/0!
0	0	0	79	0	0	141	47	258			33 #DIV/0!
0	0	176	159	52	0	47	0	0			27 #DIV/0!
0	0	176	0	0	0	0	0	0			3 #DIV/0!
0	525	0	0	0	0	0	0	0			3 #DIV/0!
0	0	0	0	0	0	0	0	0			0 #DIV/0!
0	0	0	397	0	0	0	0	0			14 #DIV/0!
0	0	0	159	0	0	0	0	0			5 #DIV/0!
0	0	0	0	0	0	0	0	0			0 #DIV/0!
0	0	176	0	52	0	0	93	0			11 #DIV/0!
0	0	0	79	0	0	0	0	0			3 #DIV/0!
0	0	0	79	0	0	0	0	0			3 #DIV/0!
331	1050	176	238	361	0	0	0	0			41 #DIV/0!
0	0	0	0	0	0	0	0	0			0 #DIV/0!
0	0	176	0	0	0	0	0	0			14 #DIV/0!
0	0	176	159	52	0	0	0	0			16 #DIV/0!
331	0	0	0	0	0	0	0	0			3 #DIV/0!
0	525	0	0	0	0	0	0	0			3 #DIV/0!
0	0	0	0	103	0	0	0	0			14 #DIV/0!
0	0	0	0	0	0	47	0	0			3 #DIV/0!
0	0	0	0	0	0	0	0	0			5 #DIV/0!
0	0	0	0	0	0	0	0	52			3 #DIV/0!
331	1575	1057	1032	516	0	47	0	258			174 #DIV/0!
0	0	528	476	103	0	188	140	309			79 #DIV/0!
109427	826668	186106	81963	26592	0	2202	0	13296			0 #DIV/0!
0	0	93053	37829	5318	0	8807	6488	15955			0 #DIV/0!
0	525	704	794	52	0	47	0	258			100 #DIV/0!
0	0	352	318	52	0	141	140	309			57 #DIV/0!

Rem.: Only 2 AUDI cases (non-starter; 507 DM04/08) added [6/6/08 [redacted]

Rem.: this page updated 16.6 [redacted]

Rem.: all pages updated 19.6 [redacted]

EA11003EN-01308[5]

ENTIRE PAGE CONFIDENTIAL

Paynter Chart 0km and field failures CP4.1 and CP4.2 for [non-responsive content removed] plant (AUDI), FeP (series)
IQIS GA20/21/40

Status: 10/20/2008 - [redacted]

Production period		Jan-Jun/07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	No of units 01/07 - 12/08	PPM total	No of units 01/08 - 12/08	PPM 2008
Supply Qty (..507/611) [redacted]		1,914	490	1,728	2,304	5,184	14,016	8,903	15,072	19,200	16,128	24,293	27,461	34,080	38,100	31,008	50,021	0	0	0	289,902		255,363	
Drivetrain damage / turned tappet	0km	2			3						4	1			1						11	38	6	23
	Field	1				1			3	1	5	1									12	41	10	39
Particles IV Non-starter	0km	0			1	2	1		1			2		1	1	1					10	34	6	23
	Field	0			1																1	3	0	0
Particles NRV Non-starter	0km	0		1																	1	3	0	0
	Field	0																			0	0	0	0
MU O-ring damaged	0km	0				5															5	17	0	0
	Field	0				1															1	3	0	0
Crack on cylinder head	0km	0																			0	0	0	0
	Field	0			1		1			2											4	14	2	8
Tappet spring broken	0km	0																			0	0	0	0
	Field	0									1										1	3	1	4
CH HP connector thread damaged	0km	0													1	1	2				4	14	4	16
	Field	0																			0	0	0	0
Assembly error (Handling error: tension pin missing)	0km	0											1								1	3	1	4
	Field	0																			0	0	0	0
Customer error	0km	0					2							3							5	17	3	12
	Field	0							1												1	3	1	4
OK according to specification	0km	0			1								1		1						3	10	2	8
	Field	0				1	1					1		1							4	14	2	8
t.b.d.	0km	0														1	1				2	7	2	8
	Field	1																			1	3	0	0
Total all complaints	0km	2	0	1	5	7	3	0	1	0	4	3	2	4	4	3	3	0	0	0	42		24	
	Field	2	0	0	2	3	2	0	4	3	6	2	0	1	0	0	0	0	0	0	25		16	
total ppm-quota	ppm 0km	1,045	0	579	2,170	1,350	214	0	66	0	248	123	73	117	105	97	60	0	0	0		145		94
	ppm field	1,045	0	0	868	579	143	0	265	156	372	82	0	29	0	0	0	0	0	0		86		63
Total acknowledged complaints	0km	2	0	1	4	7	1	0	1	0	4	3	1	1	3	2	2	0	0	0	32		17	
	Field	1	0	0	2	2	1	0	3	3	6	1	0	0	0	0	0	0	0	0	19		13	
accepted ppm quota	ppm 0km	1045	0	579	1736	1350	71	0	66	0	248	123	36	29	79	64	40	0	0	0		**110**		**67**
	ppm field	522	0	0	868	386	71	0	199	156	372	41	0	0	0	0	0	0	0	0		**66**		**51**

accepted complaints
new

EA11003EN-01308[6]

ENTIRE PAGE CONFIDENTIAL

Paynter Chart 0km and field failures CP4.1 for [Non responsive content removed] plant (AUDI), FeP (series)

IQIS GA20/21/40

Status: 10/20/2008 - [redacted]

Production period		Jan-Jun/07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	No of units 01/07 - 12/08	PPM total	No of units 01/08 - 12/08	PPM 2008
Supply Qty (..507) [redacted]		807	112	384	288	1,728	7,680	4,391	8,448	11,328	9,504	16,229	17,861	21,984	27,628	21,696	33,120	0	0	0	183,188		167,798	
Drivetrain damage / turned tappet	0km	0									3										3	16	3	18
	Field	0							1		2										3	16	3	18
Particles IV Non-starter	0km	0			1	2	1		1			2		1	1	1					10	55	6	36
	Field	0			1																1	5	0	0
Particles NRV Non-starter	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
MU O-ring damaged	0km	0				5															5	27	0	0
	Field	0				1															1	5	0	0
Crack on cylinder head	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
Tappet spring broken	0km	0																			0	0	0	0
	Field	0									1										1	5	1	6
CH HP connector thread damaged	0km	0													1	1	1				3	16	3	18
	Field	0																			0	0	0	0
Assembly error (Handling error: tension pin missing	0km	0											1								1	5	1	6
	Field	0																			0	0	0	0
OK according to specification	0km	0													1						1	5	1	6
	Field	0					1														1	5	0	0
Customer error	0km	0					2							3							5	27	3	18
	Field	0																			0	0	0	0
t.b.d.	0km	0														1					1	5	1	6
	Field	0																			0	0	0	0
Total all complaints	0km	0	0	0	1	7	3	0	1	0	3	2	1	4	3	3	1	0	0	0	29		18	
	Field	0	0	0	1	1	1	0	1	0	3	0	0	0	0	0	0	0	0	0	7		4	
total ppm-quota	ppm 0km	0	0	0	3,472	4,051	391	0	118	0	316	123	56	182	109	138	30	0	0	0		158		107
	ppm field	0	0	0	3,472	579	130	0	118	0	316	0	0	0	0	0	0	0	0	0		38		24
Total acknowledged complaints	0km	0	0	0	1	7	1	0	1	0	3	2	1	1	2	2	1	0	0	0	22		13	
	Field	0	0	0	1	1	0	0	1	0	3	0	0	0	0	0	0	0	0	0	6		4	
accepted ppm quota	ppm 0km	0	0	0	3472	4051	130	0	118	0	316	123	56	45	72	92	30	0	0	0		**120**		**77**
	ppm field	0	0	0	3472	579	0	0	118	0	316	0	0	0	0	0	0	0	0	0		**33**		**24**

accepted complaints
new

EA11003EN-01308[7]

ENTIRE PAGE CONFIDENTIAL

Paynter Chart 0km and field failures CP4.2 for [redacted] plant (AUDI), FeP (series)
IQIS GA20/21/40

Status: 10/20/2008 [redacted]

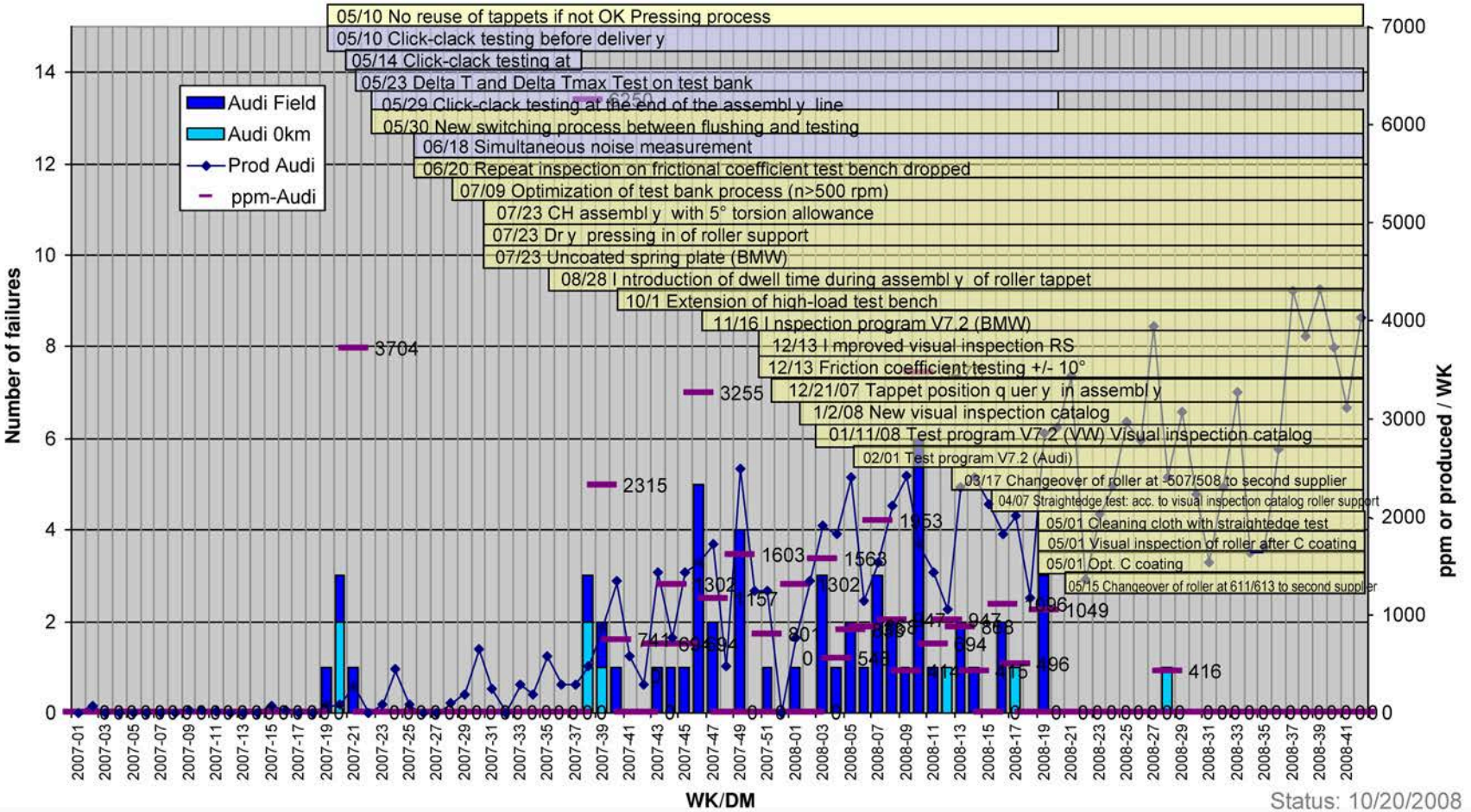
Production period		Jan-Jun/07	Jul 07	Aug 07	Sept 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	No of units 01/07 - 12/08	PPM total	No of units 01/08 - 12/08	PPM 2008
Supply Qty (611) to [redacted]		1,107	378	1,344	2,016	3,456	6,336	4,512	6,624	7,872	6,624	8,064	9,600	12,096	10,472	9,312	16,901	0	0	0	106,714		87,565	
Drivetrain damage / turned tappet	0km	2			3						1	1			1						8	75	3	34
	Field	1				1			2	1	3	1									9	84	7	80
Particles IV Non-starter	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
Particles NRV Non-starter	0km	0		1																	1	9	0	0
	Field	0																			0	0	0	0
MU O-ring damaged	0km	0																			0	0	0	0
	Field	0																			0	0	0	0
Crack on cylinder head	0km	0																			0	0	0	0
	Field	0			1		1			2											4	37	2	23
CH HP connector thread damaged	0km	0															1				1	9	1	11
	Field	0																			0	0	0	0
OK according to specification	0km	0			1								1								2	19	1	11
	Field	0				1						1		1							3	28	2	23
Customer error	0km	0																			0	0	0	0
	Field	0							1												1	9	1	11
t.b.d.	0km	0															1				1	9	1	11
	Field	1																			1	9	0	0
Total all complaints	0km	2	0	1	4	0	0	0	0	0	1	1	1	0	1	0	2	0	0	0	13		6	
	Field	2	0	0	1	2	1	0	3	3	3	2	0	1	0	0	0	0	0	0	18		12	
total ppm-quota	ppm 0km	1,807	0	744	1,984	0	0	0	0	0	151	124	104	0	95	0	118	0	0	0		122		69
	ppm field	1,807	0	0	496	579	158	0	453	381	453	248	0	83	0	0	0	0	0	0		169		137
Total acknowledged complaints	0km	2	0	1	3	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	10		4	
	Field	1	0	0	1	1	1	0	2	3	3	1	0	0	0	0	0	0	0	0	13		9	
accepted ppm quota	ppm 0km	1,807	0	744	1,488	0	0	0	0	0	151	124	0	0	95	0	59	0	0	0		**94**		**46**
	ppm field	903	0	0	496	289	158	0	302	381	453	124	0	0	0	0	0	0	0	0		**122**		**103**

accepted complaints

new

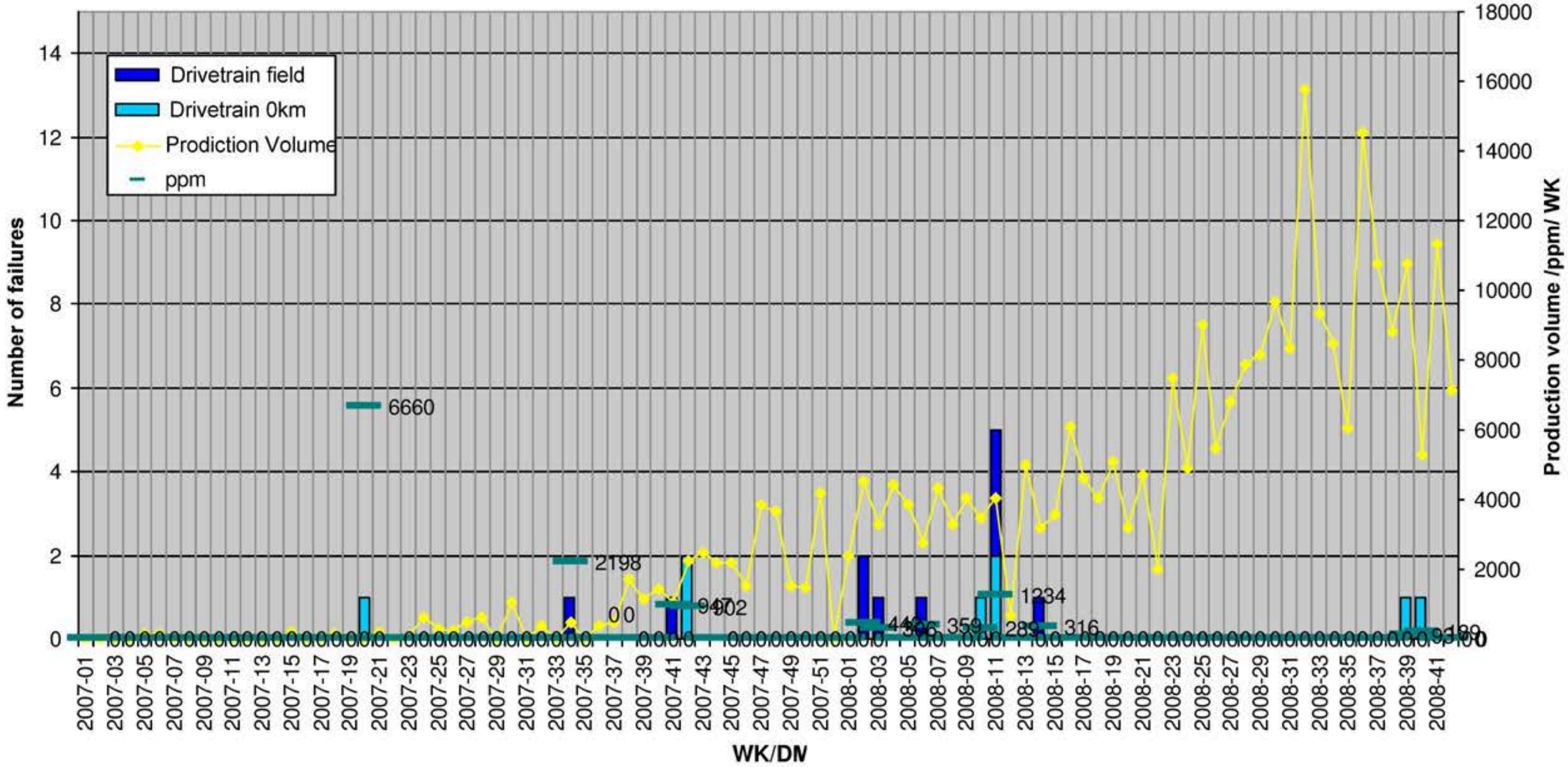
ENTIRE PAGE CONFIDENTIAL

Confirmed pump drivetrain damages Audi/VW/ CP4.2



Status: 10/20/2008

Confirmed pump drivetrain damages Audi/VW/ CP4.1

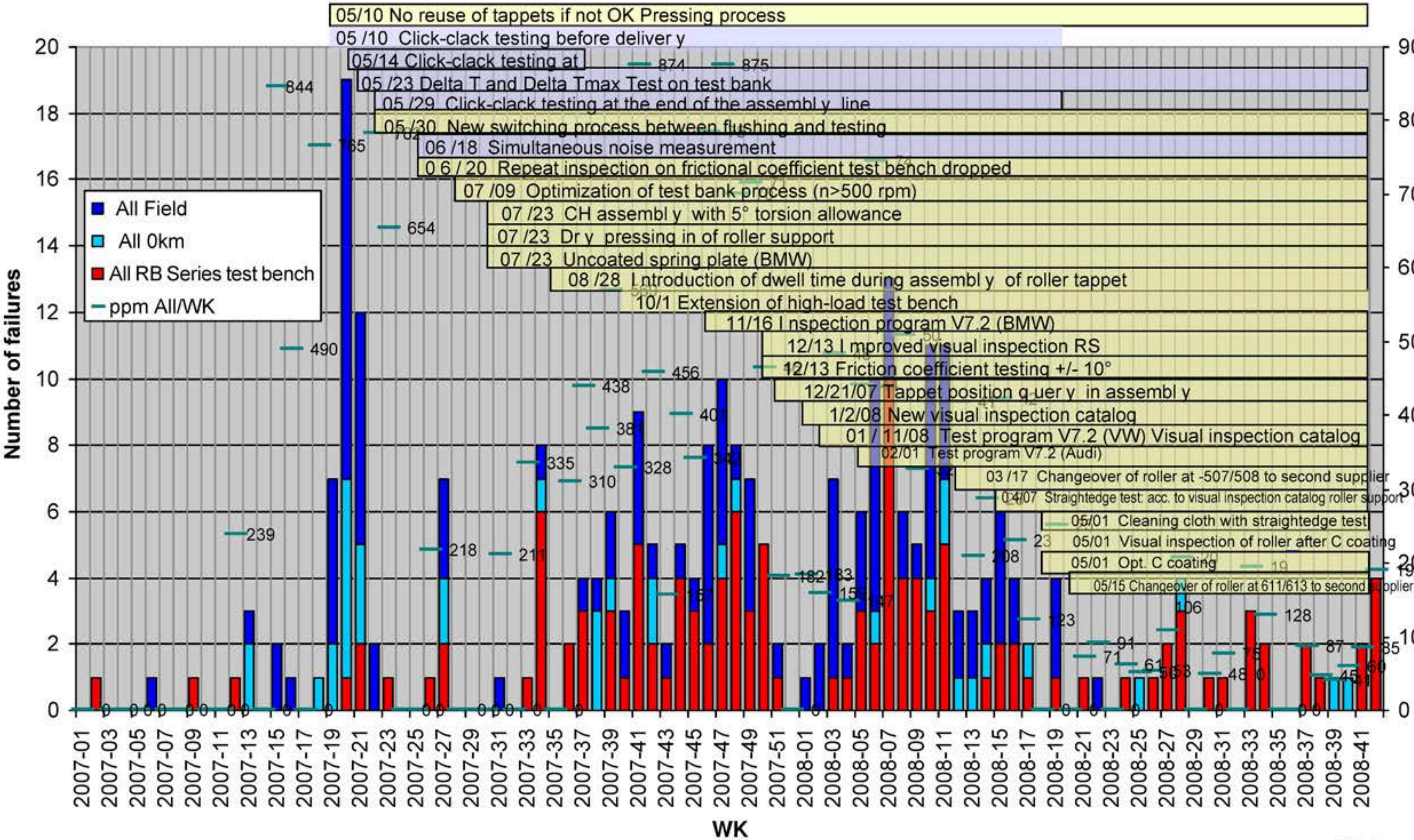


Status: 10/20/2008

BOSCH

ENTIRE PAGE CONFIDENTIAL

Confirmed pump drivetrain damages - all customer



Status: 10/20/2008

BOSCH

Production activities to reduce drivetrain failures

1) Metal spraying on roller support (RS)

1.1) Avoidance of metal splashes

Graphite/boron nitride covering on holders in C layer coating system

• Test new plant	WK36, done
• 2-day production/major trial	WK42, done
• After positive test, planned implementation	after customer approval WK48

BOSCH

Activities to reduce drivetrain damage

Status: 11/4/2008

Result of 2-day production:

➔ Target number of units in 2 batches: 2880 RS

➔ No metal spatters found

➔ Other error symptoms with usual series failure rate

➔ **No striking features with the new plant**

Status of 2 x 500h ER: ➔ No items of note

➔ **Summary:**

Series capability of new coating plant proven, plant can be released subject to customer approval. Proof of actual metal spatter impact only possible through series launch

Activities to reduce drivetrain damage

1.2) Recognizing metal spraying

Feasibility study for objective measurement processes WK36, done

Two quotations for camera monitoring in progress, major trial under series conditions required for evaluation purposes (avoidance of pseudo scrap)

Ordering of preferred solution for FeP made WK44, done

Implementation then scheduled for 09/04

2 visual inspections used at present (after finishing or frictional coefficient test)

<u>Status 11/04/2008:</u>

➔ Camera system was ordered

➔ Commissioning planned by late April 2009

➔ 1st stage: manual assessment; 2nd stage: automatic assessment

➔ Problem: Washing residues result in pseudo scrap

Production activities to reduce drivetrain failures

2) Avoidance of C layer removal during washing/transport roller

New washing/transport frame with changed roller bore imaging

- First 100 — WK40, done
- Complete changeover, modification complete — WK44, done

3) Avoidance of C layer removal during pressing, RS in tappet body TB

Flaking particles of from the C layer on RS are transferred during frictional coefficient measurement and can lead to early damage. The following potential remediation measures are currently being assessed:

- Optimization of C layer adhesion
- Avoidance of C coating

Production activities to reduce drivetrain failures

Schedule of activities: C particle transfer to roller support

3.1) Examination of one batch of RS (480) prior to Press-in process ➔ Striking features, flaking, peculiarities under microscope — WK44, done.

Result:

- ➔ Of 480 analyzed parts, the following was found:
- ➔ 16 x C layer bulge
- ➔ 1x flaking, approx. 1000µm, with additional potential for flaking at the edge and on the surface
- ➔ Additional flaking < 1000µm without further potential for flaking

Summary: C layer flaking potential present on front surface

Production activities to reduce drivetrain failures

Schedule of activities: C particle transfer to roller support

3.2) Feasibility study for "brushing" RS surface (after C coating) — WK44, done

Preliminary status 11/04/2007

➔ Tests carried out, negative so far due to abrasive damage of RS edge through brush

➔ Further tests necessary, final results — WK48

Production activities to reduce drivetrain failures

Schedule of activities: C particle transfer to roller support

3.3) Carry out analysis of identified C layer bulges of an FIP cross-section — WK44, done

Status 11/04/2008:

C layer bulges are coated, ultra-fine burrs that are still present after the OTEC process, but originate from the soft processing operation for the RS.

The C layer does not adhere to the bulge, either because there is no firm undercoat or because the scale layer from the hardening process cannot be finished down there.

Summary: C layer flaking potential present on front surface

Production activities to reduce drivetrain failures

Schedule of activities: C particle transfer to roller support

3.4) Change to RS gripping tool when pressing in the tappet body ➔ Smaller support surface, better coverage — WK48

3.5) Feasibility study for elimination of coating from RS surface — WK48

To date, 5 concepts for covering unnecessary C layer areas on the roller support are present, but were not considered effective.
Final assessment by

WK 48

BOSCH

Production activities to reduce drivetrain failures

4) Avoiding “fusing” on roller.

Currently there are two solution approaches being considered:

a) Improvement of roller contact through resilient contact plate

b) Direct alignment of the rollers (”stack of wood”) for improved contact. Solution b) is favored; if positive impact, implement by WK 48

Currently there are 2 x straightedge tests used to positive effect, (the 2nd test only turned up isolated parts)

Status: 11/4/2008:

- ➔ 2 sample holders produced / available
- ➔ First coating batch on 11/04/08 with dummy parts, result WK45
- ➔ Additional partial batches with series parts
- ➔ Series changeover not feasible in WK48; revise schedule WK48

EA11003EN-01312[0]

ENTIRE PAGE CONFIDENTIAL

From: Non-responsive content removed
To:
CC:

Date: 2/4/2009 2:31:00 PM
Subject: ANS: New testing point
Attachments: FEA_035_2009_01_26_Neuer Prüfpunkt_0445010611_Audi_V2.pdf
EHC_0569_[redacted], Druck vs. Drehzahl mit Sonderprüfpunkt, 28-01-2009.ppt

Hello Non-responsive content removed

Sometimes I allow myself the luxury of having lunch from 12-12:45 PM; that's why you didn't reach me at 12:07 PM.
;-)
But all joking aside!

I insist that the intensified testing point be presented on Tuesday!
If there is a residual risk here, we have to point it out directly to the attendees, who have to (help) decide whether it will be introduced.
Non-responsive content removed **and I don't make the decisions ourselves in any case!**
We and our bosses have a great deal of experience with such processes and can assess the risk very well when we have the facts.
Proposal for obtaining additional facts:
Audi immediately donates 143 finished pumps (from empties returns) for a second major trial (at the weekend, for example).
And Bosch assesses these pumps by 02/10/09.
That would be a fast measure on Bosch's behalf that would show that they are continuing to work intensively on the drivetrain damage topic, and could result in a rapid decision (for example, major trial 1 month = 10,000 units).
Please prepare the changed test program with +23 sec., so we can start the major trial together on 10/02/09, if applicable.

Do you agree !?

P.S.: Please add in the overheads (attachment 1)the permissible pressure speed diagram from a drivetrain like that from a 2000 bar pump, not from an 1800 bar pump (attachment 2). Then the testing point will no longer be so far from the borderline. It would also be good to work in the staged crash program somewhere, 500 bar with 4,000 rpm, up to 2,200 bar with 4,000 rpm.

Best regards

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From: Non-responsive content removed
Sent: Wednesday, February 04, 2009 12:13 PM
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Subject: New testing point

Hello Non-responsive content removed

Please find attached the overheads presented by Non-responsive content removed during the last drivetrain conference call.

<<FEA_035_2009_01_26_Neuer Prüfpunkt_0445010611_Audi_V2.pdf>>

Hello Non-responsive content removed
Unfortunately, I was unable to reach you by phone today.
During the internal meeting yesterday, there were different opinions as to whether this new testing point can be presented as a possible measure during Non-responsive content removed visit, or whether it would be better to deal with this subject the next day at the CP4 TM.

Thank you.

Best regards

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Robert Bosch GmbH

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Special testing point

Opportunity:

Intensified functional check of reduced lubrication gap between roller & roller support

-> Borderline parts result in drivetrain damage in pump.

Residual risk:

Preliminary damage of pump & failure (0km) at customer's

Activity:

Simulation & comparison of lubrication gap heights between roller support & roller

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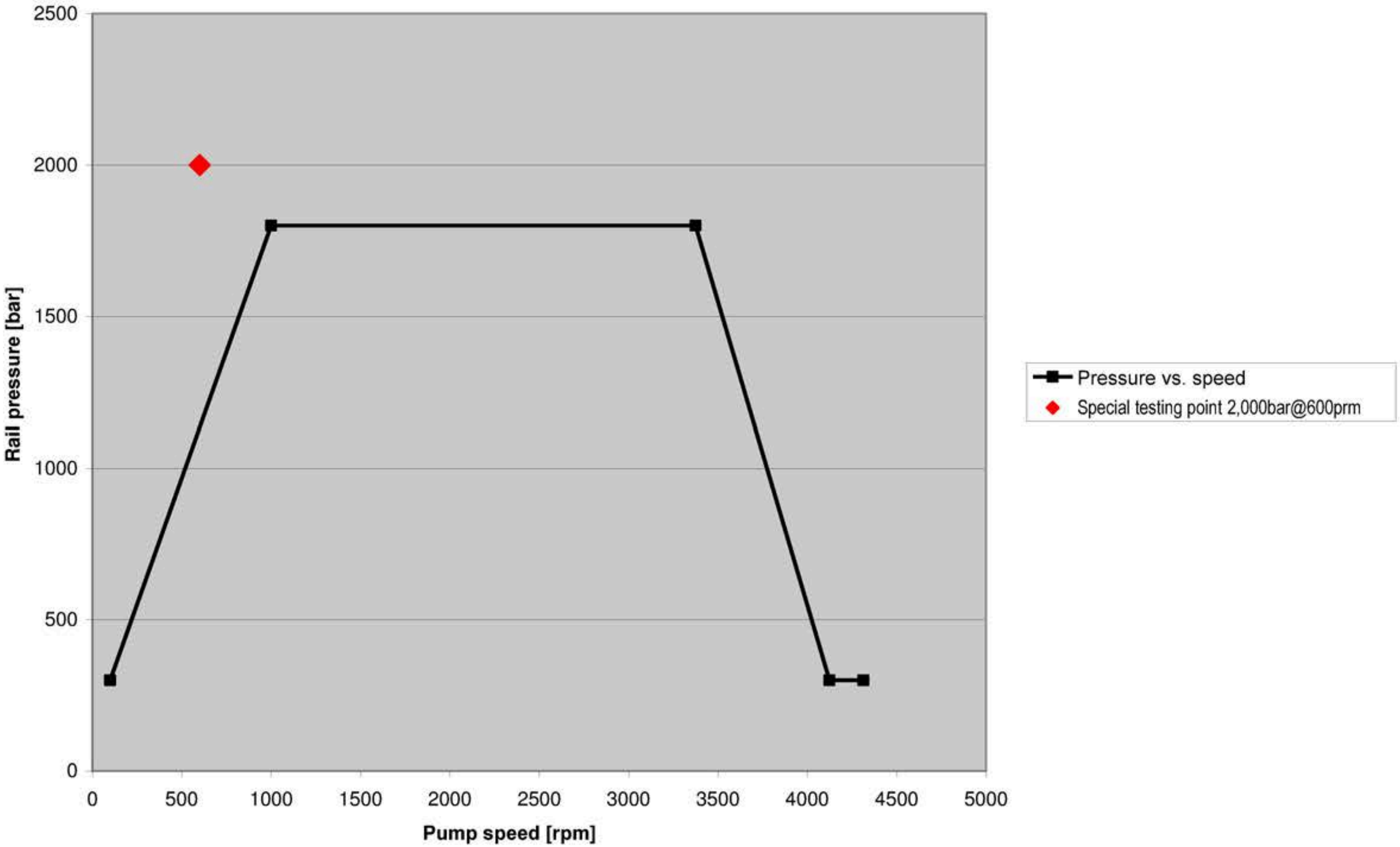
Pressure vs. speed chart

Special inspection point 2000bar@600rpm



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EA11003EN-01314[0]

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FEA_035_2009_01_26_Crashprogramm 0445010611_V2

Situation:

➔ By adding an additional testing point, to represent the critical (minimum) status of the expected lubrication gap between roller and RS, we must test whether
pumps fail due to this point in series that otherwise do not fail unless subject to other critical operating conditions in the field (fuel).

➔ The new testing point (n= 600 and 2000bar) lies far outside currently allowed specifications and will be added after the current TCD point, n=2438 and 1700 bar.

➔ The timing extension in series amounts to approx. 23 seconds.

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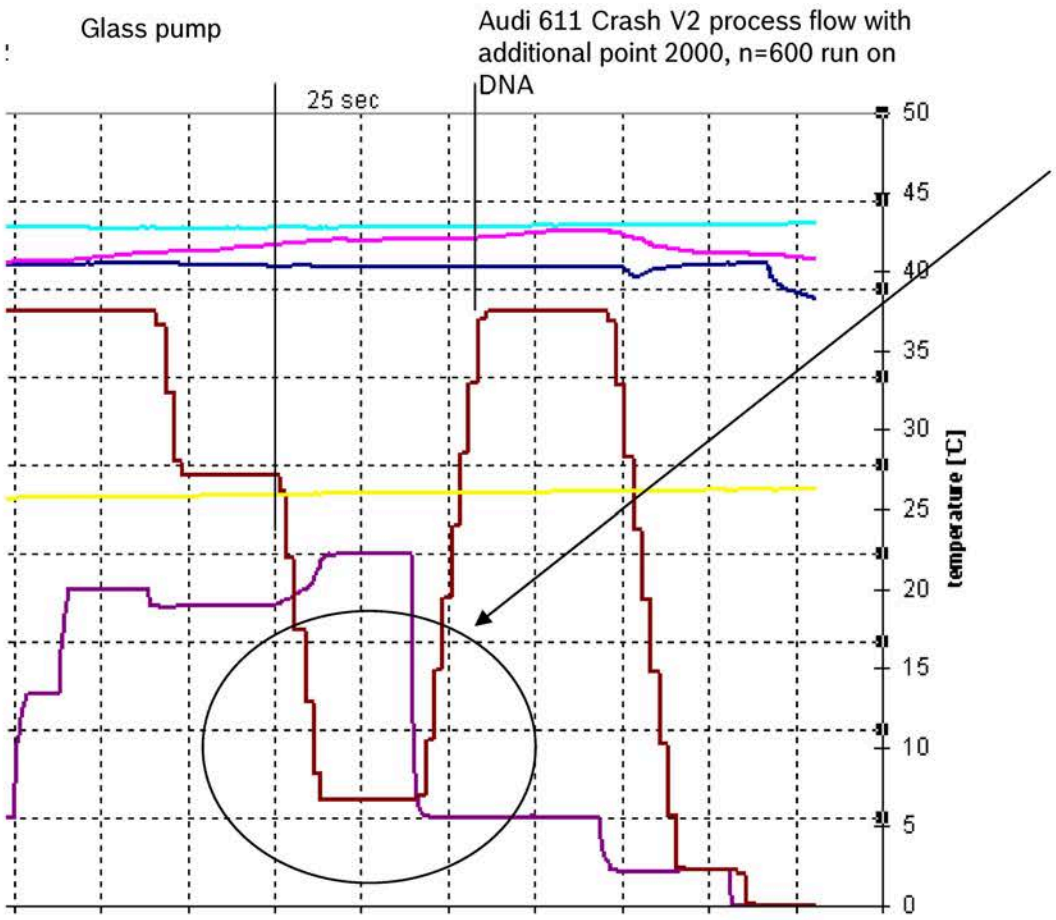
FEA_035_2009_01_26_Crashprogramm 0445010611_V2



New testing point, n=600, 2000 bar, timing increase, approx. 23 sec.

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FEA_035_2009_01_26_Crashprogramm 0445010611_V2

Verification:

➔To date, 23 pumps (twin pistons) run with even more extreme staged crash program V1

➔Of which 1x drivetrain damage, but due to incorrect assembly of tappet body (assembly was trial, not in series) ➔ In the other pumps, despite extreme load, no preliminary damage was discernible.

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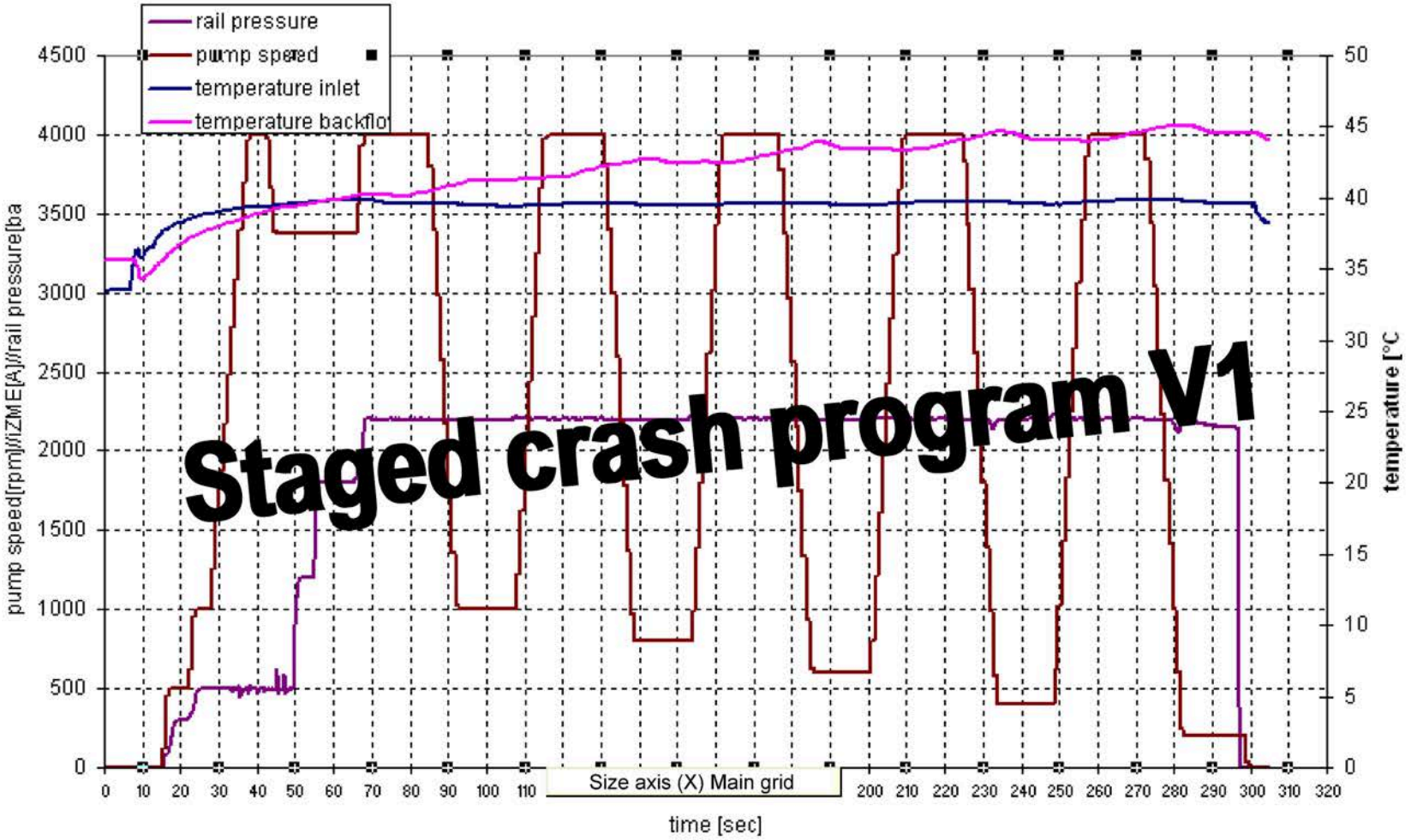
FEA_035_2009_01_26_Crashprogramm 0445010611_V2



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FEA_035_2009_01_26_Crashprogramm 0445010611_V2

Further action:

➔ Through special release with customer approval, integrate in 611 series process flow for the month of February; due to capacity problems, it will probably no longer be possible to do the extra test of this point after this date.

➔ Analysis of whether pumps fail in this testing point

➔ Beyond this period, due to capacity restrictions, this additional testing point can only be retained if compensated by the elimination of other testing points. The feasibility of this has not been verified to date.

Risk: Preliminary damage by the additional testing point cannot be ruled out 100%.

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Paynter Chart 0 km and field failures CP4.1 for all plants (VW and AUDI), FeP (series)
IQIS GA20/21/40

Status: 5/29/2009 [redacted]

Production period		Total200 6	Jan-Jun/07	Jul-Dec/07	Jan 0 8	Feb 08	Mar 08	Apr 0 8	May 08	Jun 08	Jul 08	Aug 0 8	Sept 08	Oct 08	Nov 0 8	Dec 08	Jan 0 9	Feb 09	Mar 09	Apr 0 9	May 09	No of units 01/07-01/09	PPM total
Total supply Qtty to [redacted] Non-responsive content removed			1,705	34,620	14,688	13,632	12,768	17,573	19,781	29,088	31,373	33,504	49,632	41,856	37,536	25,390	55,713	28,992	43,392	20,928	0	512,171	
Drivetrain damage / turned tappet	0km		1	2		1	4	1					2	4	3		1					19	37
	Field		0	3	6	1	3	5	1					2								21	41
Particles IV Non-starter	0km		0	5	1			2		1	1	1	1		1		1		1			15	29
	Field		0	1		1						1					1					4	8
Particles NRV Non-starter	0km		0																			0	0
	Field		0																			0	0
MU O-ring damaged	0km		0	6																		6	12
	Field		0	3																		3	6
Shaft seal leaking	0km		0	1								1										2	4
	Field		0	1																		1	2
Crack on cylinder head	0km		0																			0	0
	Field		0																			0	0
Tappet spring broken	0km		0																			0	0
	Field		0				1															1	2
CH HP connector thread damaged	0km		0								1	1	1	1			1	1				6	12
	Field		0																			0	0
Assembly error (Handling error: tension pin missing)	0km		0						1													1	2
	Field		0									1										1	2
MU error (welding plates missing)	0km		0																			0	0
	Field		0																			0	0
MU leaking (inner ring crushed)	0km		0																			0	0
	Field		0		1																	1	2

ENTIRE PAGE CONFIDENTIAL

Paynter Chart 0 km and field failures CP4.2 for [redacted] plant (AUDI), FeP (series)
IQIS GA20/21/40/70

Status: 5/29/2009 - [redacted]

Production period		Total2006	Jan-Jun/07	Jul-Dec/07	Jan 0 8	Feb 08	Mar 08	Apr 0 8	May 08	Jun 0 8	Jul 0 8	Aug 0 8	Sept 08	Oct 08	Nov 0 8	Dec 08	Jan 0 9	Feb 09	Mar 09	Apr 0 9	May 09	No of units 01/07- 01/09	PPM total
Supply Qty (611/613) to [redacted]			1,107	18,042	6,624	7,872	6,624	8,064	9,600	12,096	10,472	9,312	16,901	13,632	11,232	4,131	9,793	8,352	12,096	11,664	0	177,614	
Drivetrain damage / Turned tappet	0km		2	3			1	1			1											8	45
	Field		2	34	16	16	11	10	6	1	3	1			3	2		1				106	597
Particles IV Non-starter	0km		0													1			1			2	11
	Field		0																			0	0
Particles NRV Non-starter	0km		0	1																		1	6
	Field		0																			0	0
MU O-ring damaged	0km		0																			0	0
	Field		0																			0	0
Shaft seal leaking	0km		0																			0	0
	Field		0																			0	0
Crack on cylinder head	0km		0																			0	0
	Field		0	2		2																4	23
Tappet spring broken	0km		0																			0	0
	Field		0																			0	0
CH HP connector thread damaged	0km		0										1									1	6
	Field		0																			0	0
Assembly error (Handling error: tension pin missing	0km		0																			0	0
	Field		0																			0	0
MU error (welding plates missing)	0km		0																			0	0
	Field		1																			1	6
MU leaking (inner ring crushed)	0km		0																			0	0
	Field		0																			0	0

Paynter Chart 0 km and field failures CP4.1 for all plants (VW and AUDI), JhP (series)

IQIS GA20/21/40

Status: 5/1/2008 [redacted]

Production period		Jan 08	Feb 08	Mar 08	Apr 08	May 08	Jun 08	Jul 08	Aug 08	Sept 08	Oct 08	Nov 08	Dec 08	Jan 09	Feb 09	Mar 09	Apr 09	May 09	No of units 01/07-01/09	PPM total
Total supply Qty to [redacted]		0	13,168	18,608	27,360	26,688	28,224	19,584	30,432	37,353	39,840	24,386	11,236	27,266	18,534	25,539	24,576	0	372,794	
Drivetrain damage / turned tappet	0km																		0	0
	Field			1															1	3
Particles IV Non-starter	0km		2				4								1				7	19
	Field																		0	0
Particles NRV Non-starter	0km														1				1	3
	Field																		0	0
MU O-ring damaged	0km																		0	0
	Field																		0	0
Shaft seal leaking	0km																		0	0
	Field			1	1														2	5
Crack on cylinder head	0km																		0	0
	Field																		0	0
Pump piston seized	0km				1	1	3		1										6	16
	Field																		0	0
Piston spring broken	0km																		0	0
	Field				1														1	3

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Paynter Chart 0 km and field failures CP4.2 for [redacted] plant (AUDI), JhP (series)

IQIS GA20/21/40/70

Status: 5/1/2008 - [redacted]

Production period		Jan 09	Feb 09	Mar 09	Apr 09	May 09	Jun 09	No of units 01/07- 01/09	PPM total
Supply Qty (611) to [redacted]		0	960	960	960	0	0	2,880	
Drivetrain damage / turned tappet	0km							0	0
	Field							0	0
Particles IV Non-starter	0km							0	0
	Field							0	0
Particles NRV Non-starter	0km							0	0
	Field							0	0
MU O-ring damaged	0km							0	0
	Field							0	0
Shaft seal leaking	0km							0	0
	Field							0	0
Crack on cylinder head	0km							0	0
	Field							0	0
Pump piston seized	0km							0	0
	Field							0	0
Piston spring broken	0km							0	0
	Field							0	0

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Pump piston seized

Scope of defect

- 0km: 1x pump 0445010507/ 03L130755
- Mileage: 5 km
- DM: 5/10/2009 (serial no.: 04-0074)
- QTS: 3356625 (4VW205 – GR: 5/28/2009)
- VIN: WAUZZZ8R3AA[redacted]

Description of problem

- HPP does not build up any pressure

Root-cause analysis

- Pump piston seized in cylinder head
- Procedure
  - Cylinder head removed
  - Dimension test of pump piston: Out-of-roundness from grinding process

Immediate measures in piston production

- 5/7/2009 100% gauge insertion check
- 05/14/09: refined 100% gauge insertion check
- Analysis of grinding process is running

Fig. 1: Type plate

Fig. 2: Cylinder head with seized pump piston

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CP4.x – Customer complaints AUDI

Non-responsive content removed Plant

Pump piston seized

Risk assessment

- Increased internal failures with piston seizures in the period 04/24 - 05/19/09 (pump DM) in RB function test (see table)
- Batch releases had no striking features

- Piston production quantity: approx. 60,000 units
- Internal failures in above period: 28 units

→ 467 ppm, compared to 30 ppm in the remaining period

- Failure behavior
  - Early failures in engine and/or vehicle based on series experience at JhP in 2008:
    - Back then 6x 0km failures at engine plant, 0x field failures
    - Comment: other cause (groove) with same effect/defect mechanism

- Assessment

Max. 2 further failures must be expected

Internal failures, all customers	
DM	Units
Jan 09	2
Feb 09	2
Mar 09	3
04/24-27/09	14
05/04-11/09	12
5/19/2009	2

Image 3: disassembled seized piston

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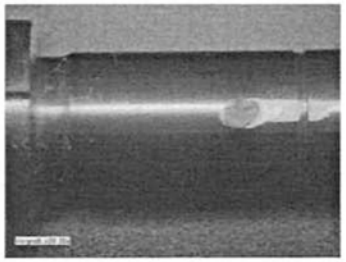
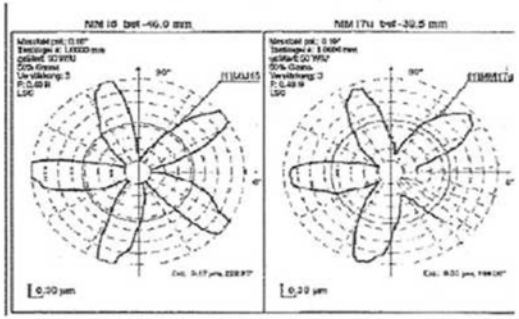
CP4 piston seizure

0km failures at Audi+VW (2+1) and other OEM (1x) in listed period

They were due to external cylindrical grinding of the pump pistons in the form of roundness defects

Nom.: 0.7 µm Actual-failure parts to 3.38 µm





Back

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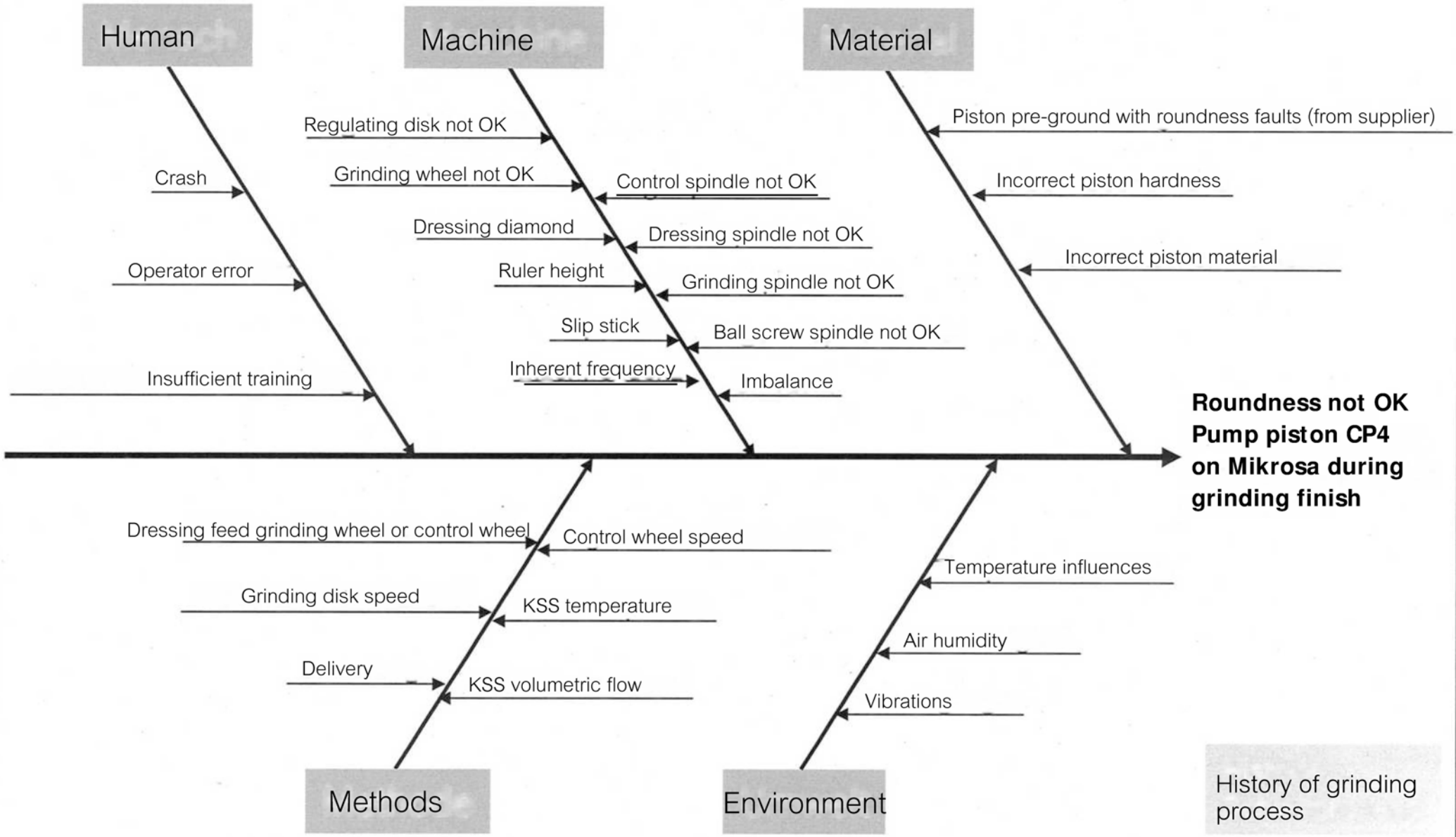
CP4 piston seizure - Ishikawa



History of grinding process

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Grinding of CP4 pump piston

Further procedure		
100% check for pump piston roundness	R	D
1. adjustment to existing measurement equipment	Non-responsive content removed	
2. Introduction of tactile measurement		Write quotations to 6/19/2009
3. 100% gauge insertion testing since 05/14/09:		
3.1 with measurement rings instead of cylinder head		
3.2 with one measurement ring for each CH class		
Investigate variances in coolant pressure		06/20
Representation of batch releases since 2008		06/19
Process capability examination before/after		
Quality loss		06/19

Audi requirement: Install pump pistons from [redacted]

Situation:

Demand from Audi ([redacted: Non-responsive content removed], due to 0km failures with seized pistons, to only install pistons from JhP in Audi products in FeP and in the whole manufacturing network, until the effectiveness of the implemented measures is proven.

Due to the shared part numbers in Audi/VW products, a separate, targeted routing of JhP pistons to only Audi products is not possible, **which means all VW and Audi products have to be switched over to JhP pistons.**

Due to pump piston capacities at JhP and FeP and the distribution to individual customers, a 100% changeover is not possible.

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Audi requirement: Install pump pistons from JhP

Recommendation:

➔ Continued mixed installation of pump pistons is allowed

➔ In FeP, a CH pre-assembly line will be equipped with only JhP pistons for Audi/VW products (preference line)

➔ All pump pistons that exceed in-house requirements at JhP will be delivered to FeP and installed in Audi/VW products here.

➔ According to current estimations (JhP closing in WK 31+32),
this means JhP = 100% JhP pistons
FeP = approx. 50% JhP pistons
in Audi/VW products

➔ This process can only be changed again after a joint decision

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		OPL Task force "CP4 piston seizure" from 06/10/09		
Seq No.	**Task from**	**Discussion item / measure**	**R**	**D**
1	TF-WDT 6/10/2009	Regular internal reporting - Set up recurring date, weekly, next meeting in WK 25 *(Management Review DS/QMM, FeP/...)* *"Illegible" on site* Regular reporting to customer. All customer documents go through QMM3	Non-responsive content removed	06/15 Seq.
2	TF-WDT 6/10/2009	In the illustrated process flow (slide 1), the gauge insertion testing and all in-series tests must be added; supplement 100% functional test		06/15
3	TF-WDT 6/10/2009	Representation of failures per day through piston DM (example: injector) *Visualization on site* Failures: 1. Direct failures on Mikrosa Stotz 2. Failures during gauge insertion check 3. Failures in function tests Show introduced measures as flags Establish process capability proof of the relevant characteristics during the failure period, including for the cylinder head		06/17 06/17
4	TF-WDT 6/10/09	The ongoing series measurements must be intensified: 2 checks every 2 hours instead of 1 check every 2 hours Create concept, proposals for near-workshop measurement equipment: 4.1 Modify [redacted] measurement equipment from VE for roundness measurement 4.2 Commissioning of [redacted] *(tactile measurement between 2 hollow tips)*		06/18 06/19 06/23
5	TF-WDT 6/10/09	--> *Roundness defect over 2.5 µ ... "Illegible"* How reliable is the gauge insertion check with regard to detection of the known roundness defects?		06/17
6	TF-WDT 6/10/09	Get subsequent measurements of failed parts from seized JhP pistons from [redacted] -- *Rounding error open*		06/17
7	TF-WDT 6/10/09	Proof of roundness errors through intentional manipulation of process parameters; create concept *A test schedule has been drawnup.**		06/17
8	TF-WDT 6/10/09	Stotz Mikrosa measurement technology; check enhancement/modification to detect roundness defects *- Quotation company "Illegible" to "Illegible"*		06/17
9	TF-WDT 6/10/09	Check roundness PK's 1. Get offers from Stotz + technical discussion 2. Involve TEF Mr. Rapp and Mr. Fritz due to tactile measurement 3. Tightening of gauge insertion check: - With measurement rings instead of CHs - One measurement ring for each CH class		06/17 06/16/09 06/18 *07/10/09*
10	TF-WDT 6/10/09	Investigate variances in cooling oil pressure		06/18
11	TF-WDT 6/10/09	Batch release measurements from 2008 to 06/2009 (roundness + 1x MM to be defined)		06/18
12	TF-WDT 6/10/09	Process capability examination before/after critical period		06/18
13	Customer	Vibration analysis Involve Non-responsive content removed		
14				
15				
16				
17				
18				
19				
20				

Deadline: Wednesday 1:00 PM - 2:00 PM

Status: 6/22/2009

done
done
done
done
done
done
done
done
done
done

** Test execution dependent on availability of micros*
Target: release of "illegible"micros"illegible" to gain time for tests here.

EA11003EN-01323[6]

23/06/09

Schwingungsanalyse MIKROSA 1

1. Zeichnungen vom mechanischen Aufbau [Lagerungen, Führungen, NC-Achsen ...]
2. Geometrie SS, RS, Linear, Werkstück
3. Prozessdaten
4. Mögliche Fehlerbilder → Messprotokoll
5. Nach punkt 4. → Festlegung Messungen die durchzuführen sind
6. Vor Ort Messen / Schwingungsanalyse
7. Messergebnisse

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V	T	
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	24/06/2009	
	24/06/09	
	23/06/2009	
	02/07/2009	
	09/07/2009	
	M/07/2009	

Handwritten texts:
"illegible"/23/09 Non-responsive content removed

Vibration analysis Mikrosa 1

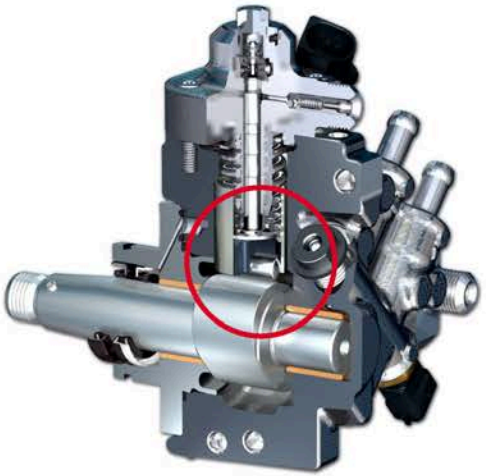
	R	D	
1. Drawings of mechanical structure [bearings, guides, NC-axes]	Non-responsive content removed	*05/23/2009*	*done*
2. "illegible" "illegible", RS, "illegible", work piece		*05/29/2009*	
3. Process data		*06/24/2009*	
4. Possible error symptoms --> Measurement protocol		*06/23/2009*	
5. After point 4 -> Define measurements to be carried out		*07/02/2009*	
6. On-site measurement / vibration analysis		*07/09/2009*	
7. Measurement results		*07/11/2009*	

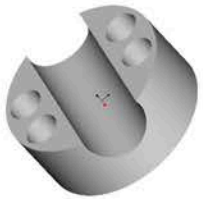
CP4 CO DS-002035496 Roller support introduction of objective visual inspection 2009.005

EA11003EN.0132410]

1. Change no. DS-002035496

2. Product CP4 Bosch no. Customer no.





Roller support

0 445 010 507	[VW] -	03L 130 755
0 445 010 508	[VW] -	03L 130 755 A
0 445 010 514	[VW] -	03L 130 755 D
0 445 010 520	[VW] -	03L 130 755 J
0 445 010 611	[AUDI]-	059 130 755 AH
0 445 010 613	[AUDI]-	059 130 755 AL
0 445 010 619	[AUDI]-	05A 130 755 B
0 445 010 620	[AUDI]-	057 130 755 T
0 445 010 624	[AUDI]-	057 130 755 S
0 445 010 631	[AUDI]-	059 130 755 AN
0 445 010 632	[AUDI]-	059 130 755 AK

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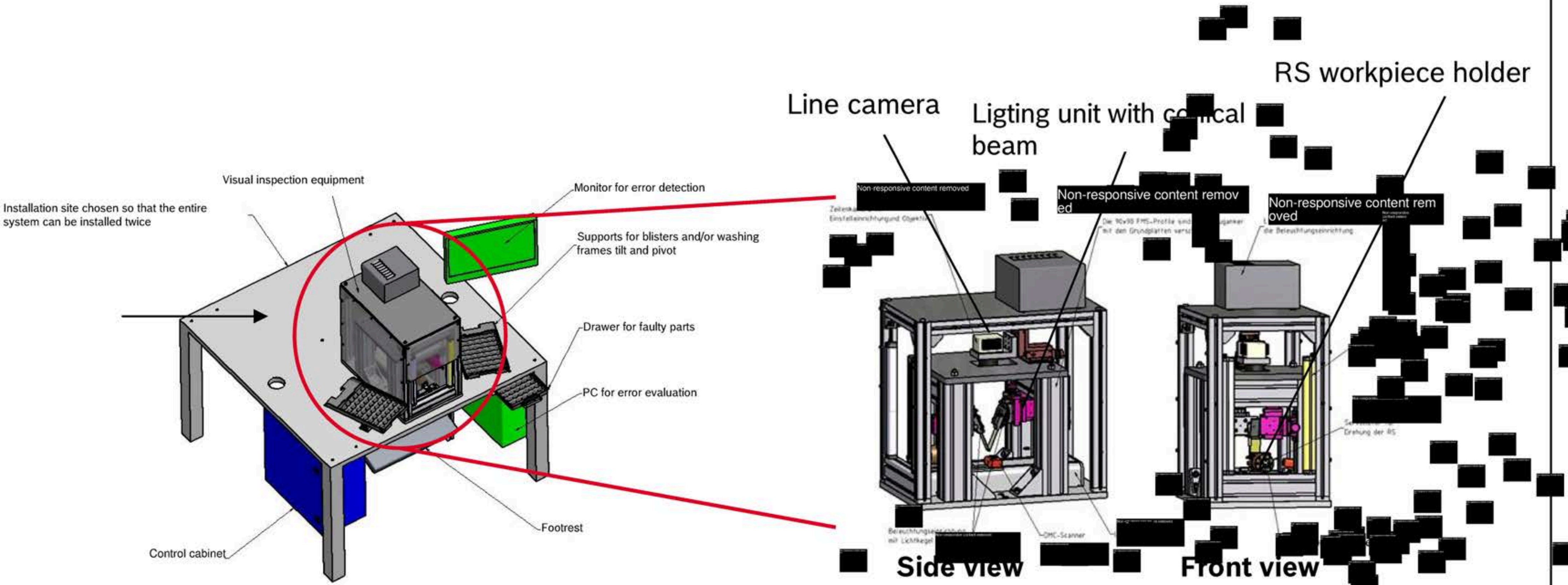
3.1 Description — **Introduction of an objective visual test** (automated display)

3.2 Reason — Quality improvement

3.3 System description



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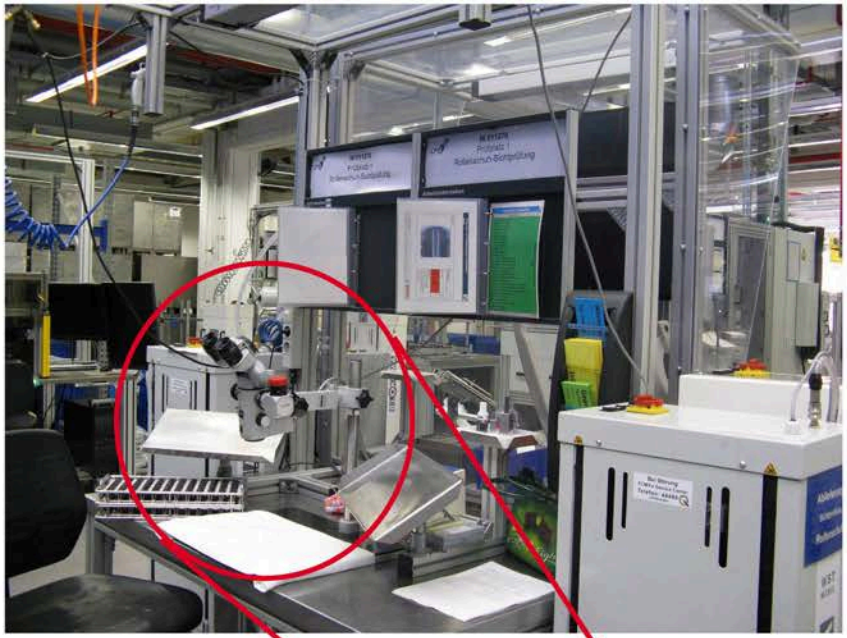
Introduction of objective visual inspection 2009.005

Re. 3.3 System description (comparison between old and new visual inspection station)

Previous technoscopic visual inspection station

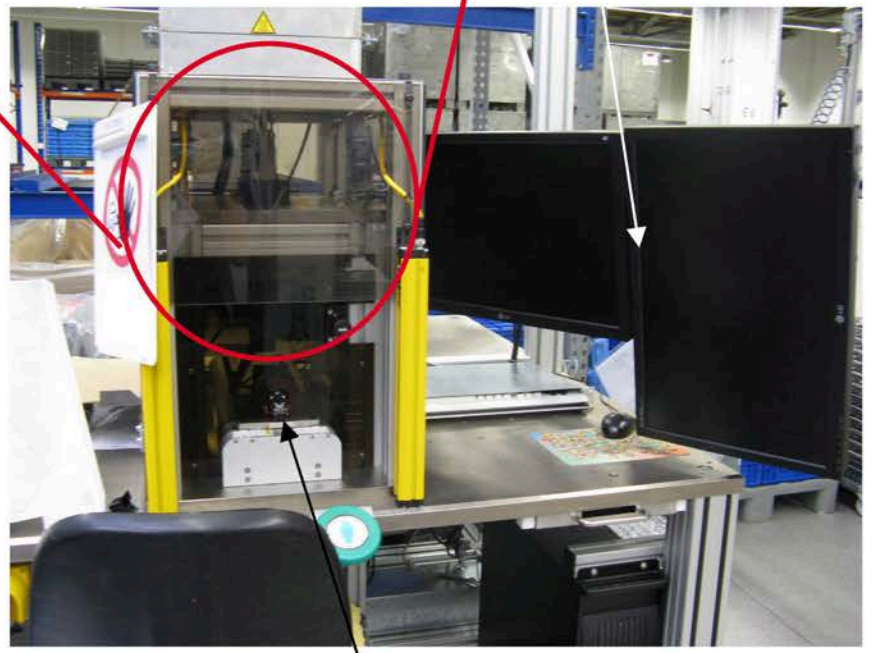


Zeiss technoscope

New objective visual inspection station

Photographic unit with line camera and lighting

2 x 27“ flatscreens



RS workpiece holder

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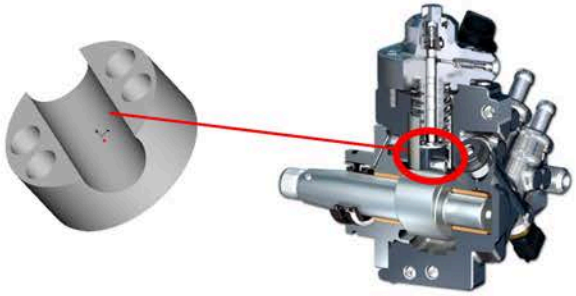
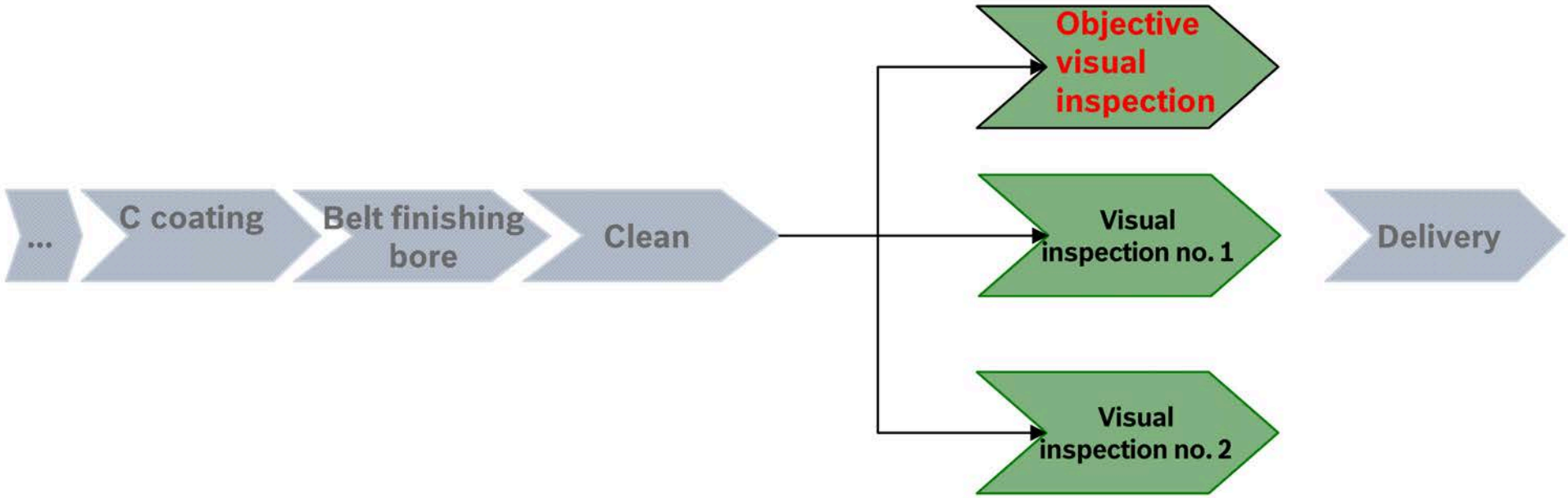
4. Details



Leg.:

- No details
- AS-IS
- NEW

Process chain (detail):



Rem.: Handling between process sequences is unchanged

5. Validation, Bosch

5.0 Function	not affected	☺
5.1 Quality assurance		
- Layout planning	carried out	☺
- P-FMEA	inapplicable	
- Proof of effectiveness	In progress	
5.2 Durability	not affected	☺

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Introduction of objective visual inspection 2009.005

6. Validation, customer	RB proposal: not required
7. Launch date:	The objective visual inspection has been carried out for roller supports (partial volume > 1000 parts / WD) since 06.2009. The approval of these parts is primarily a matter for a visual inspection staff member
8. Risk	No risk, component inspection improved
9. Alternatives	Also manual technoscopic testing
10. Remarks:	None

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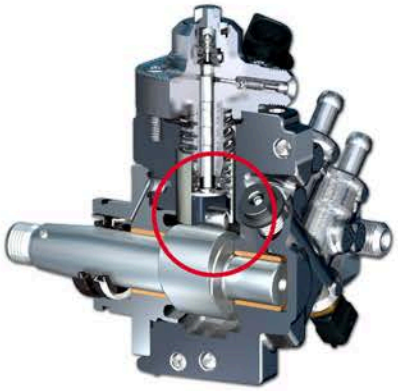
CP4 CO DS-002035496 Roller Support Status 09/15/09
Introduction of camera-supported visual Inspection 2009.005

1. Change no. DS-002035496

2. CP4 product



Roller support

	Bosch no.	Customer no.
Audi	0 445 010 611	059 130 755 AH
Audi	0 445 010 613	059 130 755 AL
Audi	0 445 010 631	059 130 755 AN
Audi	0 445 010 632	059 130 755 AK
Audi	0 445 010 619	05A 130 755 B
Audi	0 445 010 620	057 130 755 T
Audi	0 445 010 624	057 130 755 S
VW	0 445 010 507	03L 130 755
VW	0 445 010 508	03L 130 755 A
VW	0 445 010 514	03L 130 755 D
VW	0 445 010 520	03L 130 755 J
VW	0 445 010 523	03L 130 755 F

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CP4 CO DS-002035496 Roller Support Status 09/15/09
Introduction of camera-supported visual Inspection 2009.005

3.1 Description

1st step	Introduction of camera-supported visual inspection → Automatic image recording → Display of the complete drilling process on a large monitor → Check decision as before through visual inspection employee
Strategy	1. Step (partial volume) from 11/2009 <with CO 002035496 > 2. Step (total volume) with manual or automatic assessment 2010
Outlook	3. Fully automated handling with automatic assessment Vision in 2011

3.2 Reason

Quality improvement of tracking in case of drivetrain damage (image documentation)

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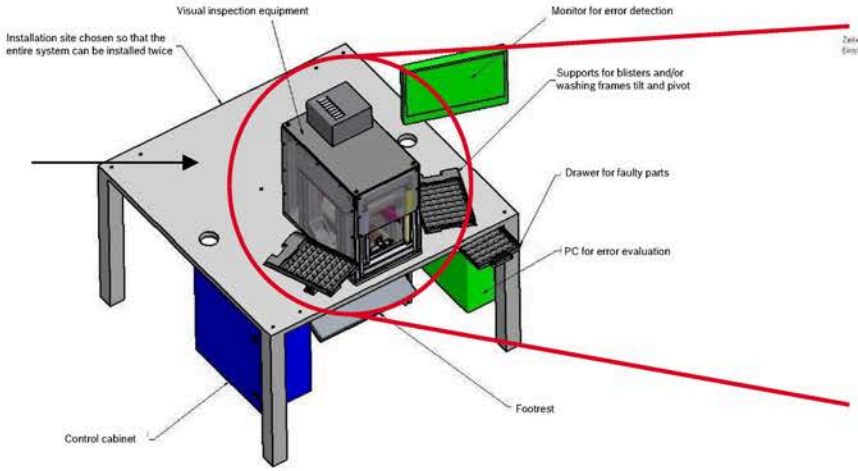
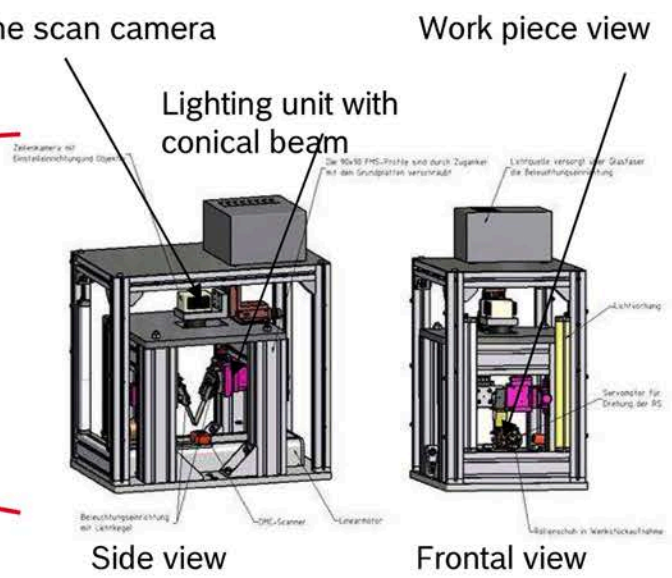
Introduction of camera-supported visual Inspection 2009.005

3.3 Description of system





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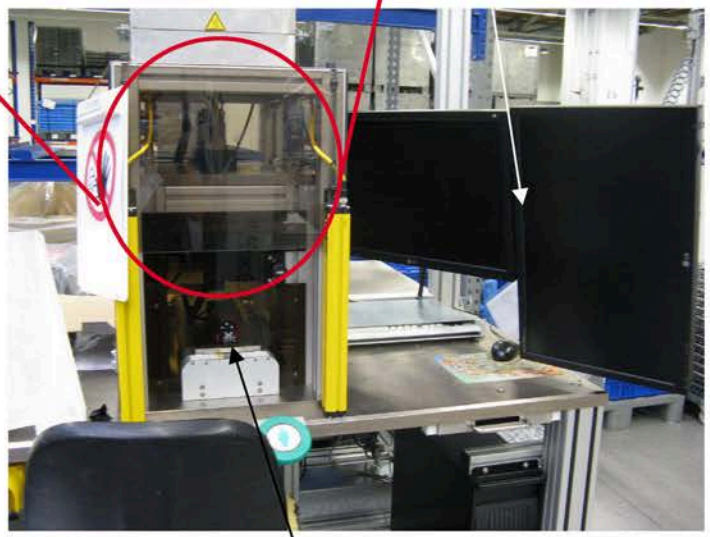
Introduction of camera-supported visual Inspection 2009.005

3.3 Visual inspection station, comparison of current and future

Previous technoscope visual inspection station

New camera-supported visual inspection station



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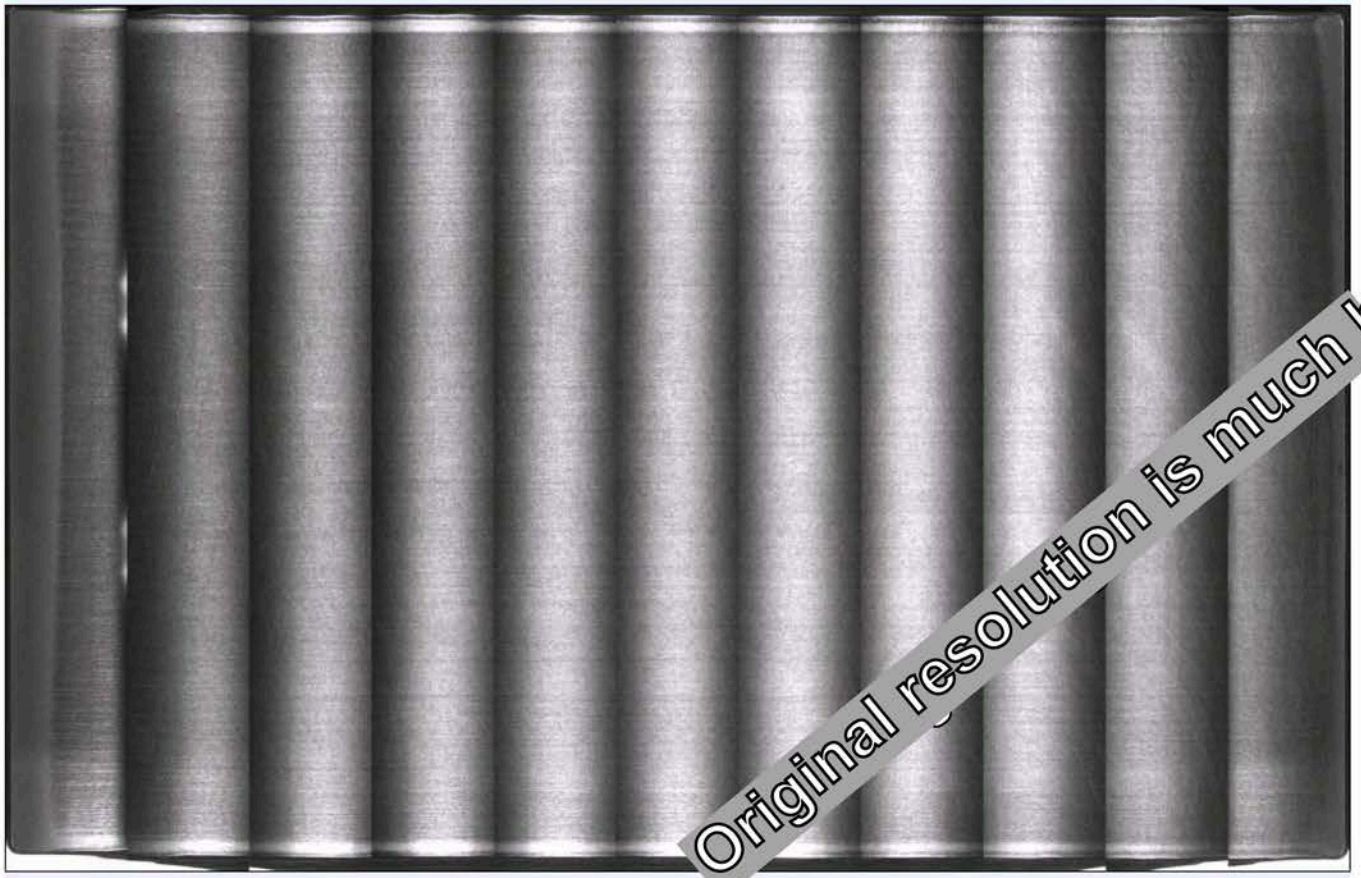
Introduction of camera-supported visual Inspection 2009.005

3.4 Handling of roller support bore



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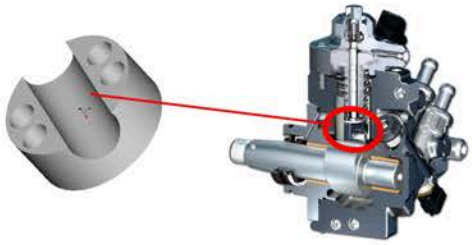
CP4 CO DS-002035496 Roller Support Status 09/15/09
Introduction of camera-supported visual Inspection 2009.005

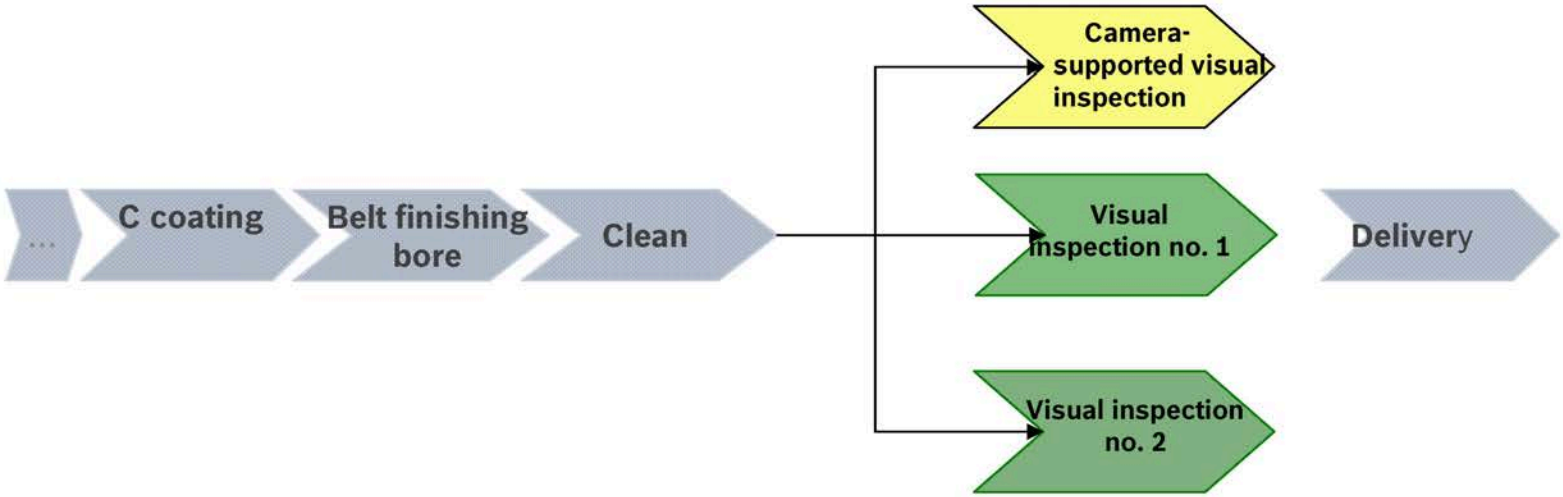
4. Details



Leg.:

- No details
- IS
- NEW

Process chain (details):



Rem.: Handling between process sequences is unchanged

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CP4 CO DS-002035496 Roller Support Status 09/15/09
Introduction of camera-supported visual Inspection 2009.005

5. Validation - Bosch:

5.0 Function not affected

5.1 Quality assurance

- Layout planning carried out
- P-FMEA unchanged
- Proof of effectiveness given

The described camera image shows defect images in at least the same quality as the technoscope, sometimes better. When flaking occurs, an objective, exact recording and assessment of the defective spot is possible

5.2 Durability not affected

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CP4 CO DS-002035496 Roller Support Status 09/15/09
Introduction of camera-supported visual Inspection 2009.005

6. Customer validation	RB proposal: not required
7. Date of introduction	11/2009 (redundant check since 06/2009)
8. Risk	No risk, component inspection improved
9. Alternatives	Continue with manual technoscope check
10. Remarks	None

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Minutes

Recipients	Participants
For Info:	Non-responsive content removed
Host	Non-responsive content removed
Participants	Non-responsive content removed
Head	
Minutes	Non-responsive content removed
Organiz.	Non-responsive content removed
Date/Location	**09/11/2009, 9:45 AM - 3:00** Non-responsive content removed
Topic	**CP4 Disassembly Audit**

This report contains a summary of the meeting on 09/11/09 in [redacted] on the topic Disassembly Audit of 5 CP4.1 units and 5 CP4.2 units. (period from 6/19/2009 to 7/30/2009)
After the participants introduced themselves, the individual striking features were discussed and assessed.

10/02/09 Results entered subsequently in blue type

Appendix 1: Table with striking features – Assignment of pictures to striking features
Appendix 2: Assessment of striking features

Rust traces on cylinder head, ext. jacket of piston bore

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CP4 Disassembly Audit

Rust resulted after the heat treatment, before assembly. Corrosion after assembly is improbable, because the components are moistened by test oil. The suspected cause of the corrosion is washing spots from the high-pressure cleaning after hard processing. Individual cases are known from internal investigations; not a systematic fault.
On the high-pressure cleaning equipment process: Pre-washing, then deburring (cleaning) with a high-pressure lance, drying, visual inspection.
This rust is not very well known from internal audits. Audi did not discover any rust in the internal bores. All known "non-starters".
Failures were not rusted

Decisions:

- ⇨ Rust in the pump is not allowed! Everyone present shared this opinion.
- ⇨ There is no direct connection to the failures.
- ⇨ Duplication test with 0%, 1%, 3%, 5% and series rust protection in detergent (5 parts each) to create rust on the outer jacket.
  Result: Rust could not be reproduced on the outer cylinder head surface with the specified concentrations. Details in attachment Rost_ZK_reproversuch.pdf. Further action: Examination of the process chain prior to hard processing, to localize and eliminate the cause of the rust spots.

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Scuffing on camshaft:

CP4.1 SN213
This topic is known internally from product audit and production; striking parts have been measured. All measured parts were within the surface specification.
The scuffing occurs as a result of the stainless steel transport frames used. The use of plastic frames or frames with soft support services was checked, but rejected due to the increased risk of particles.
Scuffing of this magnitude will be added as allowed in the internal visual inspection catalog.

Decisions:

- ⇨ Error symptom was classified as non-critical!

Shaving on locating pin.

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CP4 Disassembly Audit

Topic known at Bosch, measures already communicated to Audi and VW.

Decisions:

- ⇨ Firmly adhering shavings that do not extend beyond the camshaft surface are allowed
- ⇨ Protruding shavings can result in assembly problems, but no impact on functionality or durability after assembly is completed.
- ⇨ For the CP4.1, the chamfer was lowered by 0.2 mm to avoid shavings during the press-in (special approval). Audi requests short-term implementation of this for the CP4.2 as well. Check potential changeover date.
  - Changeover possible within 8 weeks.
  - Info provided by [redacted] at technical meeting on 09/28/09: Lowering the chamfer will not deliver any significant improvement and therefore will not be implemented for CP4.2.

  R: [redacted] done
- ⇨ To avoid residual burrs on the pin hole bore, the chamfer angle will be increased. Production test in 10/09, then implementation through change.
- ⇨ Changeover to lightweight locating pin, like the one used in CP1H, is currently being tested at RB. Audi would like information as to why the heavy locating pin is used in the CP4 instead of the lightweight locating pin (history, [redacted]..). Feedback from [redacted] Reasons for introducing the heavy locating pin: More difficult disassembly of the lightweight locating pin, stiffer profile -> less deformation under cross-forces, but this property did not prove to be necessary

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Particles on O-ring of cylinder head locking screw

Particles come from phosphating, striking feature is known to Bosch. Microscopic images from a comparison part at FeP confirm that very small particles are involved: the largest particle on the comparison part was 23 µm.

Decisions:

- ⇨ This item was deemed to be non-critical.

Roller, light scratches outside

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CP4 Disassembly Audit

Audi fears that the optical striking features will have an impact on the drivetrain function. The striking features are known at Bosch and arise when pressing in the roller. Measurements of comparison parts at FeP did not reveal any deviations from the surface requirements, no connection with drivetrain damage known. Note: Due to the finish processing, even the smallest faults are clearly visible.

Decisions:

- ⇨ A striking roller was measured during the meeting in [redacted] - result: Parts in tolerance
  T: 9/11/2009 R: Non-responsive content removed done
- ⇨ This item was deemed to be "green".
- ⇨ Investigation of roller supports in which the roller was intentionally inserted with a tilt, and then checked for C layer flaking (edge area) and particles). Result: The scuffing on the rollers could be reproduced during pressing in. The bore edges and running surfaces of the roller supports do not have any damage or flaking. Details in attachment Verkantetes_Fuegen_LR_RS.pdf
  R: Non-responsive content removed 10/2/2009 done 10/2/2009
- ⇨ Straightedge tests with scuffed rollers (parts from above test). Result: The straightedge test of the above rollers did not reveal any striking features.
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Gap shim - sliding bearing - flange

The pictures show the normal series status.

Decisions

- ⇨ Carry out residual soiling analysis on cleaned bushings, then brush (with a toothbrush, for example). Evaluate the results. In the spot, see pictures. (Transition). Result: Five cleaned flanges with pressed-in bushing were used for the tests. The butt joint of the flange was cleaned with a toothbrush for approx. 1 minute over white paper. The particles from five flanges were gathered on a pad and evaluated. Particles were brushed off during the test. The recovered particles are approx. 100-300µm in size; the largest recovered particles are broken-off pieces of toothbrush bristles. Details in attachment Buchse_Buerstversuch.pdf. Of the internal and external particle failures known to date, no particles from the bearing have been found. The result will initially be discussed internally at Bosch with Development, Production, and Procurement; presentation at cleanliness workshop on 10/27/09.
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  R: [redacted] 10/27/2009
- ⇨ Evaluate striking features once all results are available

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Minutes

CP4 Disassembly Audit

Extremely slight piston tracks, stress marks,...

Similar striking features are known at Bosch, but no connection known with internal / external failures.

Decisions:

- ⇨ Measurement according to drawing SN1166, SN507, 156, 31 — R: [redacted] 9/28/2009
- ⇨ Piston scuffing, cylinders, and pistons measured (running marks, ZK6, Sn: 31) parts were measured at FeP. — R: [redacted] 9/28/2009 done
- ⇨ Final analysis of striking features once all results are available - assessment "green" if parts are in tolerance. The results were presented at the technical meeting in [Non-responsive content removed] on 09/28/09: All measured parts were within tolerance; the items were set to green in the matrix (attachment Übersichtstabelle_090928.pdf) as agreed.

Tappet bore lower edge, intersection with drivetrain compartment

Instantiation of the edge corresponds to the series state before introduction of the measure (07/20/09) targeted removing of the edge with HP water jet (program change). Introduction in housing production on 07/20/09, use in pump from 07/27/09.

A sharp edge is desired. (avoids particle entry)

Pump DM 07/27/09 (usage date)

Decisions:

- ⇨ Parts have regular series status up to housing DM 07/20/09.

Housing transverse passage inlet from MU to cylinder head

Particles in this area can result in non-starters - current focal defect in the CP4.1. Edge is checked 100% in housing check.

Burr formation at this point can be avoided by using a ball cutter. Ball cutter has been used for CP4.1 housings manufactured at FeP since 06/04/09 through a special approval.

Only for FeP. JhP will apply only after the major trial.

Decisions:

- ⇨ Introduction of ball grinder at change meeting on 09/17/09 in Brunswick for CP4.2 — R: [redacted] done
  - ○ Ball cutter was presented orally at change meeting. Audi/VW request implementation in the short term, RB will initially prepare a deviation permit for this,

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Minutes

CP4 Disassembly Audit

regular implementation through CO at next change meeting.

- ⇨ Preparations for changeover, desired date 09/23/09 for CP4.2 — R: Non-responsive content removed
- ⇨ Check whether greater bore scope can be deburred — R: [redacted] done
  - o It is not possible to go deeper with the ball cutter, because otherwise the bore base will be damaged.

Transverse passage inlet in interior

Striking part has a sharp edge, no burrs discernible. Sharpness is allowed.

Decisions:

- ⇨ Omit "We" item in matrix (attachment 1)

Impact mark abutting face bushing in pump housing

The impact point results from the insertion process in assembly and is allowed according to the internal borderline catalog.

Decisions:

- ⇨ Check feasibility of "modified" insertion tool. Result: Due to space restrictions, a more exact guide using a modified insertion tool is not possible without additional risk of damage, particularly the flange fit. We feel the risk of damage to the flange fit is more critical than the currently allowed impact points. Currently no change to the insertion tool. — R: Non-responsive content removed 09/28/2009 done 10/2/2009

- Check whether a radius (instead of a chamfer) on the camshaft can be implemented. — R: Non-responsive content removed 10/2/2009 done 10/2/2009

  Result: Feasible in principle, but the support length of the bearing cannot be reduced, which means the radius will have to be small. As a result, the effect to avoid impact points on the housing bearing is thought to be very low. The subject will not be pursued further.

Imperfection outside on the jacket surface

The imperfection occurred before the hardening process and is an optical defect. There is no indication of a systematic defect.

Decisions:

- ⇨ Subject will not be pursued further at the present time.

Tappet body run marks

The striking run marks likely stem from increased aluminum particle abrasion. The subject is known at Bosch. No failures known in connection with this striking feature.

Decisions:

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CP4 Disassembly Audit

- ⇨ EDX test for aluminum abrasion Sn1166 (picture 2.10)
  - EDX analysis confirmed that aluminum abrasion was involved.

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Particles from shim between sliding bearing and flange

Test description/task:

⇨ Carry out residual soiling analysis on cleaned bushings, then brush (with a toothbrush, for example). Evaluate the results. In the spot, see pictures. (Transition)

⇨ Evaluate striking features once all results are available

Test execution:

- Five cleaned flanges will be used for the test.
- The butt joint of the flange was cleaned with a toothbrush for approx. 1 minute over white paper.
- The particles from five flanges were gathered on a pad.
- Photo documentation of the particles.

Photo documentation:

- Burr on butt joint. Slide 3.
- Particles on pad. Slides 4 -8.
- Particles were indicated with a ○ circle

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Particles from shim between sliding bearing and flange

Result:

- Several particles were brushed off during the test. Slide 4.
- The retrieved particles are around 100-300µ in size. Slides 5-7.
  Note: None of the failed pumps (internal & external) ever contained a particle of this size
- Two large particles are broken-off pieces of the toothbrush bristles. Slides 5, 6.

- Optically, the particles match the burr on the butt joint. Slide 3.

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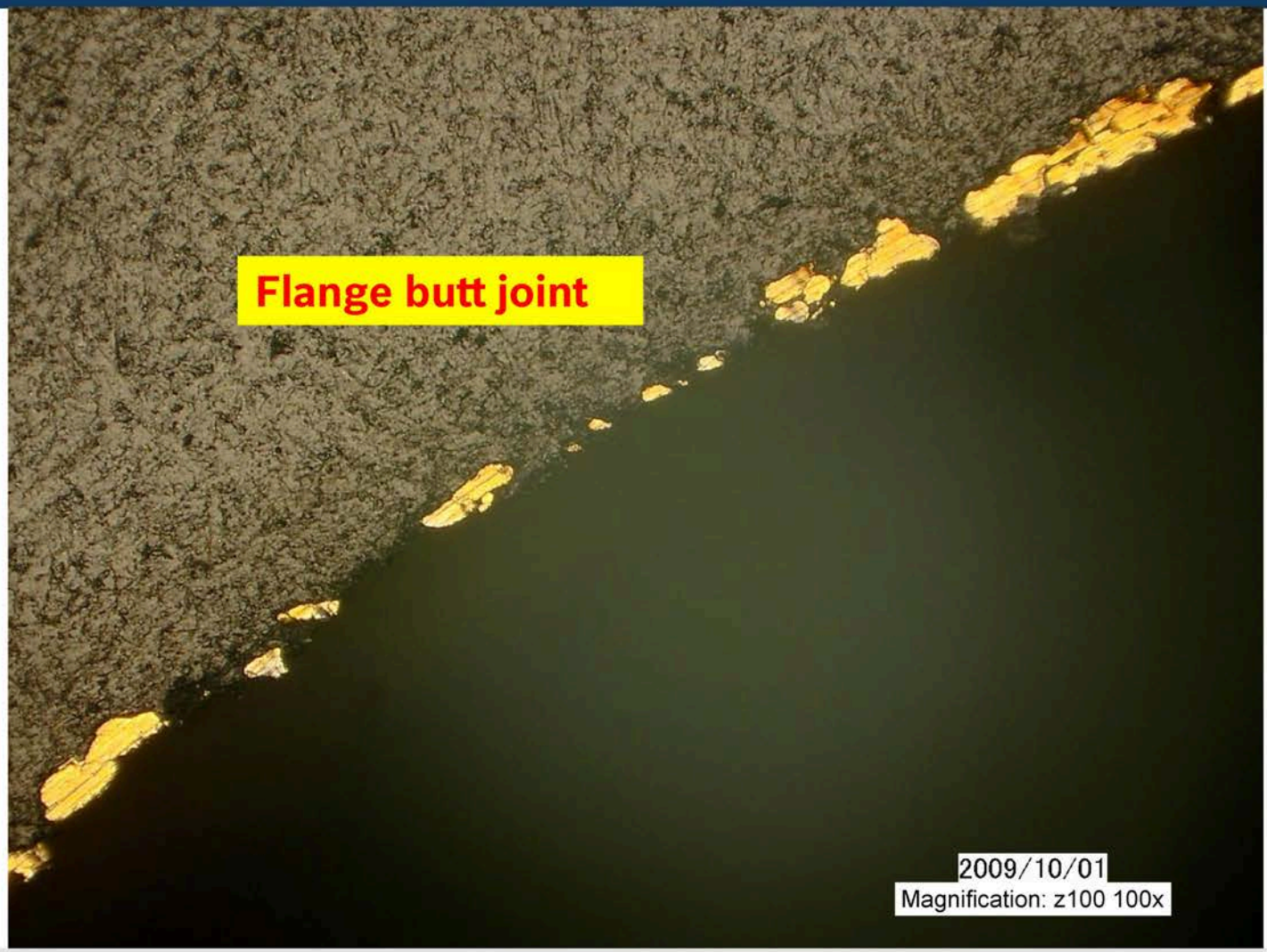
Particles from shim between sliding bearing and flange



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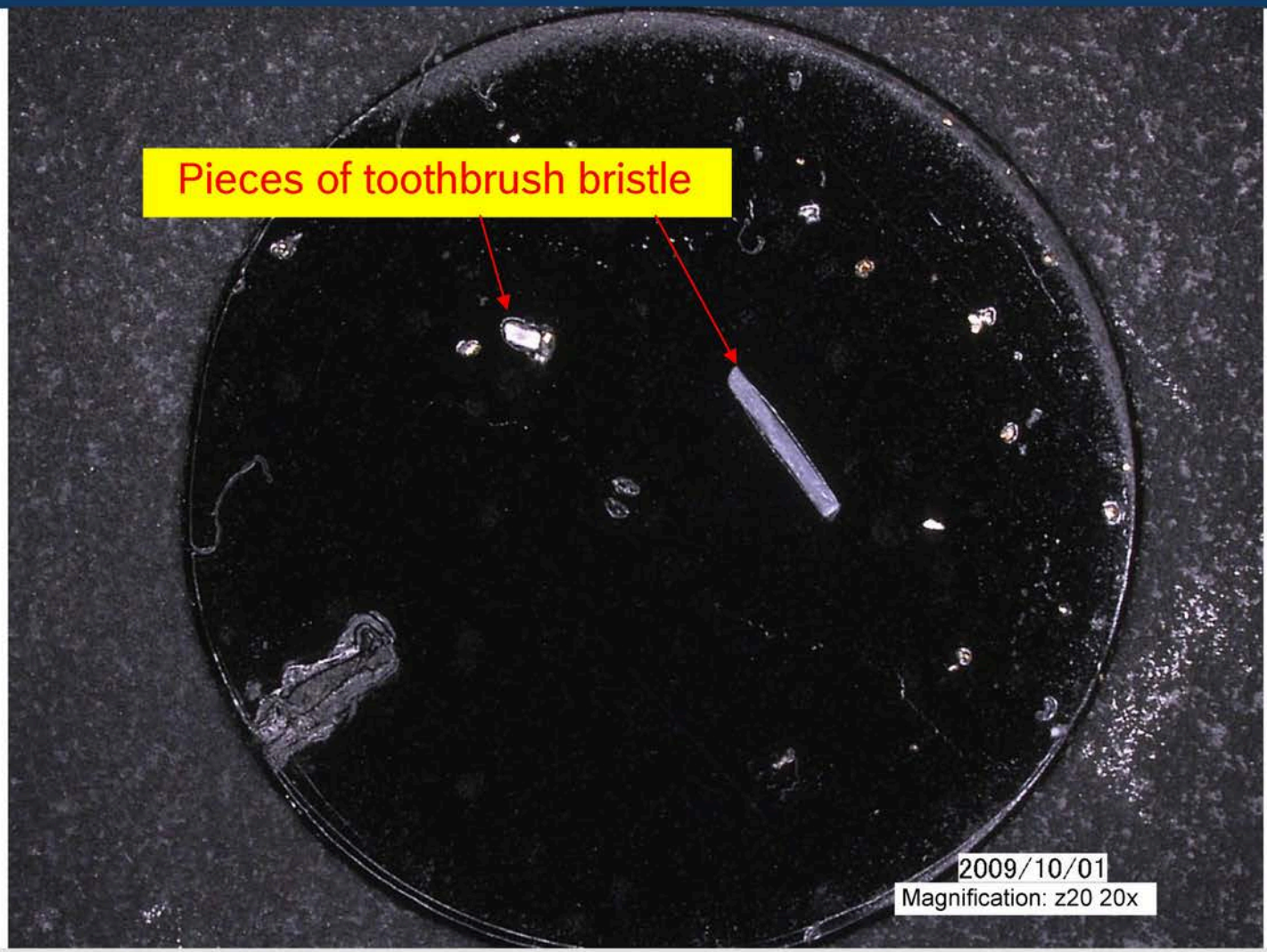
Particles from shim between sliding bearing and flange



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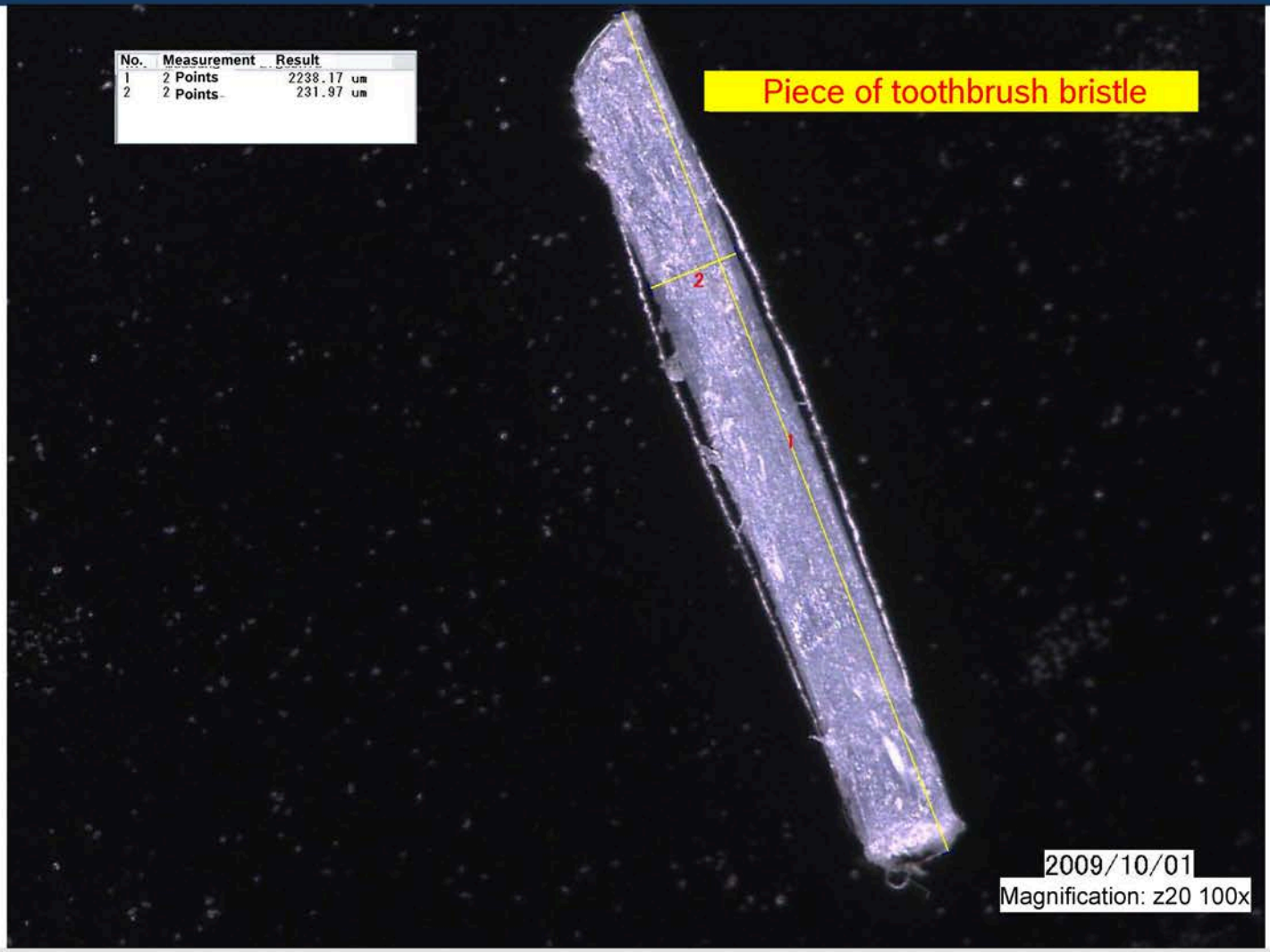
Particles from shim between sliding bearing and flange



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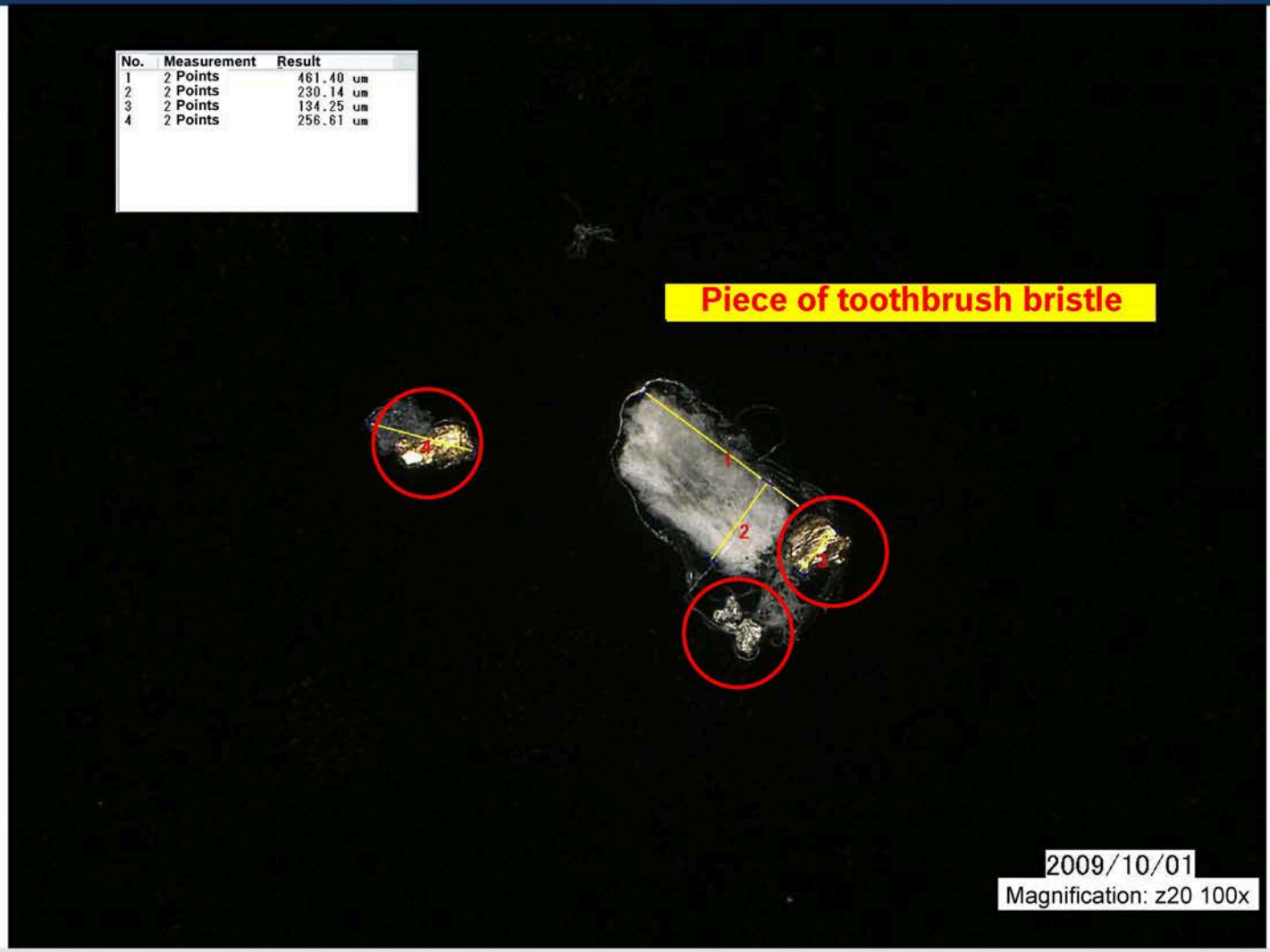
Particles from shim between sliding bearing and flange



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Particles from shim between sliding bearing and flange

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Rust traces on cylinder head

Information on the test

➔ Duplication test: External jacket of the piston bores of 5 cylinder heads exposed to various concentrations (0%, 1%, 3%, 5%, series rust protection)

➔ Striking features documented

➔ Pictures taken.

Information on medium:

- Name of rust protection medium: Hakupur 319RB
- Prewash and main wash carried out with the same medium
- Prewash and main wash carried out with concentrations of 1.5-3% of rust protection medium

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Rust traces on cylinder head

Once the CH were cleaned on the Markert, the reproduction test was carried out immediately.

Result:

No rust traces detectable, neither during test with demineralized water nor with other concentrations (1%, 3%, 5%). Merely water residues were found.

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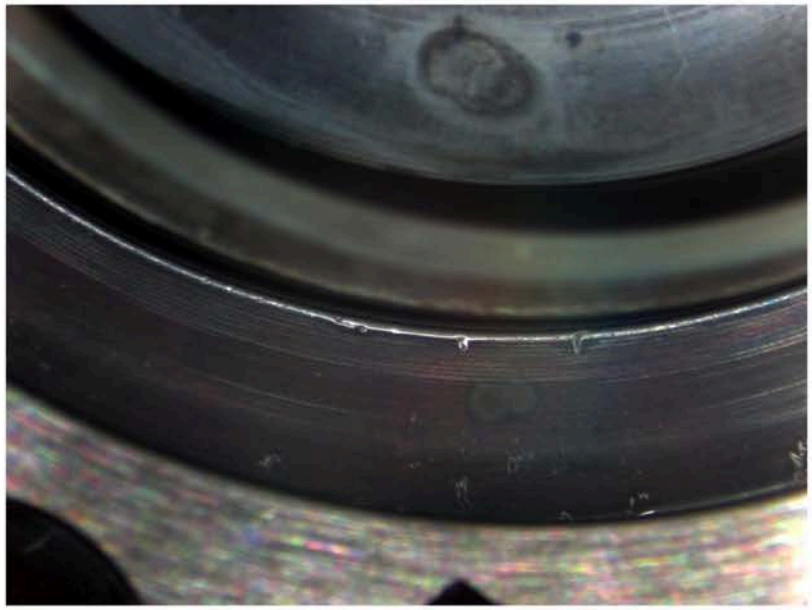
Rust traces on cylinder head

Since there were no striking features, the CHs were "degreased" with ethyl alcohol and the reproduction test was carried out again.

Result:
No rust traces detectable, neither during test with demineralized water nor with other concentrations (1%, 3%, 5%). Here, as well, only water residues were found.



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Striking feature	Rust traces cylinder head / ext. jacket piston bore	Scuffing on camshaft	Shaving on locating pin
Impact on function / durability	Wash marks, corrosion on external contour (no functional surfaces) no impact on function, durability	Scratches on comparable point within surface requirements	Protruding shavings could cause problems with belt pulley assembly, no impact on durability
Within specifications	Rust not permitted	Comparison parts within specifications	Protruding shavings not permitted - noticeable parts not critical to mounting methods, some small burrs on camshaft surface - not critical
Known at RB	Individual cases, not a systematic defect	Known from product audit and production, subsequent measurement of striking features: Parts in spec.	Known from in-house production and customer complaints
Possible causes	Rust on components prior to assembly, violation of glove requirement, detergent residues	Friction on transport frame	Process, design
Checks	Check media (weekly) for corrosion protection content - details for pre-wash and high-pressure wash	Product audit	100% visual inspection before delivery
Measures	Corrosion protection trials, various concentrations 5 parts each (0,1,3,5), effect of wetting test oil	None	Process improvement, design measures
Remark			

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Striking feature	O-ring CH abrasion	Roller, light scratches outside	Gap shim - contact bearing - flange
Impact on function / durability	No impact	No impact on function, durability, provided friction coefficient OK	Not critical, no failures due to particles from bushing (peek, bronze) known, surface of pumps similar after 500h ER
Within specifications	Abrasion comes from CH phosphating: ultra-small, soft particles	Particles nondescript in friction coefficient test, surface measurement comparison part at RB and rejected part Györ OK	Corresponds to series status
Known at RB	From production and product audit	Production, task force drivetrain	Normal series status
Possible causes	Abrasion of phosphate layer	Occurs when pushing the roller into the roller support	Series status surface after bushing production
Checks	Residual dirt assessment conducted for one part, maximum size 23µm		Random sampling in goods receipt
Measures	None	100% friction coefficient test Incorrect insertion attempts, then checked roller support for C layer damage, flaking, particles examined, then roller in straightedge testing again	Clean bushings, assess brushing on transition and abrasion
Comments			

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Striking feature	**Very slight traces on piston**	**Tappet bore bottom edge, very small burr**	**Housing transverse passage inlet from MU to cylinder head, residual burr**
Impact on function / durability	Not critical, symptom known from pumps after 500h ER	Instance of burr root similar after 500h ER, loose particles should be avoided	Burrs in this area are function-critical - Consequence of fault: non-starter
Within specifications	Measured comparison parts within surface tolerance, **measurement at FeP - in tolerance**	On-site diagnosis - normal series status prior to 07/20/09 housing	Striking feature confirmed
Known at RB	Known from product audit	Normal series status	Characteristic is checked 100% in series (limit sample catalog)
Possible causes	Handling, tiny particles, burr when joining	Residual burr from housing machining	Residual burr from machining
Checks	Product audit	100% visual inspection in housing production	100% visual inspection in housing production
Measures	Measurement and assessment according to drawing	Remove tappet bore burr with HP lance in housing introduced 07/20/09, in pump 7/27/2009	Use of ball cutter for VW pump implemented at FEP since 06/04/09
Comments			Approval from customer Audi open

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Striking feature	Tappet body run marks	Impact point on cylinder wall CH	Circumferential mark on piston
Impact on function / durability	Increased particle abrasion - no failures known in connection with this striking feature	Not a functional surface	Not critical, symptoms with heavier marks known from pumps after 500h ER
Within specifications	Striking feature - marks disappear after running time - indication of particles	Damage, even to non-function areas, must be avoided	**Measurement at FeP - within tolerance**
Known at RB	Known from analysis	No systematic defect	Identified in framework of piston seizure task force
Possible causes	Regular start-up, aluminum abrasion when inserting tappet body into housing	Handling, conspicuous part damaged in soft condition	Particles, wear on control wheel
Checks	Product audit, analysis in DRA	Product audit	Product audit
Measures	EDX analysis of run marks	Sensitize employees	Measurement and assessment according to drawing
Comments			

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Striking feature	Grinding marks on piston	Impact mark on face surface of bushing in pump housing
Impact on function / durability	Not critical, symptom known from pumps after 500h ER	Not a functional surface
Within specifications	Measured comparison parts within surface tolerance, **measurement at FeP - in tolerance**	Within limit sample catalog
Known at RB	Known from QC inspection and analys is	Known from analysis
Possible causes	Very small particles	Manual joining process camshaft in housing
Checks	Product audit	Product audit
Measures	Measurement and assessment according to drawing	Check improvement to joining tool
Comments		

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Tilted insertion of roller into RS

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Test description/task:

⇨ Examination of roller supports for which roller was intentionally inserted tilted for C layer flaking (edge area) and particles

⇨ Straightedge tests with scuffed rollers (parts from above test).

Test execution:

- 5 rollers and 5 roller supports were cleaned for the test execution.
- Mark roller on left front surface (1-5).
- Photograph (20X) roller and roller support before insertion.
- Insert roller tilted (left front surface) from the right (RS).
- Photograph (20X) roller and roller support after insertion.
- Visual inspection of roller and RS under microscope (20X).
- Photo documentation slide 3-7, from **top right** in counterclockwise direction.
- Straightedge test on inspection station for roller elevations.

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Tilted insertion of roller into RS

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Result:

- On all five rollers, scuffing on two sides occurred during tilted insertion. The most striking scratches were photographed.
  Slide 3-7; picture on lower right.
- The bore edges and running surfaces of the roller supports do not have any damage or flaking. Slide 3-7; picture on lower left.
- During the straightedge test of the rollers, on the inspections station for roller elevations in W011270, there were no striking features.

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Tilted insertion of roller into RS: Roller 1 + RS 1

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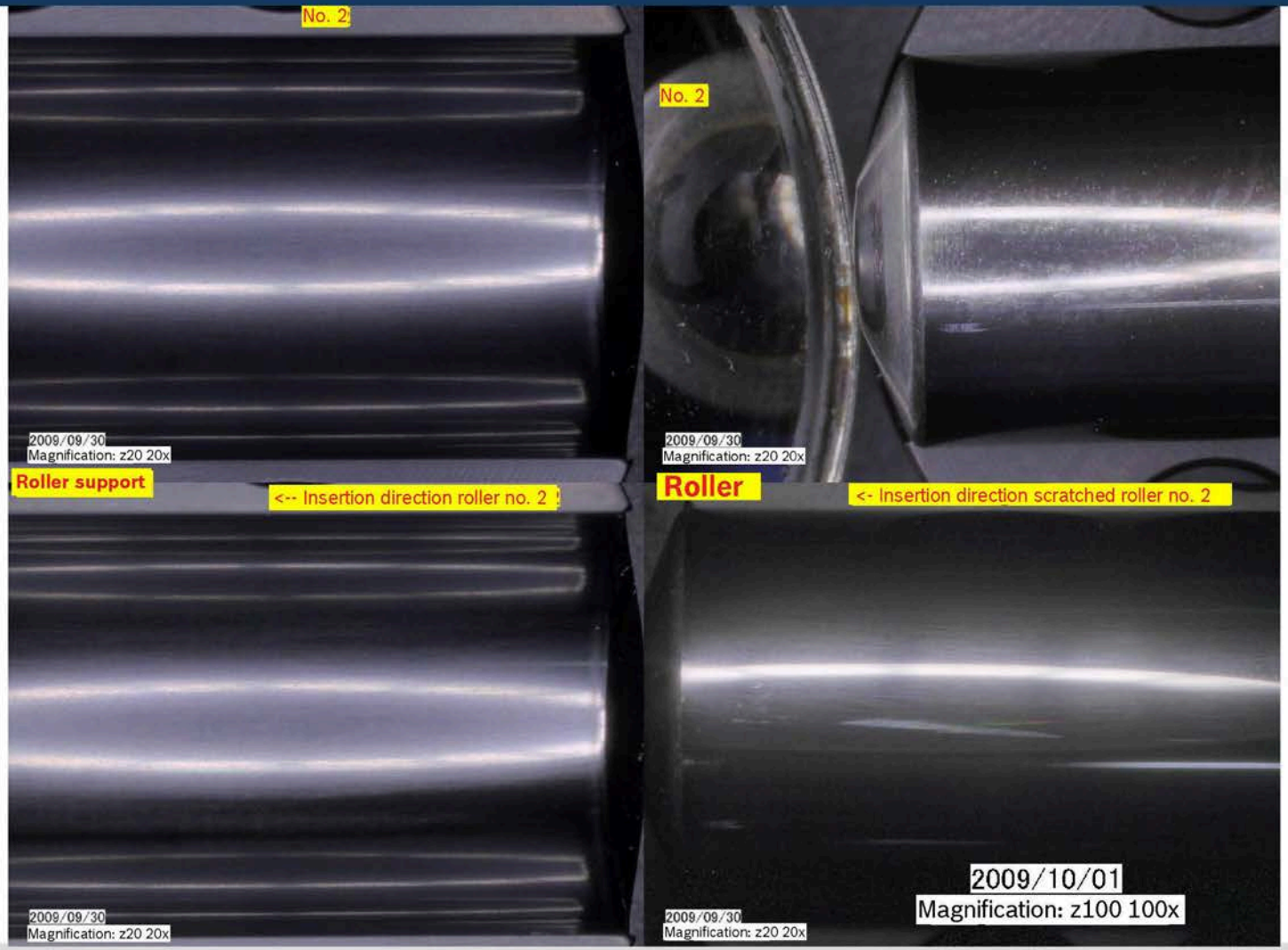
Tilted insertion of roller into RS: Roller 2 + RS 2



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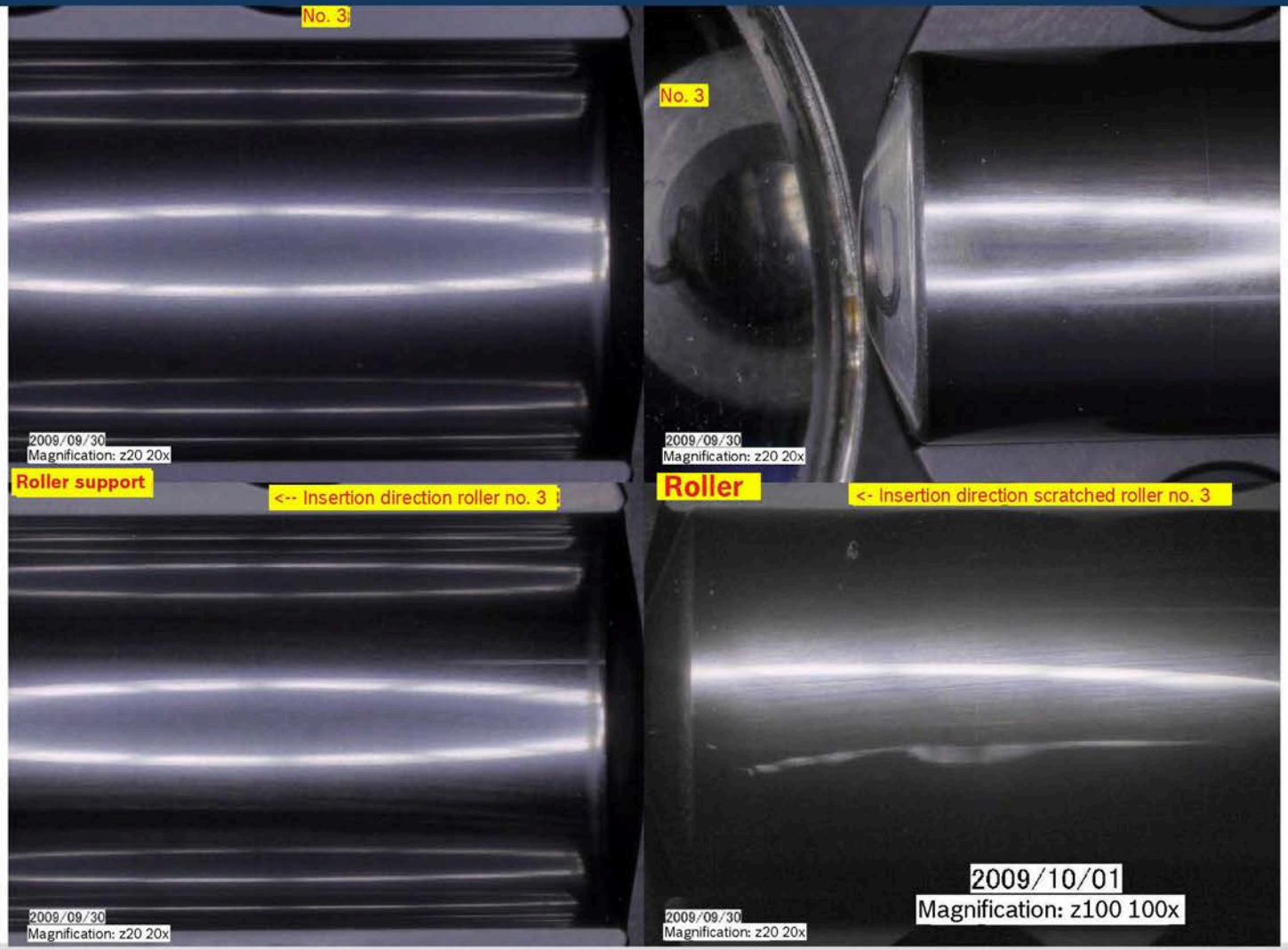
Tilted insertion of roller into RS: Roller 3 + RS 3



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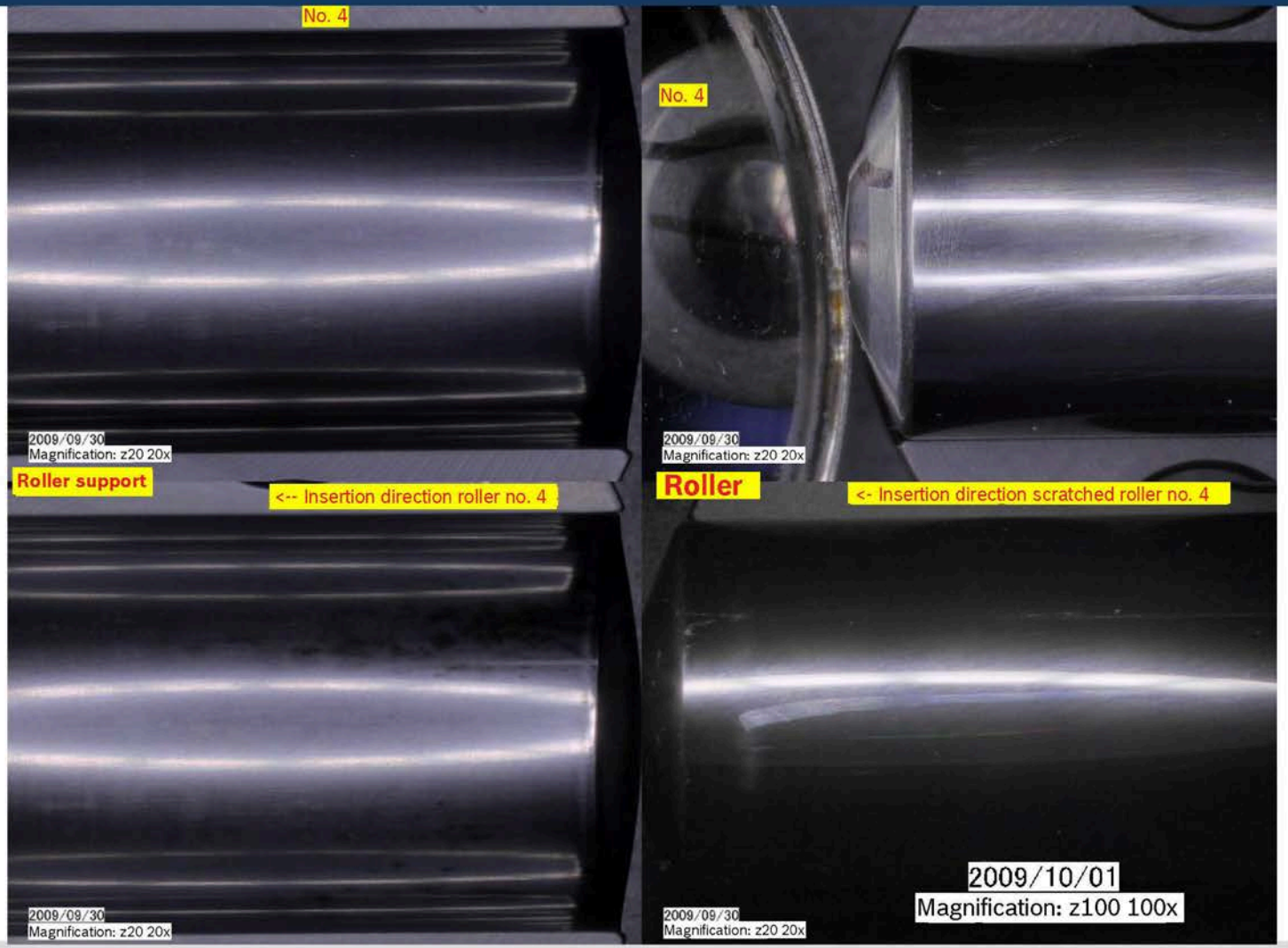
Tilted insertion of roller into RS: Roller 4 + RS 4



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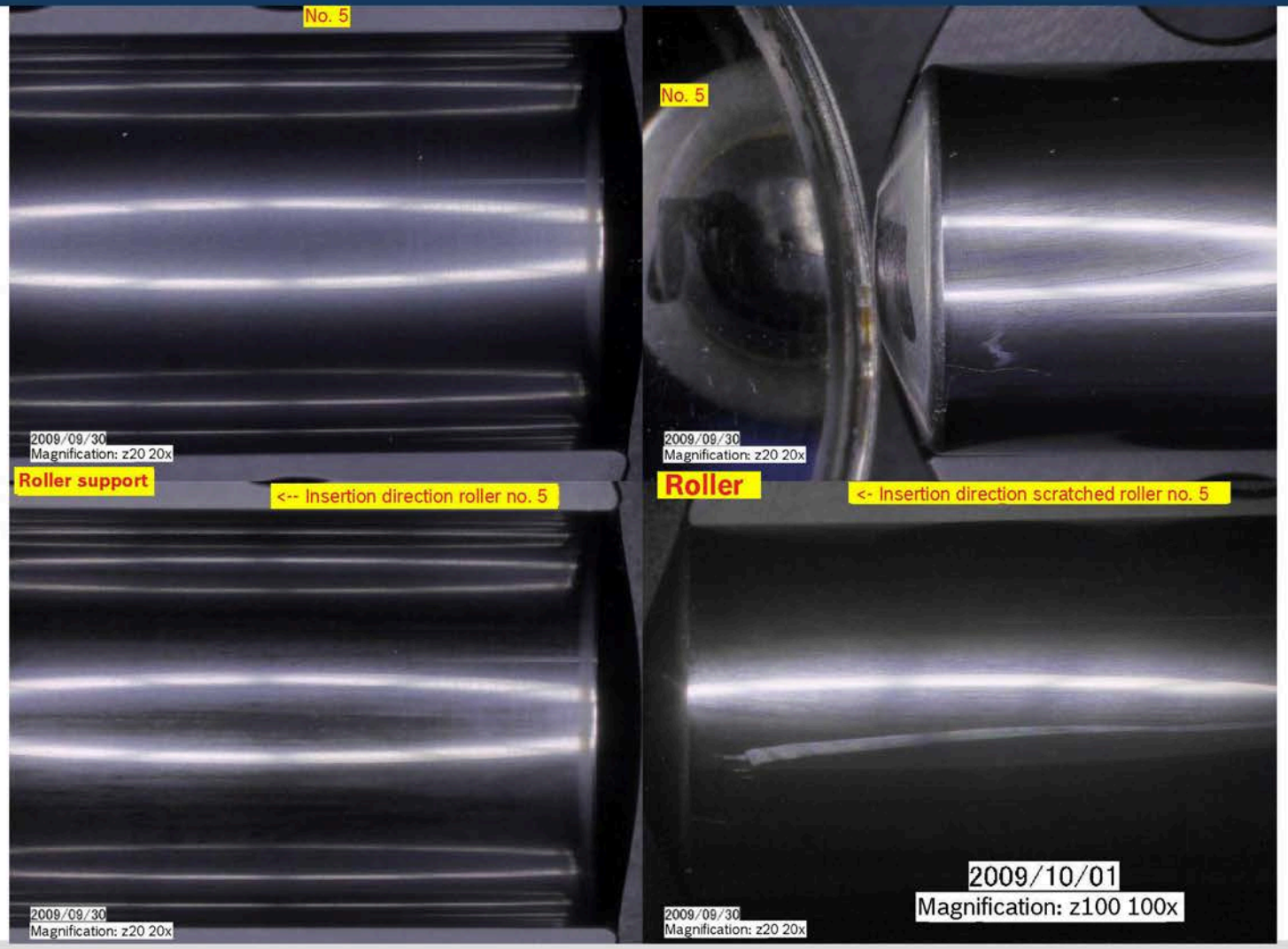
Tilted insertion of roller into RS: Roller 5 + RS 5



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Subject: CP4 robustness

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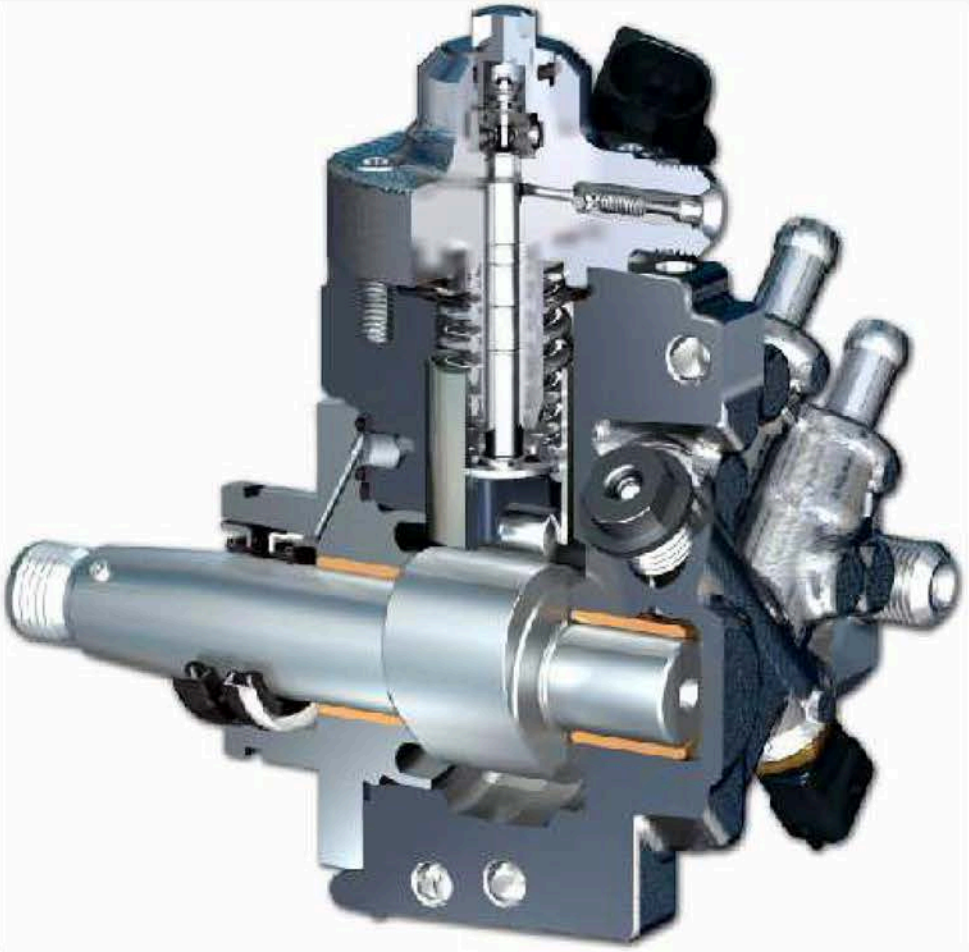

TOP meeting on Tuesday, October 27, 2009

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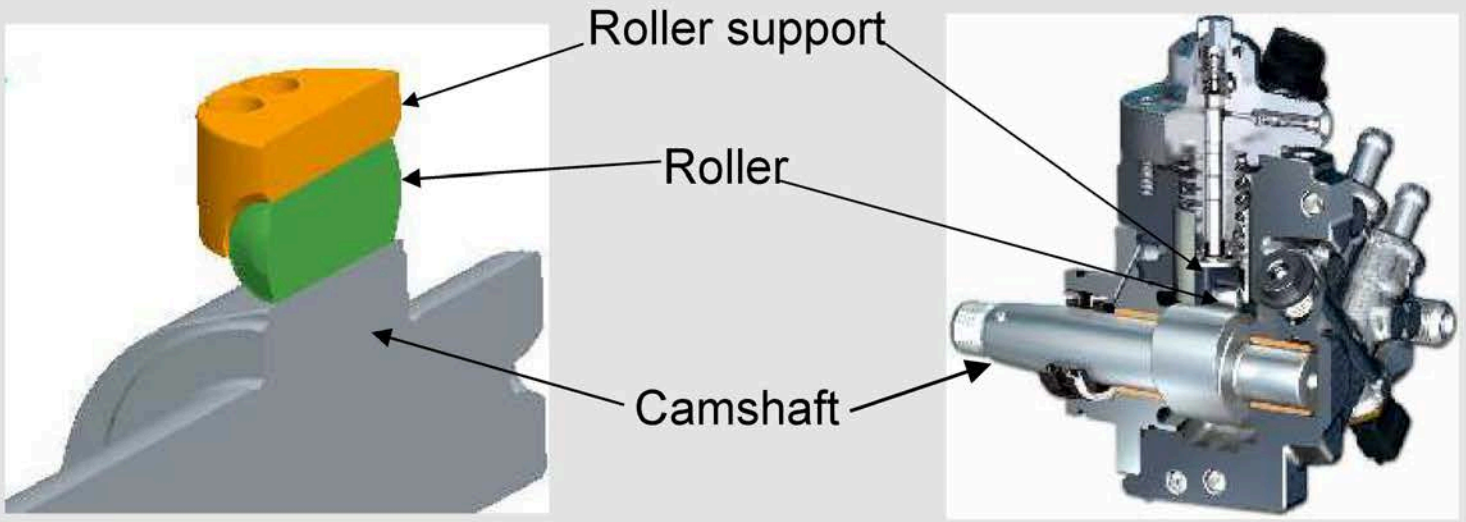
Vorsprung durch Technik

Subject: CP4 robustness

Cause-effect relationship CP4 drivetrain damage

Cause of drivetrain damage is operation with impermissible fuel qualities and/or high component function sensitivity.



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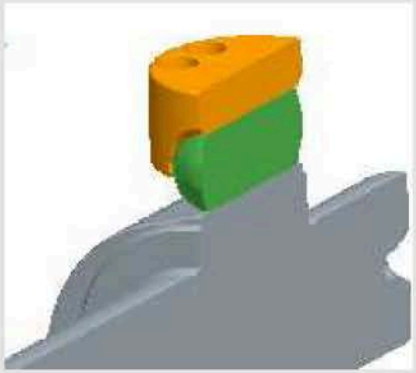
Subject: CP4 robustness

Influence of fuel quality



Low lubricity (kerosene, water, ...)

- In start case (mixed friction area), results in increased wear in roller/roller support assembly (up to 200 rpm)

Low viscosity [Non-responsive content removed] diesel, kerosene, water….)

- Results in small lubricating film thickness -> Increased friction / component contact -> Increased slippage (roller stops)

Water in fuel

- Influence as emulsion: see lubricity & viscosity
- Free water (in droplet form) can result in hydrogen embrittlement / stress corrosion and thus to fatigue of the roller partner

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Subject: CP4 robustness

Measures to increase robustness - fuel-critical markets

Lubricity

• Continue development of wear-optimized C layer	SOP	07/10
(already being tested for medium duty application)		

Viscosity

• Optimize texture/surface of roller		done
• Optimize texture/surface of C layer in roller support	SOP	07/10
• Optimize component tolerances (play) roller-roller support	SOP	07/10

Water

• Implementation of water separator required for critical markets		OEM
• Avoid fatigue through more high-grade substances on camshaft / roller (pre-tests with high-grade material pairing underway)		04/10
After completion of pre-tests, long-term testing needed	SOP	?

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Subject: CP4 robustness

Reduce component function sensitivity in current series

- Switch washing before C coating

  (from aqueous to HC cleaning)

  ➔ Major test completed — Wk 43

  ➔ Possible implementation date
  (Approval from all customers required) — Wk 46

- 100% Conversion of the visual inspection of the roller support from technoscope to camera inspection — E 4/2010

TOP meeting on Tuesday, October 27, 2009

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Diesel Systems

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[redacted] 12/14/2007 No. 881007

Minutes - 4. Steering Committee VW / Bosch

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For info.	
Host	
Participants	
Management	
Log	
Organiz.	
Date/location	**12/14/2007, 10:00 AM,** Non-responsive content removed
Topic	**4. Steering committee VW/ Bosch**

Date: 5. Steering Committee VW / Bosch

- Following discussion in WK 12/08

Summary

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12/14/2007
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4. Steering committee VW/ Bosch

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- Status of findings - CP4.1:
  -> Basic engine program: 70%
  -> Reliability test: 30%
  - Positive result
  - 1 pump with items of note: Corrosion due to water in the fuel
  -> Further clarification in the project meeting

- Status of system verification for VW Tiguan, Jetta, Audi B8: testing completed successfully (most critical component of CP4.1 positive) with exceeding the permissible threshold of 60g on the connector

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Diesel Systems

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12/14/2007
No. 881007

Log

4. Steering committee VW/ Bosch

1.1 Status of turned tappet - CP4.1

Bosch presents the failures concerning drivetrain damage:

- From WK 42/07 (production) -> Install engine (WK 48/07):
  -> No further failures with customers known
- Internal failures continue to exist, testing has been intensified
  -> Damaged pumps are being detected

Bosch has provided several failure hypotheses:

Hypothesis 3: Sluggish roller

-> Package of measures 1 was introduced on 07/23/07 (see attachment)

Hypothesis 4: Sluggish roller, failure model 'thermal bump ' due to elevated fault

-> Probable cause is individual C layer faults

Hypothesis 6:Turned tappet > 15° confirmed when assembling tappet group

-> Package of measures 2 was introduced on 08/28/07 (see attachment):

Visual inspection + impact time for tappet body during assembly, further failures in click-clack testing, additional inspection of the alignment of the tappet body assembly position by means of laser sensors

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Further action:

- VW is offering synergies from the piston pin problems
- Final proof has not yet been provided, the process is being optimized continuously -> Bosch provides photographic documentation to VW

- Optimized testing process was introduced at BMW on 16.11 (better flushing due to greater pressures and speed),
  -> VW has not yet accepted this testing process.
  -> Approval should be pushed by VW and Bosch, there will be a telephone conference in WK 51/07 for this purpose with the following participants: [redacted]
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1.2 Further action HP leak-tightness

Current status:

- Approx. 20 CP4.1 have been complained about due to a considerable pressure failure in the pressure drop test (leakage test) during the cold test
- Measurement (calotte measurement) at Bosch corresponds to the VW measurement

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4. Steering committee VW/ Bosch

Measures:

- 4 non-return valves measured at Bosch (seat and calotte)
  ->Result: Seat is OK
  Calotte is not OK

Hypotheses: 1. Statistical problem
2. Deformation / adaptation to seat of the calotte after test run in FeP

Further action:

- 6 point program included in the attachment ->Bosch reports in good time r.e. the results

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Further points regarding the CP4.1:

1.Release status for 'Güntert' roller

- Bosch objective: Release in WK 02/08
- VW requests more / more precise information for the release
- VW gives OPL for processing
- Then release

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2. Approval by JhP

- 2DP on 12/17-18
- Release on WK 02/08

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3. C coating on piston crown

- Discussion regarding omission of C coating
- Bosch will present 30 internal ER findings to VW ->then evaluation regarding omission

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4. Duplication of coating plant

- Bosch measures have been presented
- VW requests evaluation regarding existing plant for a better assessment
- VW requests an inspection of the plant Non-responsive content removed

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1.3 Verification for follow-on projects

- Status of the system verification has been presented by Bosch
- Low-pressure verification in the PQ46 concerning return pressure with a cold start not OK, clarification of cause running at VW with the support of Bosch
- Due to the borderline low-pressure design concerning the return pressure, Bosch is proposing checking in each case one vehicle test for each platform and each brand (also Seat/Skoda), VW does not see any necessity for additional verification at Seat/Skoda

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Diesel Systems

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4. Steering committee VW/ Bosch

- Differences concerning low-pressure circuit between the vehicle platforms (PQ35/46, Audi longitudinal concepts) will be represented by VW by means of familiar parameter lists, in order to keep the expenditure as low as possible
- Mutual evaluation by VW and Bosch required for the concepts that are still to be checked
- Bosch system release extends to measured vehicles and/or vehicle variants with the same low-pressure circuit

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Agenda

4. Steering Committee VW / Bosch on 12/14/2007
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Diesel Systems

BOSCH

4. Steering Committee VW / Bosch

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1.1 Status of turned tappet - CP4.1

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SC 12/14/07 VW R4-low 2.0l CRS3.2

Status of customer test - **positively assessed**

		Nom	Status
CRI 3.2	Basic validation Engine full load	2 x 500 h	100 % (6 engines, Σ 4,247 h)
	Basic validation Engine program	3 x 1,000 h	20 % (1 engines, Σ 600 h
	Basic validation Field (incl. GDV)	5 veh. Σ 350,000 km	100% (8 veh., Σ 757,277 km ∅ ~ 95,000 km)
	Reliability validation Field *	13 veh. Σ 1,650,000 km	45% (8 veh., Σ757,277 km ∅ ~ 95,000 km)
CP4.1	Basic validation Engine full load	2 x 500 h	100 % (10 engines, Σ 6,433 h)
	Basic validation Engine program	3 x 1,000 h	70 % (3 engines, Σ 2,126 h
	Basic validation Field (incl. GDV)	5 veh. Σ 350,000 km	100% (5 veh., Σ 491,819 km ∅ ~ 98,360 km)
	Reliability validation Field *	13 veh. Σ 1,650,000 km	30 % (5 veh., Σ□491,819 km ∅ ~ 98,360 km)

-> So far 1 failure on the CP4.1 (38,000 km GER, drivetrain damage)

* Required for full warranty

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SC 12/14/07 VW R4-low 2.0l CRS3.2

Status of system verification in the VW Tiguan, Jetta and AUDI B8

	Load collective measurement	Vibrational acceleration on Bosch components	Maintaining flow and return pressure	Max. system temperature
VW Tiguan	✓	(✓)*	✓	✓
AUDI B8	✓	(✓)*	✓	✓
VW Jetta US07	✓	(✓)*	✓	✓

* Per. limit of 60g exceeded on the connectors, post testing of critical components on the CP4.1 positive

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CP4 testing status, Audi LK 12/06/2007

Project	Status	Comment
Audi		
V6 EU5/CO2	Green	In series
V6 Bin5/EU6	Yellow	Comp. ER: running, so far no failures, 2x with lateral start-up Engine test KST: 2 x failures - drivetrain damage Engine test Audi: so far no failures, so far 4 returns pos. assessed Com: Returns VW-CP4.1 from US testing so far no striking features (so far 12 pumps)
V8-Q7 (GP)	Green	Comp. ER: ended, no failures, findings not yet concluded
V8-D4	Green	Comp. ER: in set-up
V12 (GP)	Green	Comp. ER: completed successfully, GP findings not yet concluded
VW		
R4	Green	In series
R4 Bin5	Green	Comp. ER: completed successfully, 1 x bearing melted, reappear test positive, returns VW-CP4.1 from US testing so far no striking features (so far 12 pumps)

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Status drivetrain damages - 12.14.2007

- Failure hypothesis 3: Stiff roller, initial commissioning at small engine speed, confirmed

Measures package 1 adopted on 07.23.
- Optimization of engine speed profile of test bench (n > 500 rpm)
- Uncoated spring plate (anti-friction coating omission)
- Dry pressing in of roller support / tappet body
- Cylinder head assembly with 5° allowance for relaxation of tappet spring

- Failure hypothesis 6: Turned tappet > 15° during assembly of tappet group, confirmed

Measures package 2 adopted on 08.28.
- Visual inspection + impact time of tappet body during assembly, further failures in click-clack testing

Also:
- Inspection of the mounting position alignment of the tappet body using laser sensors D: WK 46-50/50 FeP
  Implementation in JhP planned before 01/2008

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Status drivetrain damages - 12.14.2007

- Failure hypothesis 4: stiff roller
- Failure model 'thermal bump' due to elevated fault confirmed for LR seizures, through boundary sample tests (see below) and FEM calculation.
  Suspected cause: single C coating error
- 2100 production parts examined using WP method, abnormalities are currently being examined using tactile measurement method, SEM and FIB.

- Extreme tests with impermissible excessive abnormalities
  - Spot fields -> no failure
  - nm deposit -> no failure
  - Bump -> failure

- 2 part 4 (of 2,100) found so far with a bump, but not in the main load direction.
  FIB analysis (Focused Ion Beam) is running.
  Objective: Finding a bump in the main load direction, pump test, proof of failure.

Image of coating flaws WP measurement results

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Status drivetrain damages - 12.14.2007

- **Further procedure:**

- **Damage mechanism:**

- Additional damage challenge tests seizures with faults

- **Fault prevention:**

- Improvement of the C3 coating quality, sustainable elimination of metal splashes

- **Fault detection:**

- Friction coefficient test fluctuating below +-10° D:WK 50 FeP, 01/2008 JhP

Objective: Increase detectability of fault parts

- Retraceability of C3 batches to readings show correlation between failure rate in friction coefficient testing and C coating batch -> Rejection rate for friction coefficient testing does not correlate with failure rate.

- New pump testing program with improved flushing action and a high proportion of full load since 11/16/2007 in use at pilot customer. Not accepted by AUDI / VW yet.

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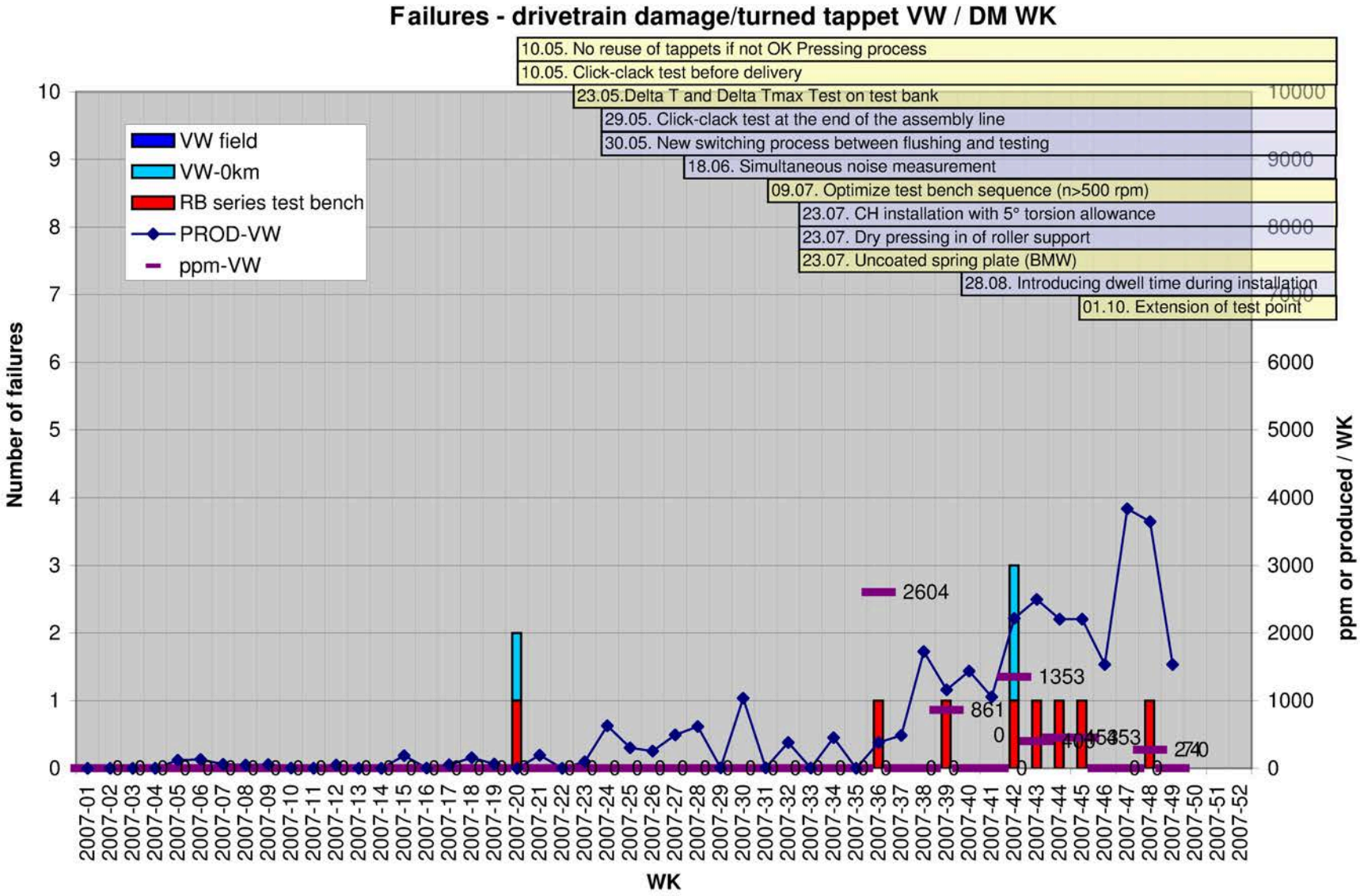

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Production figures referring to SAP delivery date

Status: 12/11/2007

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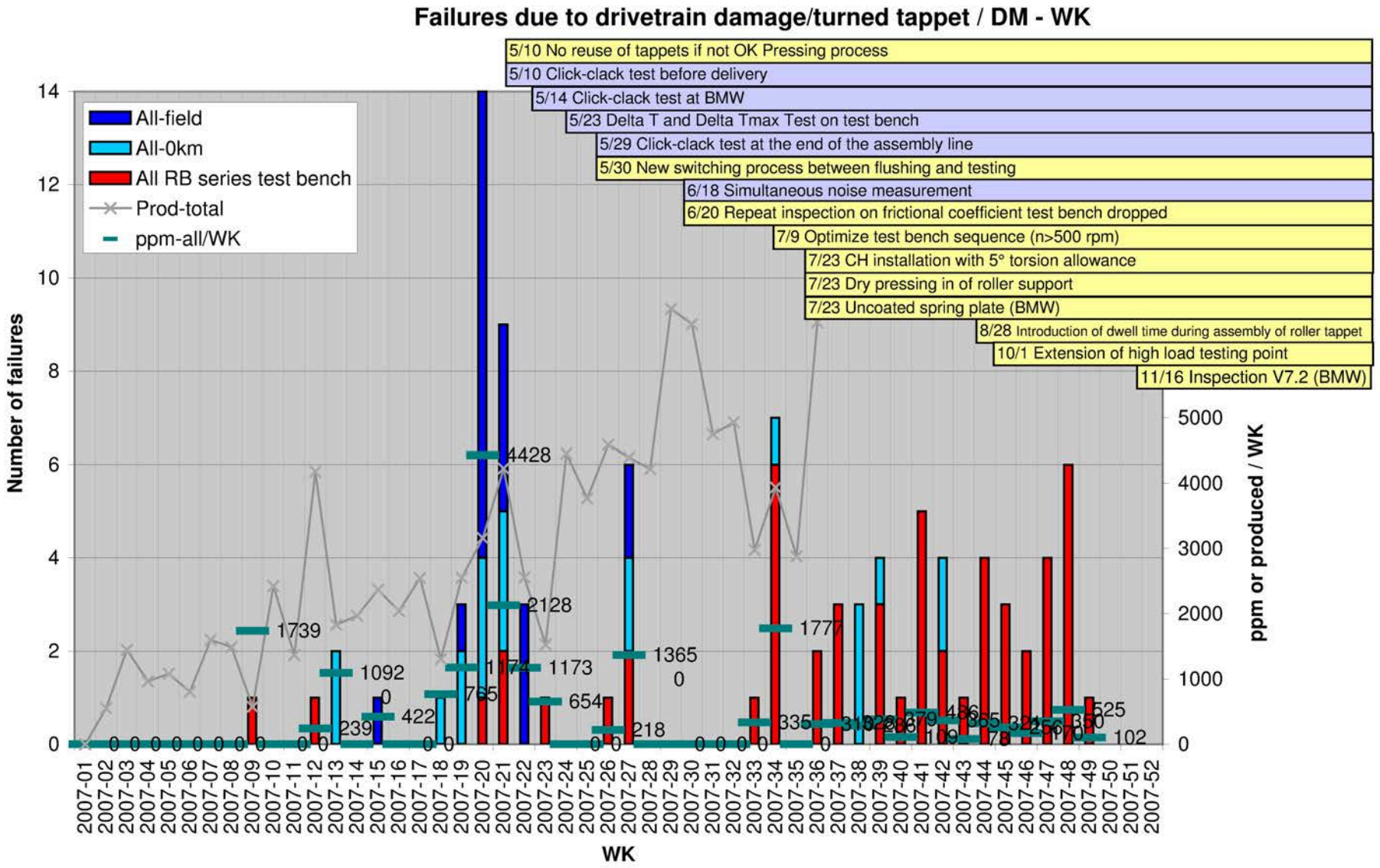

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Status: 12/11/2007

Optimization of product - test run

Objective:

→ Pumps in test run loaded earlier and for longer (speed, max. rail pressure)

=> more time to recognize drivetrain damage by detecting an increased return temperature

=> targeted relaxation of tappet assembly due to greater speeds

=> improved residual particle values

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Optimization of product - test run

Status today

→ Ventilate	0 rpm	0 bar	5 bar
→ Flush	500 rpm	300 bar[1]	3.7 bar
	1,000 rpm	„	„
	1,500 rpm	„	„
	2,500 rpm	„	„
→ Warm run-up	2,500 rpm	500 bar	„
→ 1st measurement	3,375	„	„
→ 2nd measurement	3,375	„ (1,2A)	„
→ 3rd measurement	1,000	1,800 bar	„
→ 4th measurement	200	200 bar	„

optimized

→ Ventilate	0 rpm	0 bar	**5.5 bar**
→ Flush	500 rpm	300 bar[2]	„
	1,000 rpm	„	„
	1,500 rpm	**500 bar**	„
	2,500 rpm	„	„
→ Align	**4,000 rpm**	„	„
	3,375 rpm	„	„
	„	**1,200 bar**	„
→ Warm run-up	„	**1,800 bar**	„
→ 1st measurement	1,000 rpm	„	
→ 2nd measurement	3,375	500	„
→ 3rd measurement	3,375	„ (1,2A)	„
→ 4th measurement	200	200 bar	„

[1]...via rinsing nozzle

[2]...via rail

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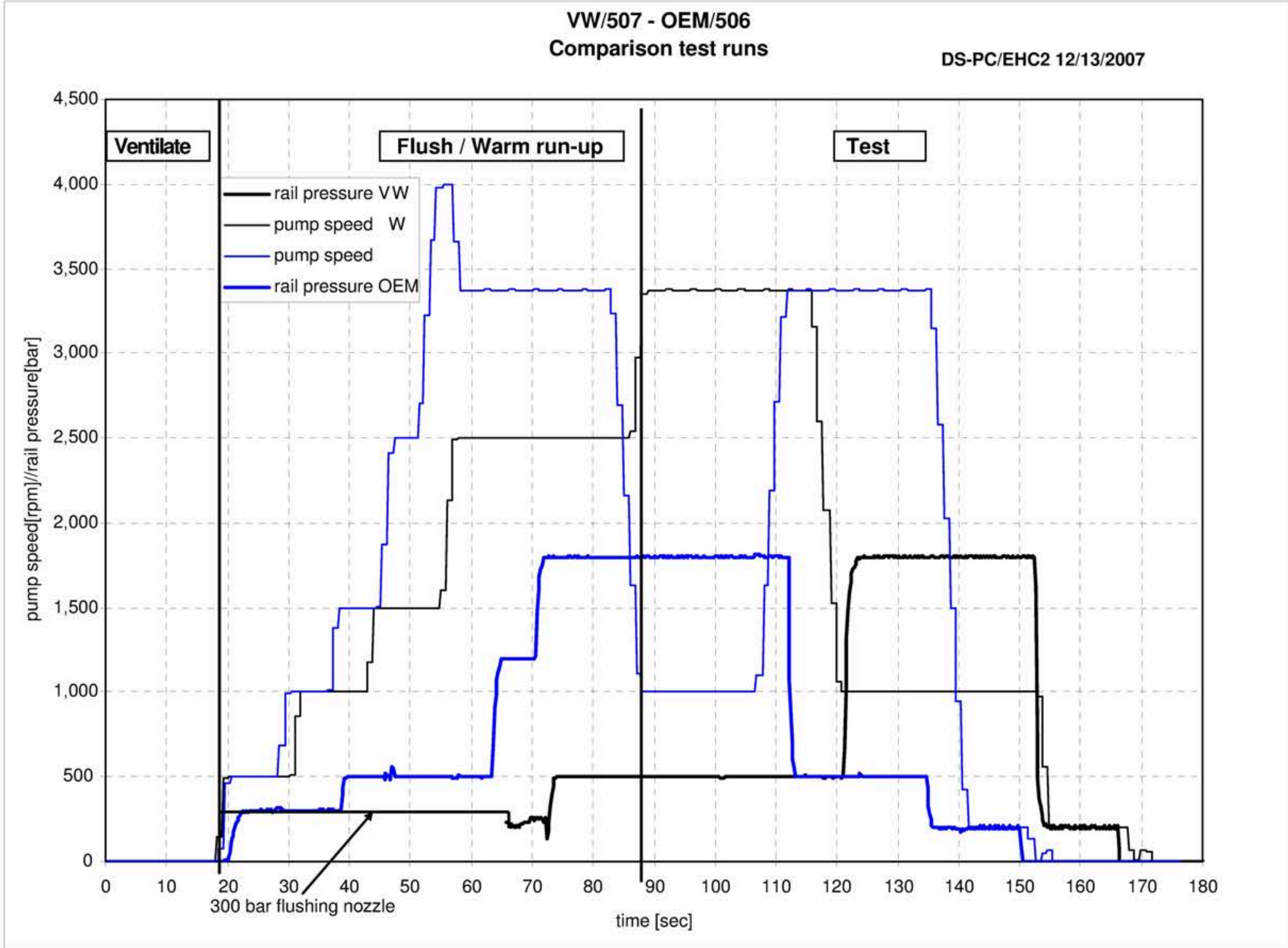
Comparison of VW test run - status today vs. optimized



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Optimization of product - test run

Verification

Test	Quantity	Analysis results
→ Dismantling test:	40 pumps	No striking feature
→ Residual particle analysis	10 pumps (out of 40)	Tendency better
→ Crash tests:	20 pumps	No striking feature
Crash program:	(4x) Jerk up 0->4,000->800 rpm / 1,800 bar	

→ Introduced for pilot customers

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CI 4.1 VW R4 2.0L Special meeting 12/19/2007

RB:	Name	R:(Dept.)	D (WK)	Sig./ Date
1.	Checking the evaluations and results (see page 4)	Non-responsive content removed	12/17/07	Non-responsive content removed
2.	Development release		12/19/07	
3.	Release of the quality assurance		12/19/07	
4.				
5.				
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9.				
10.				
VW	**/Audi**			
1.	Customer approval VW			
2.				

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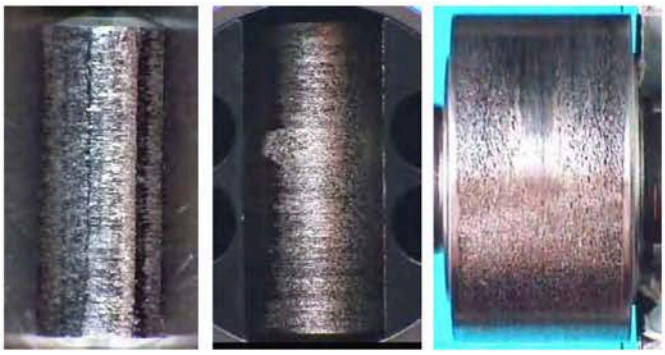
CRP CP4.1 and 4.2 - AUDI
0km complaints - FeP

Drivetrain damage

Scope of defect

- 0km: 5 x pumps 0445010611/ 059130755AB
- DM 2 x 05/14/2007
  2 x 09/20/2007
  1 x 09/28/2007
- GR 07/06/2007 / 10/26/2007 / 11/07/2007 / 11/14/2007



Description of problem

- Vehicle cut-off
- Injectors contaminated with particles

Cause analysis

- Considerable wear across the entire coating surface of all rollers and camshafts
- Diameter of the roller considerably reduced so that it could no longer be held by the roller support
- Turned tappets most probably primary damage

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CRP CP4.1 and 4.2 - AUDI
0-km complaints - Feuerbach plant

Measures

- PHA carried out in Dresden on 7/12/2007
  Result: Commissioning conditions not according to specification. Commissioning of the pump has been changed
- Optimization of test bench process - RB
  D:07/09/2007 compl.
- CH assembly with 5° torsion allowance
  D: 07/23/2007 compl.
- Dry pressing of roller support
  D: 07/23/2007
- Introduction of dwell time during assembly of roller support
  D: 8/28/2007
- Extension of high-load testing point
  D: 10/1/2007

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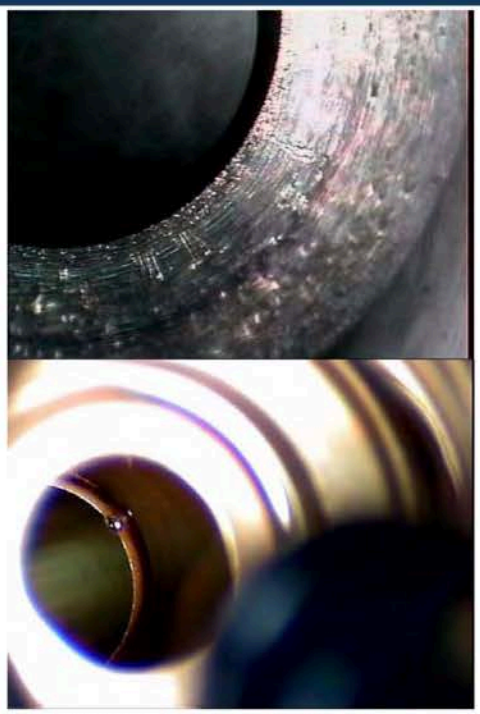
Leaky non-return valve



Scope of defect

- 0km: 1 x pump 0445010611/ 059130755AB
- DM 8/21/2007
- GR 9/27/2007

Description of problem

- Fuel rail system pressure too low

Cause analysis

- Non-return valve leaking during pressure test
- Impressions on cylinder head seat of the RSV. Suspect particles, but could not clearly confirm this.

Measures

- Optimization of particle situation CP4
  Focus on cylinder head and housing

R: Working group

Damaged O-ring MU

Scope of defect

- 0km: 5 x pumps 0445010507/ 03L130755
- DM 10/5/2007
- GR 11/21/2007 / 12/10/2007 / 12/13/2007

Description of problem

- Rail pressure too high during yard drive

Cause analysis

- Measurement of housing geometry and tool. -> No items of note
- Assembly tests with dry press-in O-rings. -> Damage possible on O-ring
- Assembly test in WaP O-ring pre-assembly -> Damage to O-ring if assembled in incorrect order possible; Possible twisting of O-ring during assembly
- Analysis of the fracture surfaces of 5 O-rings (microscope, SEM)
  3 x failure parts, 1 x test in FeP, 1 x test in WaP

Fracture structures of the failure parts and of the O-ring damaged in the FeP test are similar, O-rings have been twisted

CRP CP4.1 and 4.2 - AUDI
0km complaints - FeP

Damaged O-ring MU

Cause analysis

Summary: In the case of simultaneous occurrence, faults could be found at the following points

- MU O-ring not oiled when assembled in the pump
- “crooked” join of the MU in the MU bore
- O-ring on MU twisted when assembled

Measures

• FeP: Change the assembly sequence (ensure oiling)	D: 11/22/2007
• FeP: additional visual inspection for pre-damage	D: 11/22/2007
• WaP: Assembly of O-ring with joining aid to prevent twisting of O-ring	D: 1/7/2008
• WaP: Spatial decoupling of strainer and O-ring assemblies	D: 01/07/2008
• WaP: Change from MU production from small series line to large series line with mechanical O-ring assembly	D: 2/1/2008

Release by VW / Audi being clarified

Bruss shaft seal (BSS) folded

Scope of defect

- 0km: 2 x pumps 0445010507/ 03L130755
- DM 11/9/2007
- GR 11/30/2007

Description of problem

- Pump leaking

Cause analysis

- Assembly of 7 pumps with folded BSS and subsequent He leak test -> all pumps very leaky — D: 11/29/2007 compl.
- Test BSS in the SEM for run marks — D: 12/11/2007 compl.
  -> Rotation marks on the camshaft in the folded area
- Try to reproduce fault pattern on the test bench — D: 12/11/2007 compl.
  -> Partial folding of the BSS could be relatively reproduced with an inlet pressure of 6.8 bar

BOSCH

CRP CP4.2 - AUDI
0km complaint - FeP

Measures

- Sorting action in Feuerbach and Györ for folded shaft seals on flange – Result: All checked pumps OK
- Visual inspectors have been instructed to look out for the faults.
- On-site visit to Audi in Györ for a mutual assessment of the test conditions in the engine plant

Conclusions

- Incorrectly assembled BSS at RB detected in the leak test
- Failure part also shows smoothing tracks in the folded area => The BSS was not folded during the functional check at RB
- After functional check, pumps were visually inspected twice (completion, barriers) – so far no pump with partially folded BSS came to attention
- BSS will probably fold during the hot test

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Intake valve leaky

Scope of defect

- 0km: 5 x pumps 0445010507/ 03L130755
- Field: 1 x pump 0445010507/ 03L130755
- DM 11/8/2007
  9/28/2007
  10/31/2007
  11/8/2007
  09/17/2007 **Field**
  10/31/2007
- GR 11/30/2007 / 12/03/2007 / 12/13/2007 / 12/14/2007 / 01/11/2008 / 01/16/2008

Description of problem

- Pump does not develop any rail pressure

Cause analysis

- Cylinder head leaking in the analysis
- Chip discovered and secured in the intake valve
- Material analysis of the particles

CRP CP4.2 - AUDI
0km complaint - FeP

Cause analysis

- Intake valve in the cylinder head leaking in four cases due to particles. In two cases, the particles could not be retrieved, but the leaking was detected
- Material and dimensions of the particle
  - Al from housing — Length 976 µm narrow
  - Mn/Fe alloys on several parts of the pump — 334 µm quadratic
  - Fe alloy not included in the pump Height — 340 µm 1200 µm length
  - Mn/Fe alloy on several components in the pump — Length 1.65 mm narrow

Measures

- Optimization of particle situation - CP4
  Focus on cylinder head and housing — R: Working group

Cylinder head CP4 – breakdown Field complaint

Pump type:	0445010611/ 059 130 755
AB Failure date:	1/17/2008
DM - pump	9/29/2007
Cons. no.:	01-0141
Mileage:	1,771 km
Vehicle:	Q7 3L V6 TDI CR
Failure:	Breakdown - field complaint

Cause of failure:
Vibration rupture, starting from a non-metallic inclusion
Inclusion could not be detected using state-of-the-art standard test methods (CDR 0.7).

Process-improving measures at the material supplier:
- 3-gate valve December 2007

Failure prognosis:
Individual fault, experience values pump/nozzle unit: approx. 1 ppm

OPL PHA [redacted] 05/09/2007

Participants VW: Audi
Participant Bosch:
Next meeting:

done
important
Changes compared with last status

Cons. no.:	Topic	Component	OPL point	Measure	Responsible	Deadline	Status
[redacted]							
19	Assembly	CP4	Third screw difficult to fit, as only the first 2 screws are tacked and screwed in	Tack all three screws before tightening	[redacted]	WK 20	
20	Assembly	CP4	Degrease the cone of the pump camshaft. According to statement from [redacted] - not necessary (experience from CP3)	1) Clarification with Mr [redacted] 2) Check between series status and “dry” with RB		WK27	
21	Assembly	CP4	Hub installation -> nuts partially with chips in the thread	Clarification with supplier		WK 20	
[redacted]							

Causes and measures

- ➔ Elevations on the roller
  - Impact of elevations on the roller
    - Assessment through large trial
      - Documentation of the failure potential of the elevations on roller fault pattern in the short-term area (functional test) and as medium/long-term failure (0-km/field).
      - Set-up of 50 pumps (if possible) with documented elevations (WLI measurement + EDX analysis).
      - Documentation of tappet assemblies before and after friction coefficient check
      - Installation of tappet assemblies in pumps. Documentation of tappet assemblies after functional test – Evaluation of failures
      - Definition of selected pumps for a short ER

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Causes and measures

- Elevations on the roller
  - Identification of elevations on the roller
  - Current identification of elevations: The identification of rollers with elevations is very difficult. The visual inspection is very error-prone.
    - Currently no failures in the visual inspection
  - Measures to improve identification of elevations
    - Set up a simple device in which the roller is rolled manually against a sharp edge (blade).

Causes and measures

- Elevations on the roller
  - Schedule to improve identification of elevations
    - Set up simple testing device — D: 04/04
    - Test the device on the current series — D: 04/04
    - Selection of striking rollers from the current series (Prerequisite: The device works and a sufficient number of parts is found) — D: 05/02
    - Documentation + measurement + EDX analysis of striking parts (parallel to 3) — D: 05/09
    - Assemble tappet assemblies, Friction coefficient check and before/after documentation — D: 05/09
    - Installation of tappet assemblies in pumps. Execution of functional test — D: 05/15

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Causes and measures

- Elevations on the roller
  - Schedule to improve identification of elevations
    - Assessment of results + decision of ER pumps — D: 5/16
    - End of short ER test (100h) — D: 5/26
    - Complete major trial — D: 5/27

Remark

The above schedule always indicates the end of an activity for all 50 pumps. Many of the activities will run in parallel, which means interim results will be possible. A prerequisite for a successful trial is the functioning detection of elevations and the identification of a sufficient number of elevated rollers