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 AIRBUS HELICOPTERS QUALITY MATERIALS & PROCESSES LABORATORY		SYNTHESIS REPORT 2020-3223 indB <i>(Cancels and replaces the version without index)</i> Airbus Helicopters - LMP - Aéroport International Marseille Provence - 13725 Marignane	
Affair/Order number	2020-0456		
Affair designation	Hydraulic pump drive bearing seizure POST MOD 07-9568		
Requested by	[REDACTED]		
Reference document	BEM N° ETMD-2020-47403, BEM N° ETID-2020-47697B, ISIR EC-1865C		
Attached report	U9-184/20, 2021-40137, 2021-40244		

Issue date	29/04/21
Affair/order followed by	[REDACTED]

Helicopter N° :	AS 350 B3	Part number:	350A35013201 (Post Mod 07-9568)
Customer/user:	MACNEIL AVIATION LLC	Part Designation:	Hydraulic pump drive assy
Operating hours:	108	Supplier:	Not applicable

Distribution list :	[REDACTED]
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ETXLL	ETXLL
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
When the report is available in different languages, the native language (if available) in which the report is written prevails. This test report and the results concerns specimens submitted to tests only. The reproduction of this report is authorised only in its integral form.	

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1. CONTEXT

Inspection revealed the hyd belt shredded and detached from the pump. Moreover, the pump pulley bearing is seized. The aircraft was towed from the runway to the ramp.

This event was declared to NTSB and EASA.

The objective of investigations is to disassemble the pump in order to check and assess all the internal components of the pump and its blocking or non-blocking.

2. CONCLUSION

The observations on the elements of the hydraulic pump drive assembly are as follows :

The rotation of the **pump** is possible.

The rotation of the **pulley** is impossible. In the thread, belt residues are found and surface oxidation is observed. This damages are probably due to overheating resulting by the locked rotation of the pulley.

On the inner diameter, material repulsions due to a smearing phenomenon are observed. They are probably created when the bearing is fitted in the pulley. This material repulsions can lead to improper placement of the bearing in the pulley.

In the thread (360°) of the **driving pulley**, belt residues are found and surface oxidation is observed. This damages are probably due to overheating resulting from the locked rotation of the pulley.

After opening and cleaning the bearing, a small amount of dry grease is found showing abnormal operation.

Both **flanges** have scratches and drips showing loss of grease. The end of the flange seal, drive shaft side, is torn off.

The laboratory was informed (by the design office) that the lids are pre-drilled in new by the supplier to facilitate regreasing in use. Tests of lids drilling, carried out by the laboratory (see report 2021-40244), have shown that observation of the lids condition doesn't make it possible to determine if bearing has been regreased.

Drive shaft side of bearing, plastic deformation of the surface raceway of the **inner ring / outer ring** is present: pile up of material is observed probably due to locked balls which slid on the raceway.

The **cage** present significant wear of the cells with material removal. Drive shaft side, material removal causing material pile up and then material pick-up.

The surface of the **balls**, drive shaft side, show plastic deformation which can cause bad rolling / lock of the balls in the cage. The locking of the balls leads to the pile up of material observed on the raceways of inner / outer rings.

The microscopic section of a ball (drive shaft side) with a plastic deformation showed a microstructure modification on the surface of it. *The tempering temperature of the material () of the balls and outer/inner rings is about 140°C.*

We can say that the bearing reached temperatures of a least 140°C which resulted in a loss of mechanical properties of the material (as illustrated by the modification of the microstructure), causing the plastic deformations observed on balls and also on the raceway of the inner ring and outer ring, drive shaft side.

Degradation of the bearing conditions, leading to a lock of the hydraulic pump assembly, are probably due to the improper placement of the bearing in the pulley resulting in an increase in temperature then degradation of the grease.

The dimensional control of the pulley (see report U9 - 184/20) showed a non-compliance of the inner diameter, which could be related to the improrper placement of the bearing.

Regarding the hardness tests carried out on the inner ring, outer rings and ball, even if the hardnesses obtained are compliant with the drawing, the microstructure shows that the material is affected.

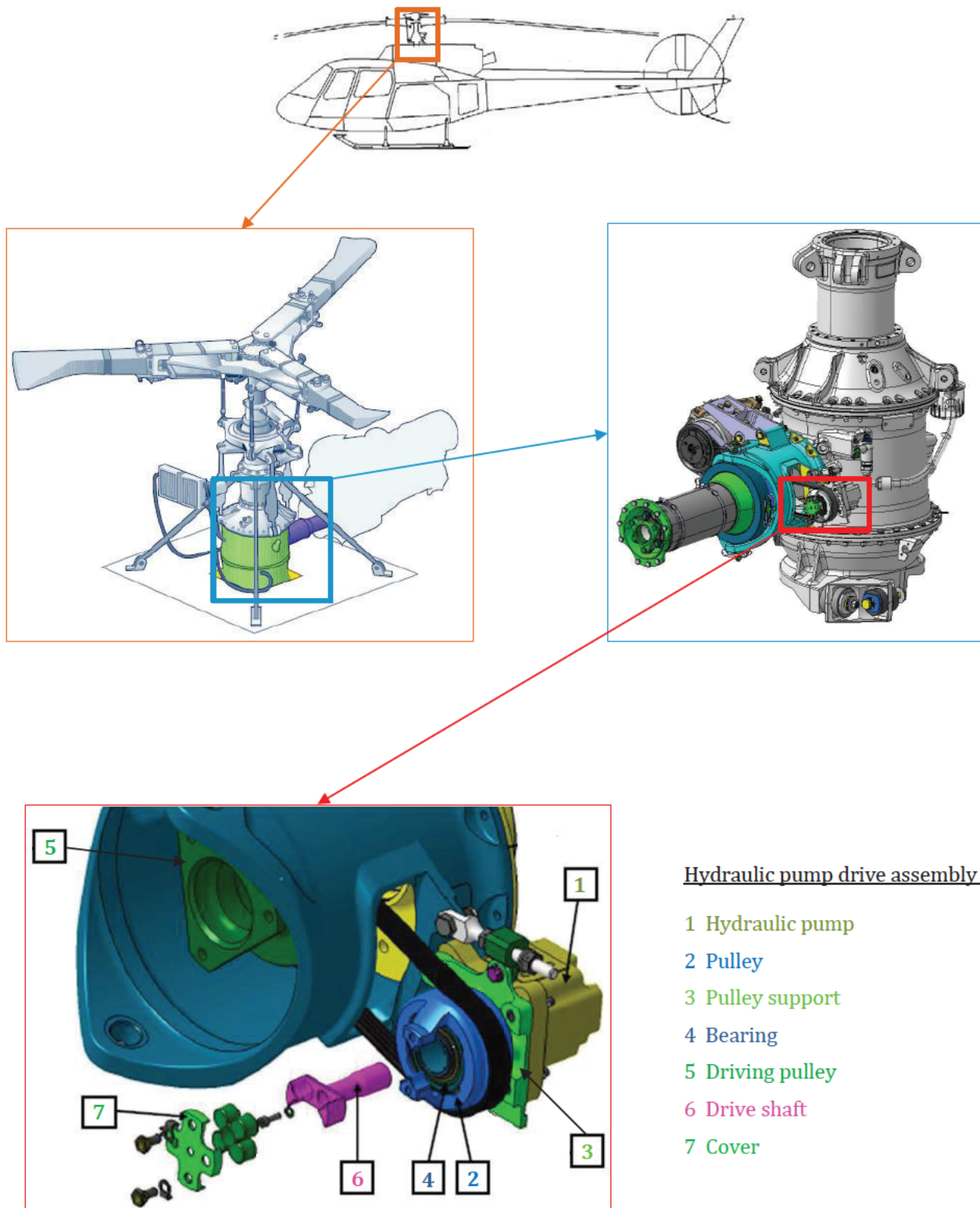
3. LOCALISATION OF SPECIMENS/SAMPLES SUBMITTED TO TEST ON THE HELICOPTER AND/OR PARTS

CUSTOMER	MACNEIL AVIATION LLC		
HELICOPTER	AS 350 B3 (8594)	OPERATING HOURS	108

SUB ASSEMBLY DESIGNATION	Hydraulic pump drive	SUPPLIER	Not applicable
SUB ASSEMBLY REFERENCE	350A35013201 (Post Mod 07-9568)		

LABORATORY REFERENCE	PART DESIGNATION	PART REFERENCE	MATERIAL	MARKING
2020-0456-1	Hydraulic pump	P/N 704A34310004 S/N A5015280	NA	A5015280 AM.E 704A34310004 190203938
2020-0456-2	Pulley	P/N 350A35131520 S/N 501776	██████	350A35131520 501776 (MGP/RL)
2020-0456-3	Pulley support	P/N 350A35130000 S/N MGPA 1685	NA	350A35130000 MGPA1685 (MGP/CC)
2020-0456-4 Bearing	Inner ring	P/N 704A33651269 S/N 15-15733	██████	704A33651269 15-15733 1294538-33 D2456 FAG 594976 GERMANY
	Outer rings		██████	
	Cage		██████	1297924-232
	Balls		██████	NA
2020-0456-5	Driving pulley	P/N 350A35109420 S/N 55992	██████	350A35109420 55992 (MGP/KT)
2020-0456-6	Drive shaft	P/N 350A352520 S/N 54842	██████	350A35132520 54842 (MGP/JS)
2020-0456-7	Cover	P/N 350A35132020 S/N 46455	██████	350A35132020 46455 MGP/LT

AS 350 B3



4. LABORATORY RESULTS

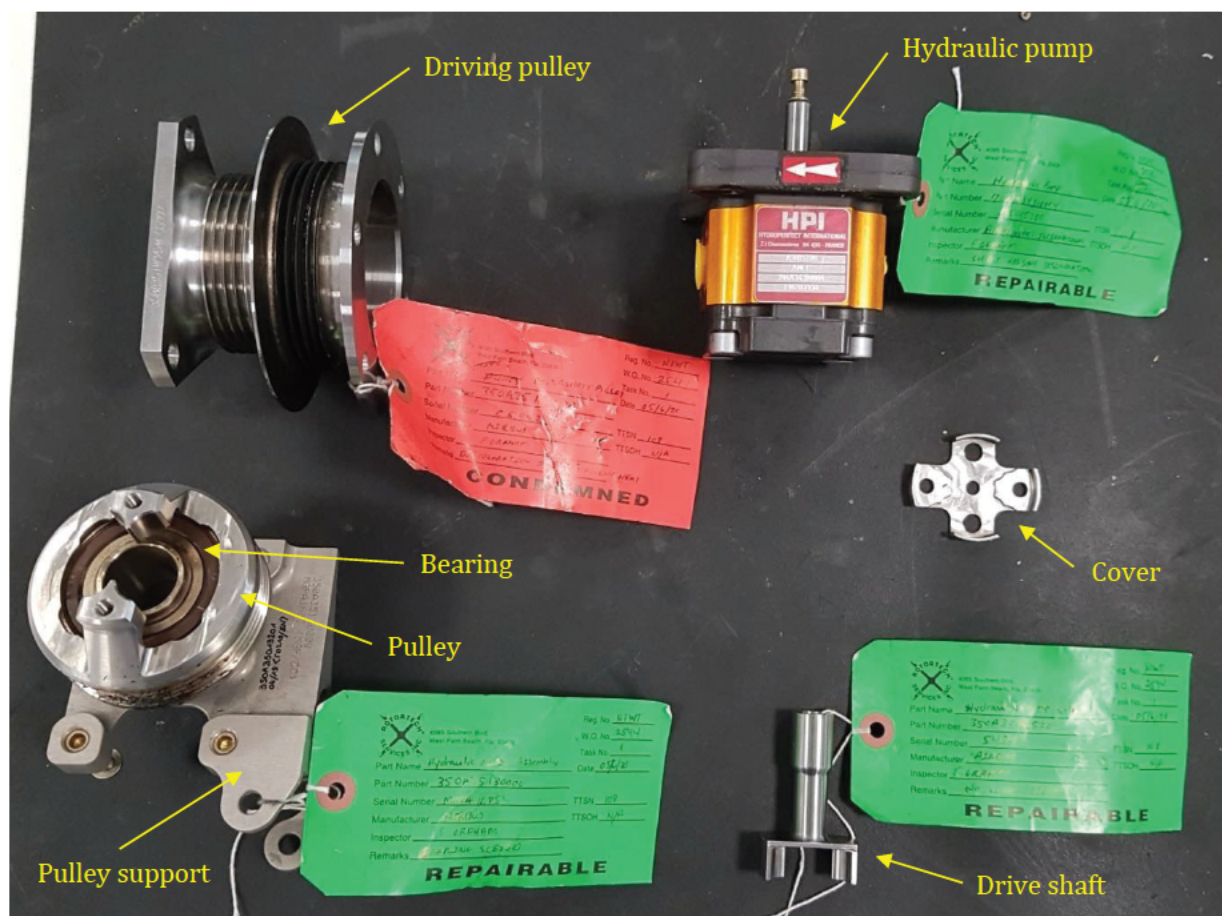
4.1 LIST OF TEST REPORTS

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Test report No	Title of the test report	Test performed
2021-40137	Laboratory test report	Hardness test
2021-40244	Laboratory test report	Drilling tests of bearing regreasing lids

4.2 EXAMINATION

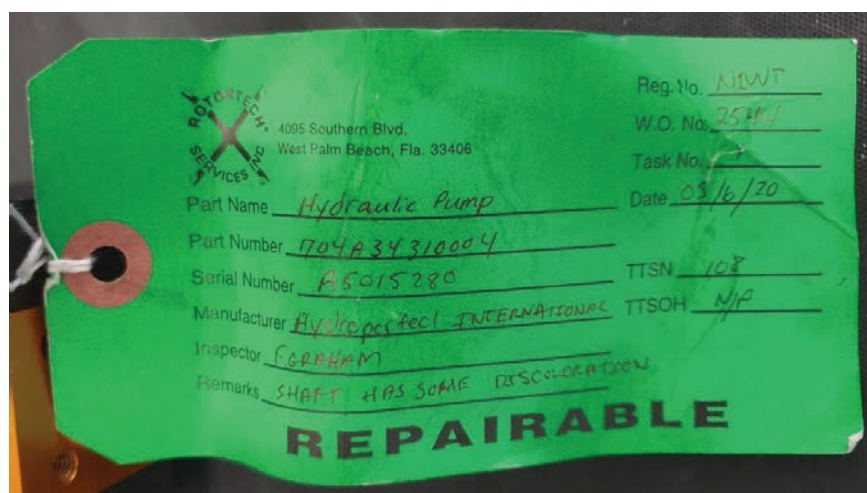
Parts received by the laboratory as part of the expertise :



Expertise relates to all parts, it is carried out according to the examination plan provided by NTSB (No. ENG20NA031).

4.2.1 HYDRAULIC PUMP

➤ Identification



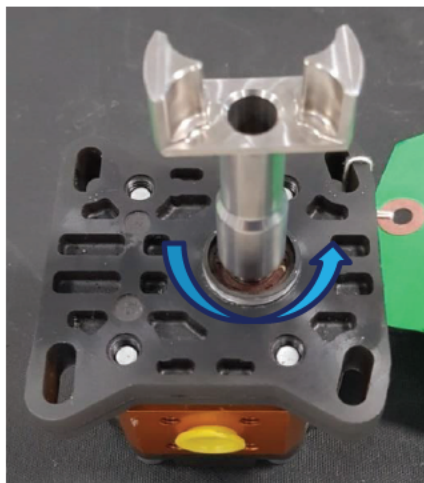
Marking on part : A5015280

AM.E

704A34310004

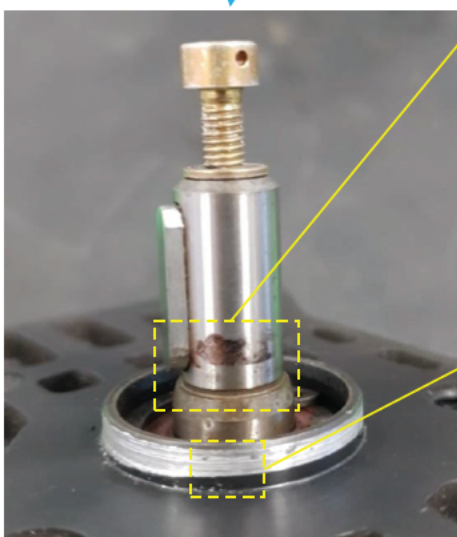
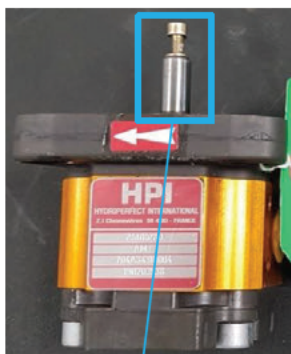
190203938

➤ Pump rotation

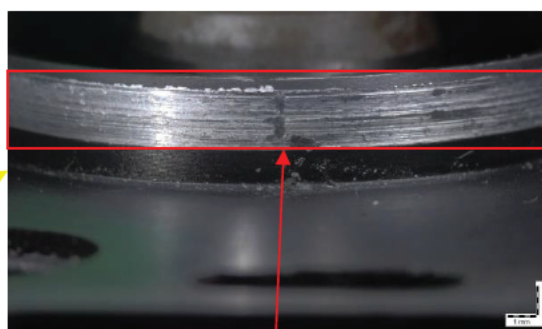


Using the drive shaft, the rotation of the pump is possible.

➤ Damages observation



Fretting and corrosion are observed on the axis (on 90°).

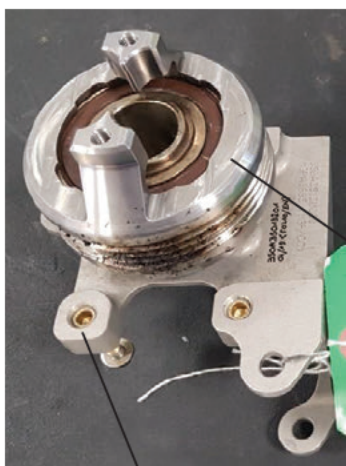


Friction marks are observed, on 360°, probably due to the assembly/disassembly.

No sign of overheating of the pump housing or leakage is observed.

4.2.2 PULLEY SUPPORT AND PULLEY

➤ Identification

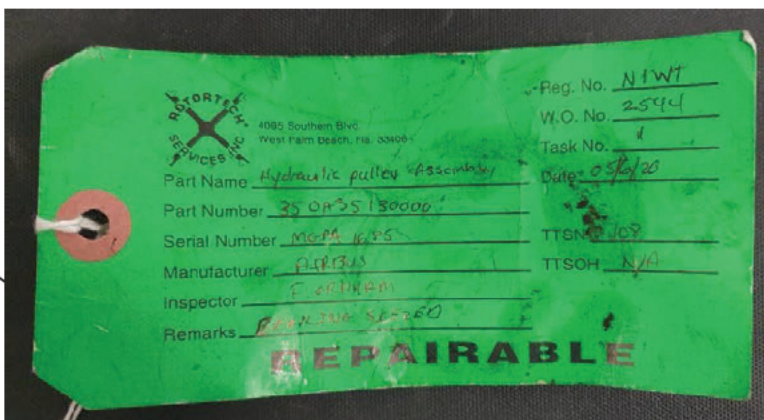


Pulley support



Marking on part : 350A35130000

MGPA1685 (MGP/CC)



Pulley

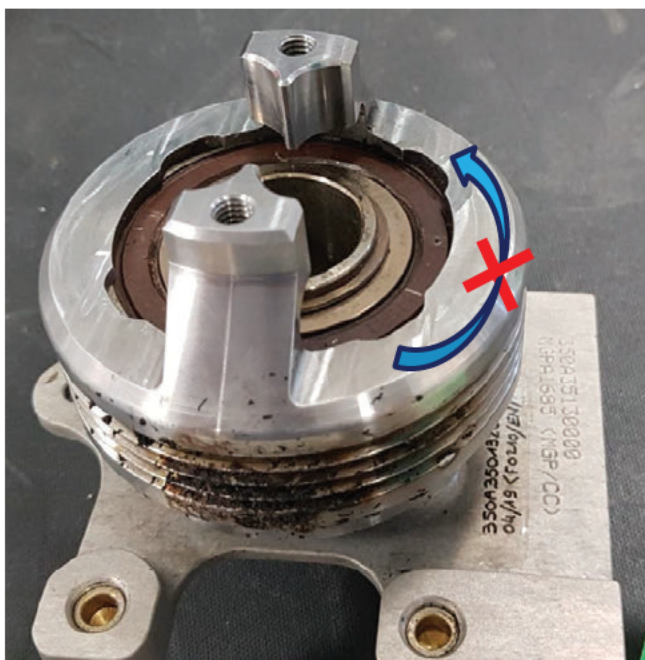


Marking on part : 350A35131520 501776 (MGP/RL)

Assembly marking : 350A35013201

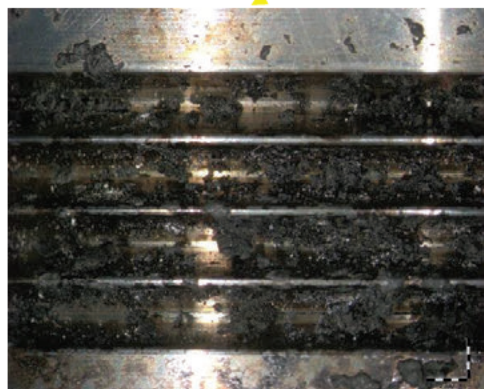
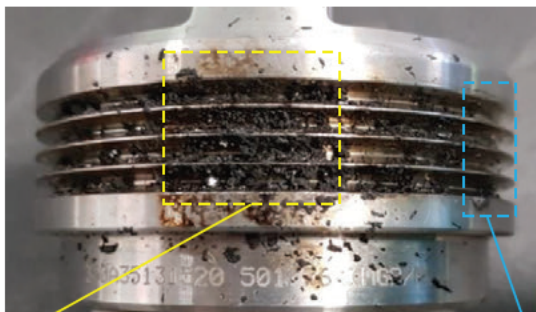
04/19 <F0210/EN>

➤ Pulley rotation



Rotation of the pulley is not possible.

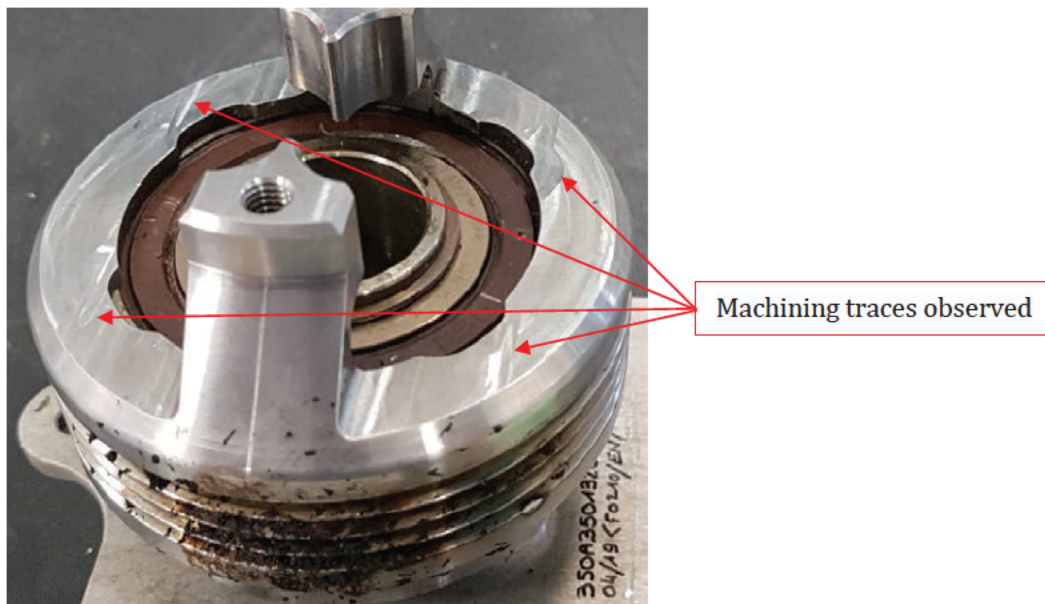
➤ Observation of pulley damages (before disassembly)



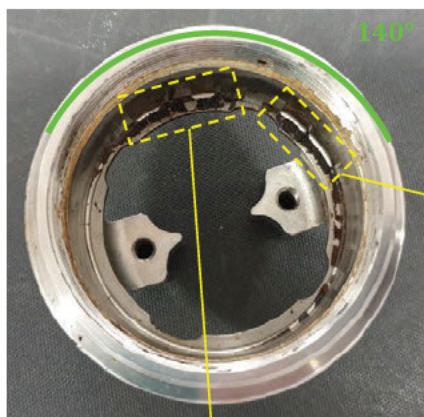
In the thread, on approximately 100°, black residues are observed. It is most likely belt residues.



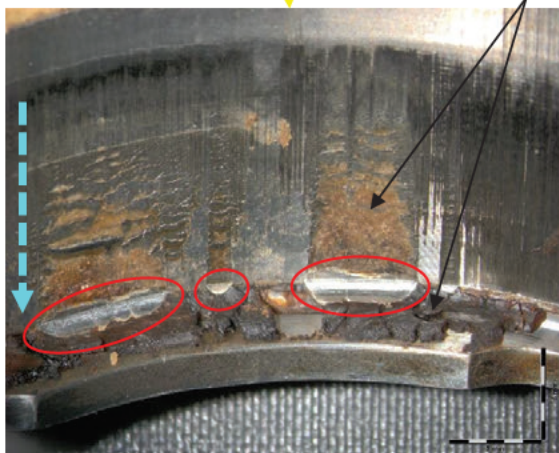
Surface oxidation is observed in the thread (360°), probably due to overheating.



➤ Observation of pulley damages (after disassembly)



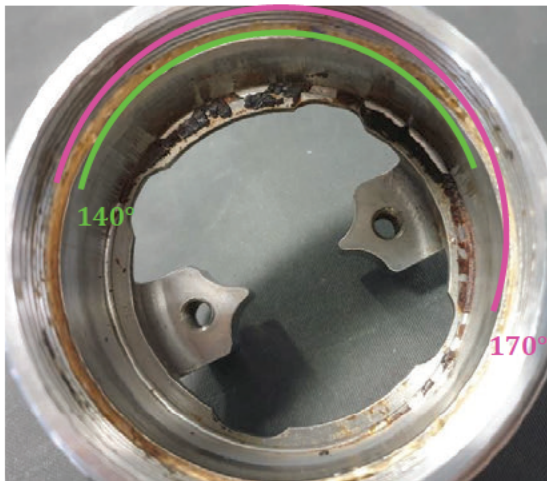
Grease residues



On the inner diameter (140°), **material repulsions** due to a smearing phenomenon are observed. They are probably created when the bearing is fitted in the pulley. Material repulsions can lead to improper placement of the bearing in the pulley.

Grease residues are also present.

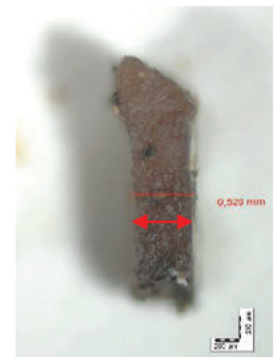
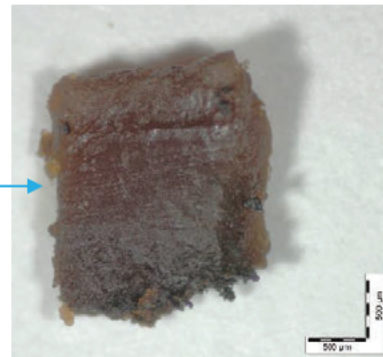
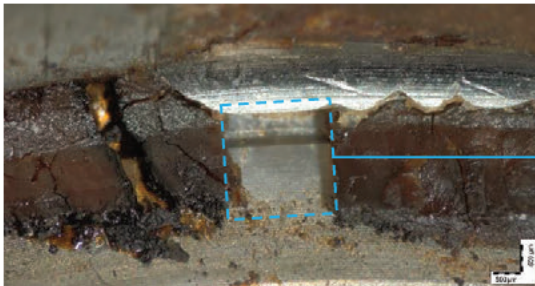
Location of grease residues :



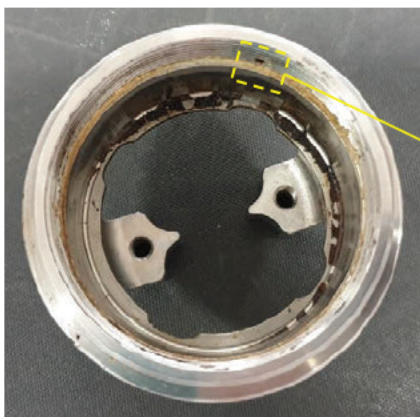
Grease residues
Material repulsions

The grease residues observed come from the bearing during its fitting in the pulley.

The residues are located on the section of 170° where the bearing is probably not in contact with the end (drive shaft side) of the pulley. This illustrates the improper placement of the bearing in the pulley.

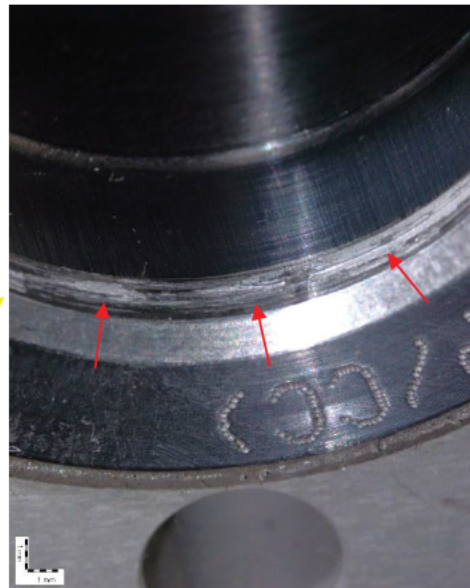
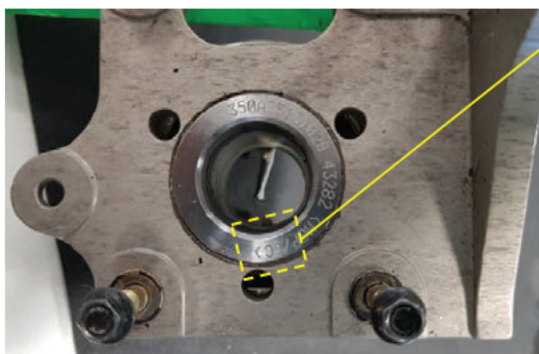
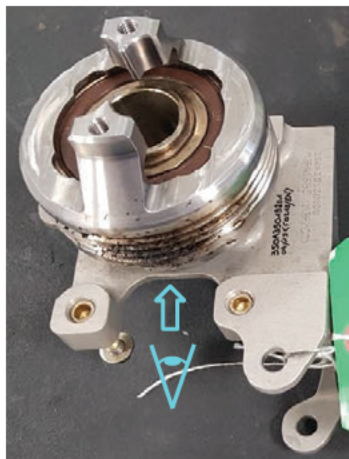


A piece of grease residue is taken to measure its thickness to estimate the gap between the bearing and the end of the pulley.
The measured thickness is 0,52 mm.



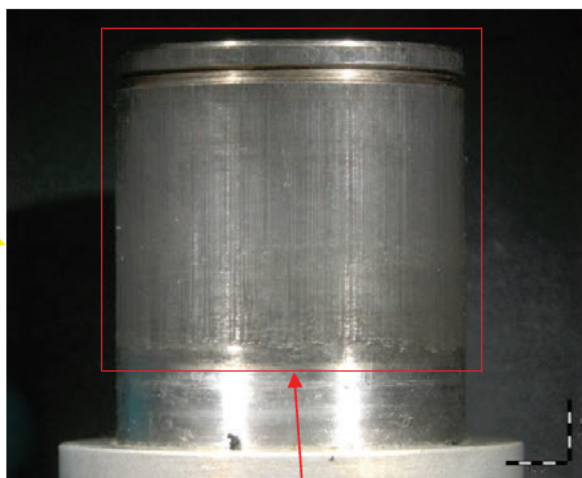
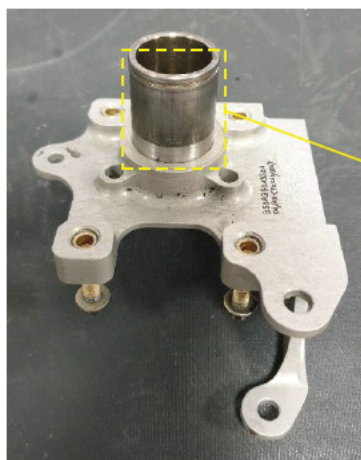
Grease residues observed (360°)

➤ Observation of pulley support damages (before disassembly)



On 360°, friction marks were observed, probably due to the assembly/disassembly.

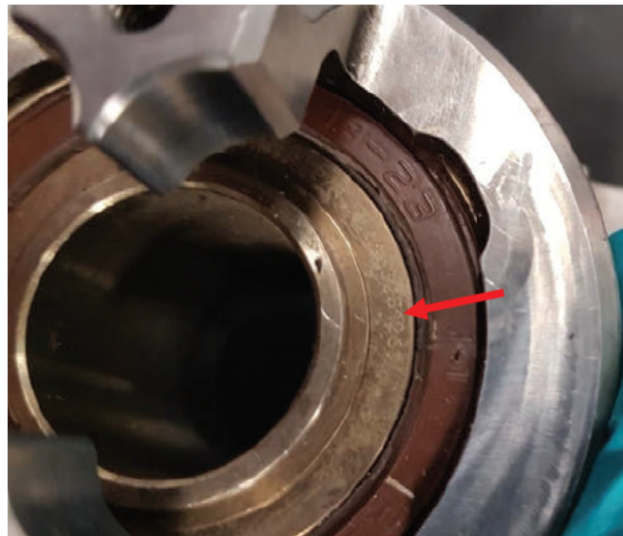
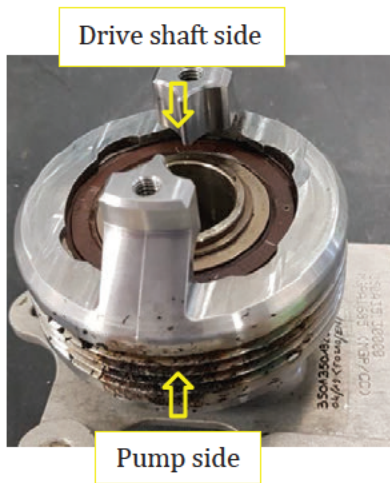
➤ Observation of pulley support damages (after disassembly)



Presence of longitudinal scratches on the stud (360°), on which the inner ring of the bearing is fitted. They were probably caused during assembly/disassembly.

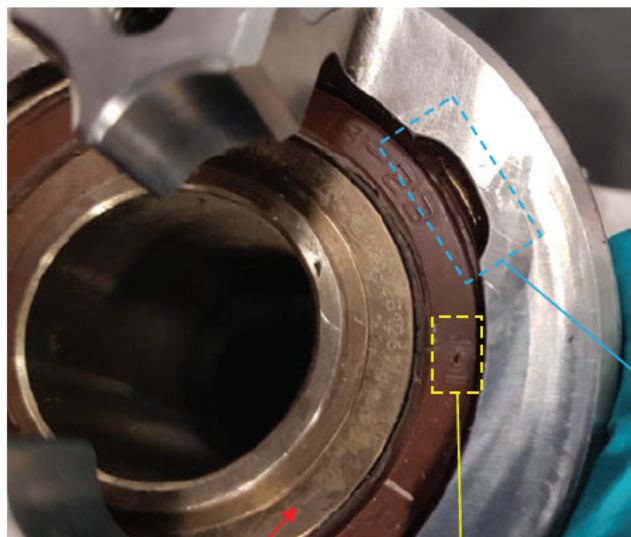
4.2.3 BEARING

4.2.3.1 Identification



Marking on part : 704A33651269 15-15733 1294538-33 D2456 FAG 594976 GERMANY

4.2.3.2 Damages observation (before disassembly)



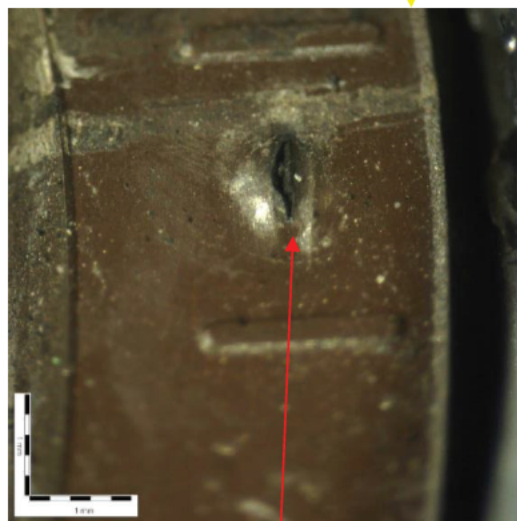
An oxidation of the inner ring is observed, probably due to overheating.



Presence of dry grease



The flange has one over more material (beading) on different areas.



The lids are observed after disassembly of the pulley-bearing assembly, see page 17-18.

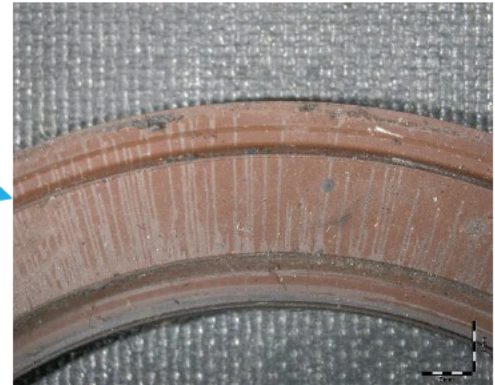
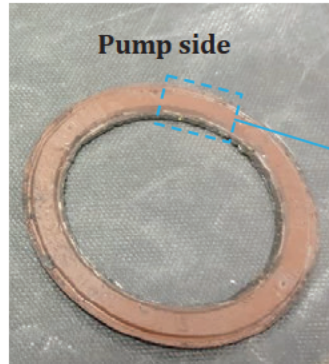
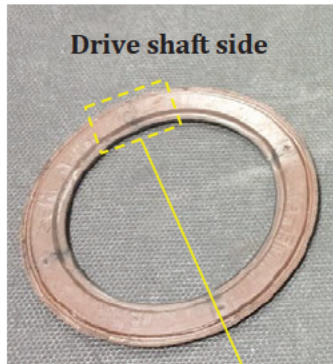
Ind B

4.2.3.3 Damages observation (after disassembly and before cleaning)

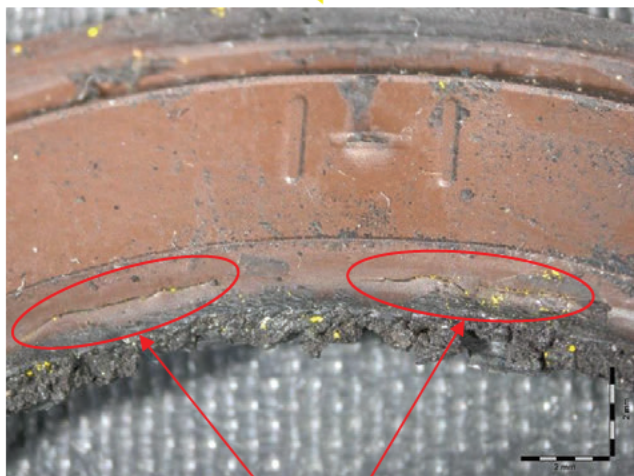
The bearing is disassembled from the pulley using a press. The bearing is weighed before opening, its weight is 324,157g.

➤ Flanges

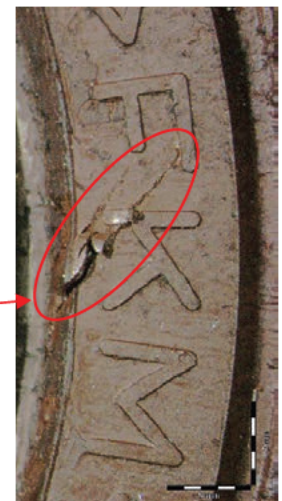
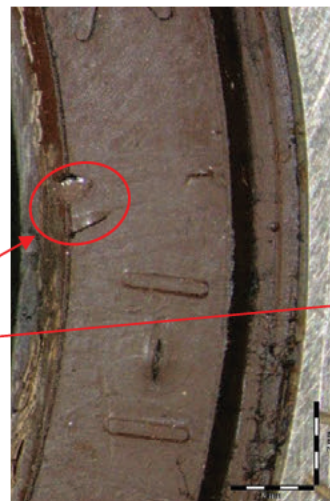
Flanges - Outer side



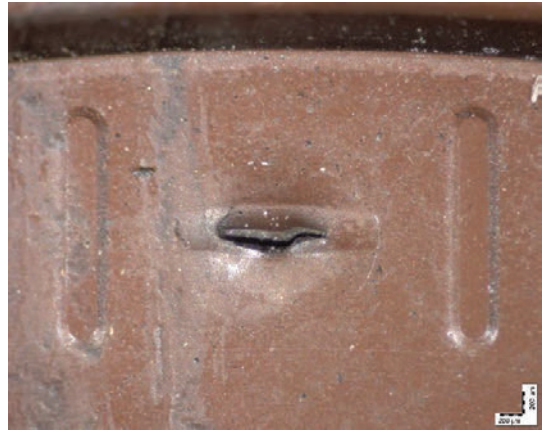
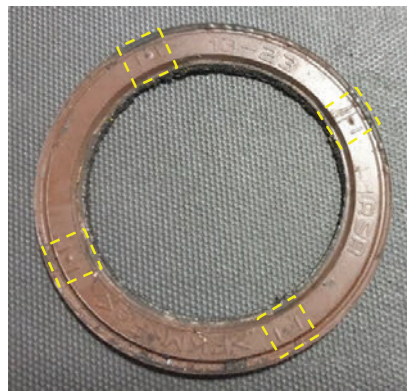
Radial drips, probably corresponding to grease escaping from the bearing. They are observed on the 2 flanges.



Presence of scratches on the 2 flanges allowing a loss of grease.



Observation of the flange lids, drive shaft side :



The laboratory was informed (by the design office) that the lids were pre-drilled in new by the supplier to facilitate regreasing in use.

Ind A Tests of lids drilling, carried out by the laboratory (see report 2021-40244), have shown that the difference between the condition of a lid that has only been pre-drilled and one drilled (regreasing) is not significant. The observation of the lids does not make it possible to determine if the bearing has been regreased.

The observation of the bearing lids, drive shaft side, shows that they are actually pre-drilled.

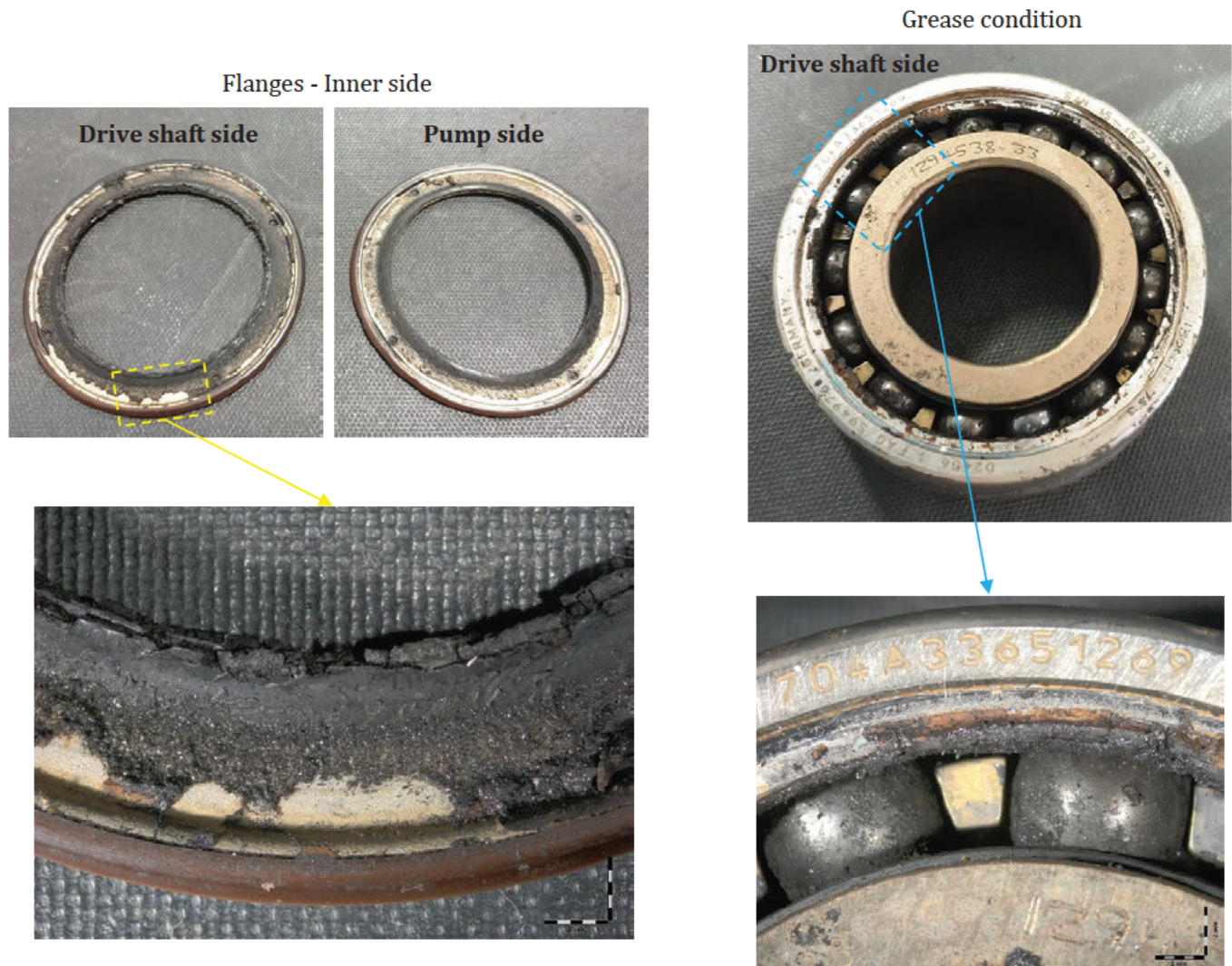
Observation of the flange lids, pump side :



Ind A

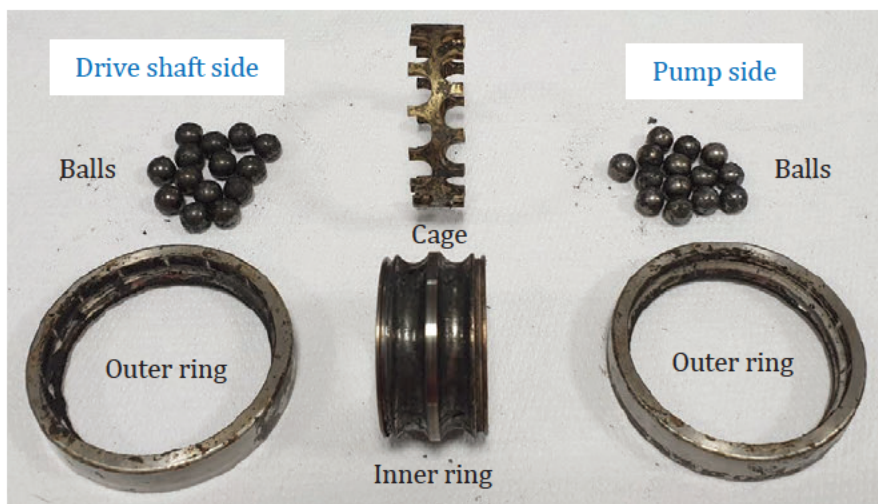
The bearing lids, pump side, are pre-drilled.

As detailed previously, the tests of lids drilling showed that it was not possible to determine, by observing the condition of the lids, if the bearing is regreased or not.

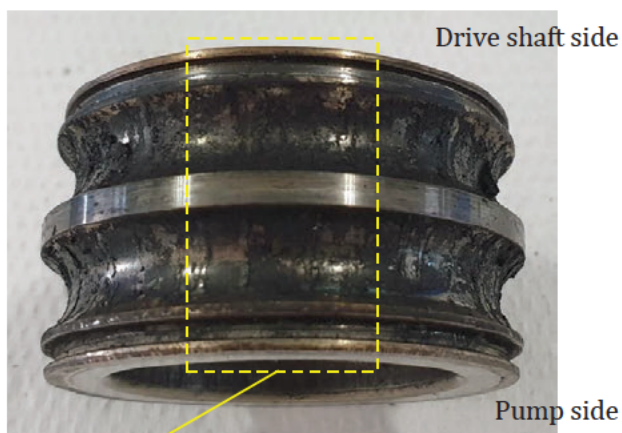


Black residues are observed inside the bearing and on the 2 flanges. This black residues are probably coked grease.

This abnormal appearance shows a degradation of grease, probably due to overheating. In addition, the small amount found shows a loss of grease, as suspected with the observation of drips on flanges.

Overview

➤ Inner ring



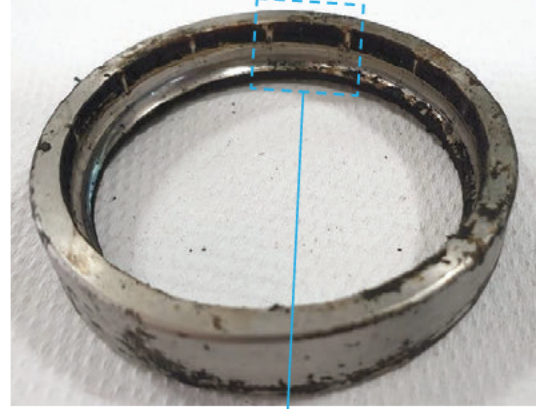
Presence of coked grease delimiting balls locations, after jamming.

➤ Outer rings

Drive shaft side



Pump side



Presence of coked grease showing the position of the cage, after jamming.

➤ Cage



Presence of coked grease all over the cage.

➤ Balls

Drive shaft side



Pump side

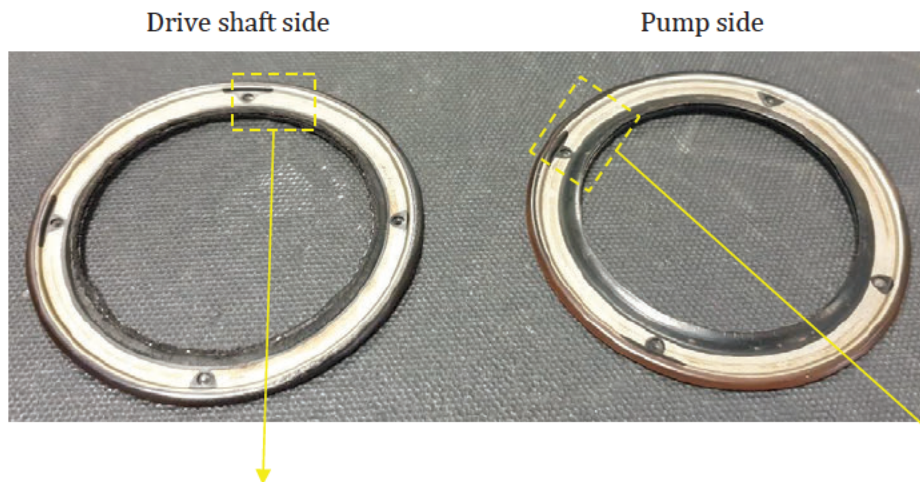


Presence of coked grease on all the balls.

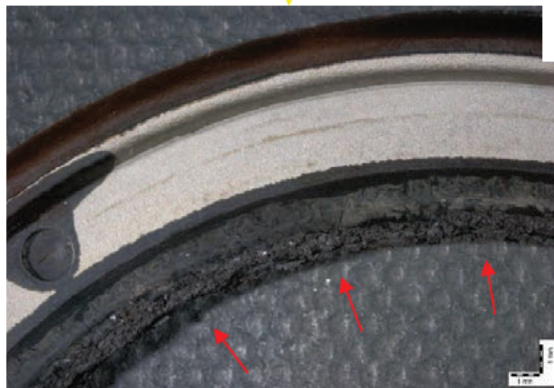
4.2.3.4 Damages observation (after disassembly and after cleaning)

The bearing is weighed after opening and cleaning, its weight is 323,294g. There is a difference of 0,86g with the weight before opening, this corresponds to the small amount of grease remaining in the bearing. Note that there is still a small amount of coked grease that has not been removed (on balls and inner ring).

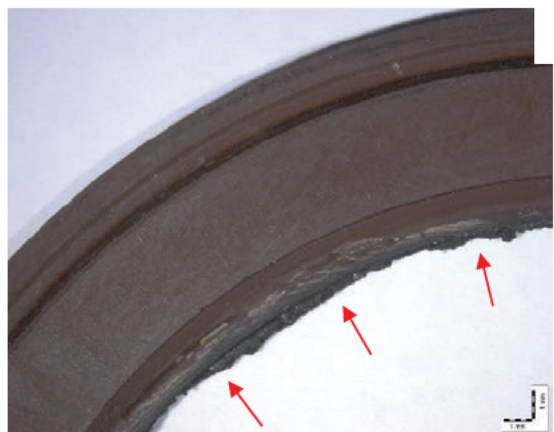
➤ Flanges



There is no trace of rust on the 2 flanges.



Inner side



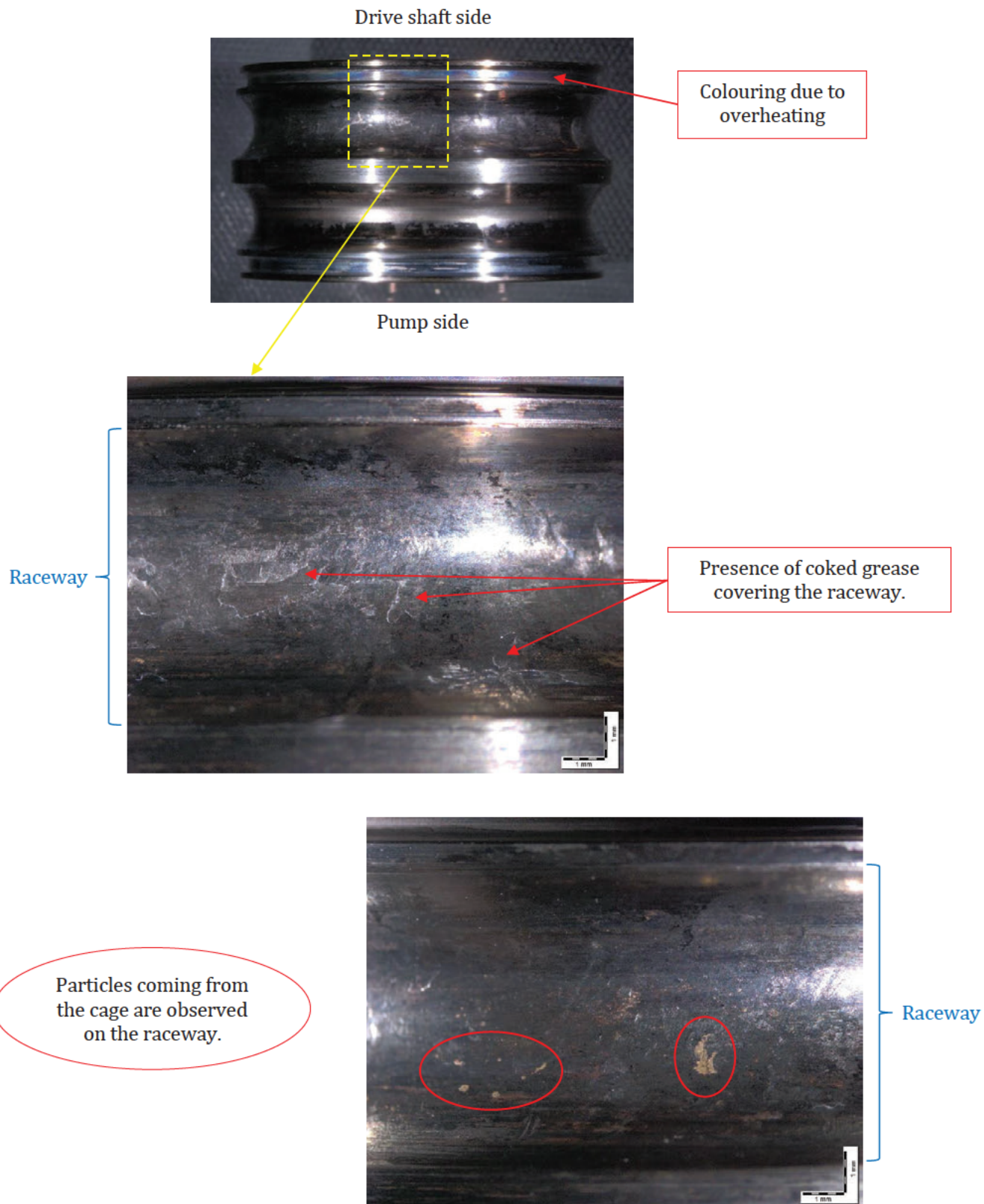
Outer side

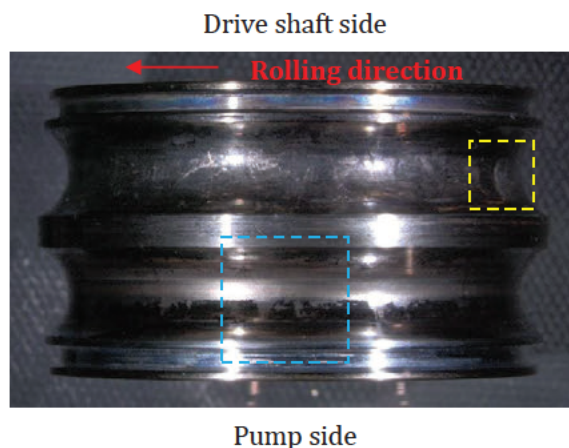


The end of the flange seal, drive shaft side, is torn off.

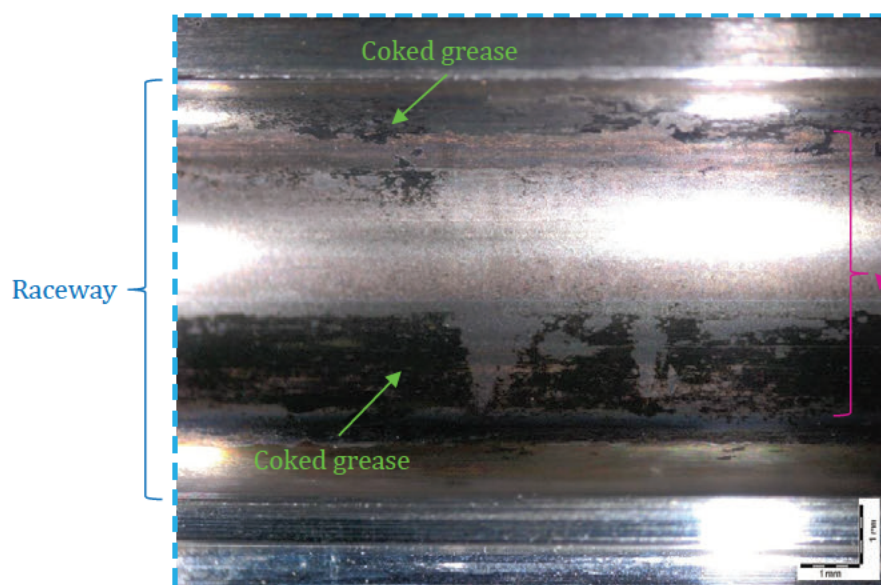
The end of the flange seal, pump side, is not damaged.

➤ Inner ring



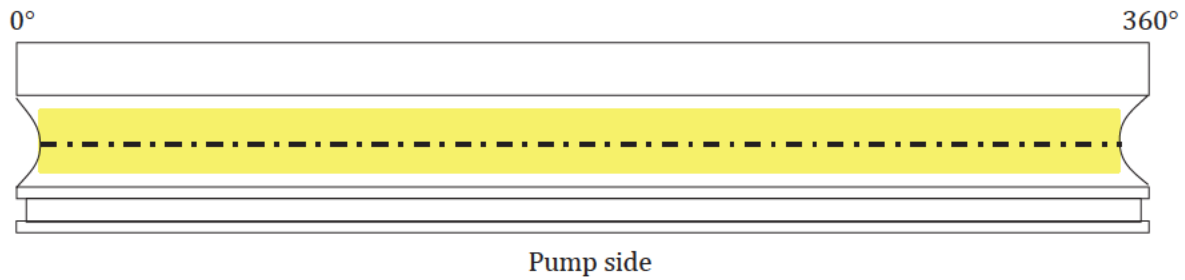


Plastic deformation of the surface of the raceway : pile up of material is observed probably due to locked balls which slid on the raceway.

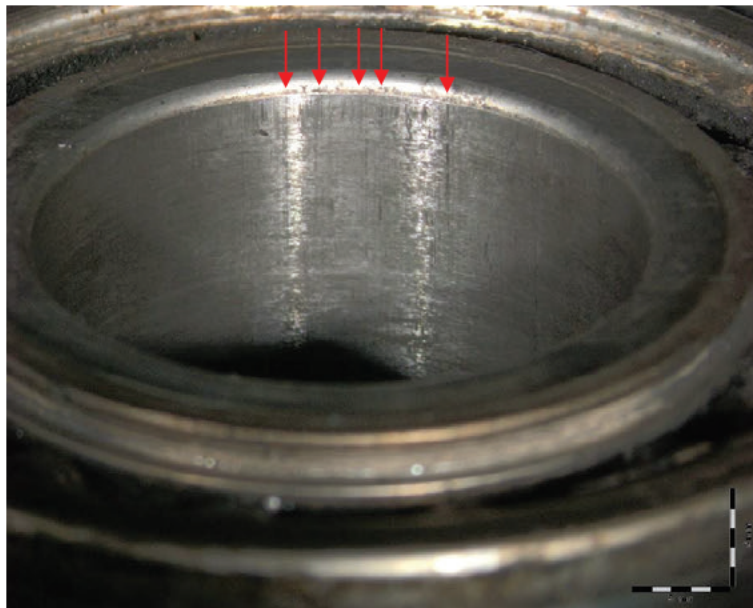


The preferential contact area presents abrasion wear.

Morphology of abrasion wear on the raceway (pump side) :



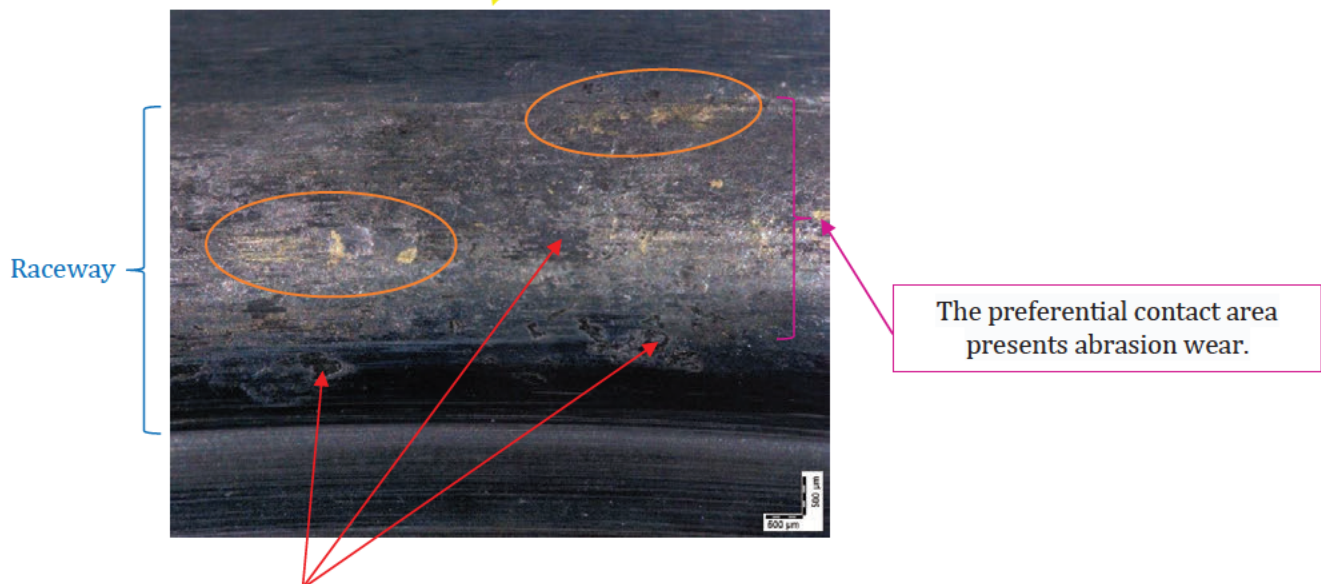
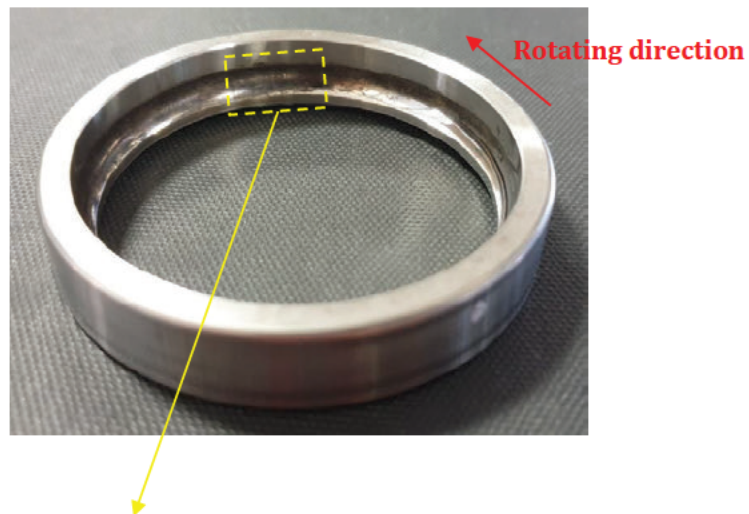
Inner diameter :



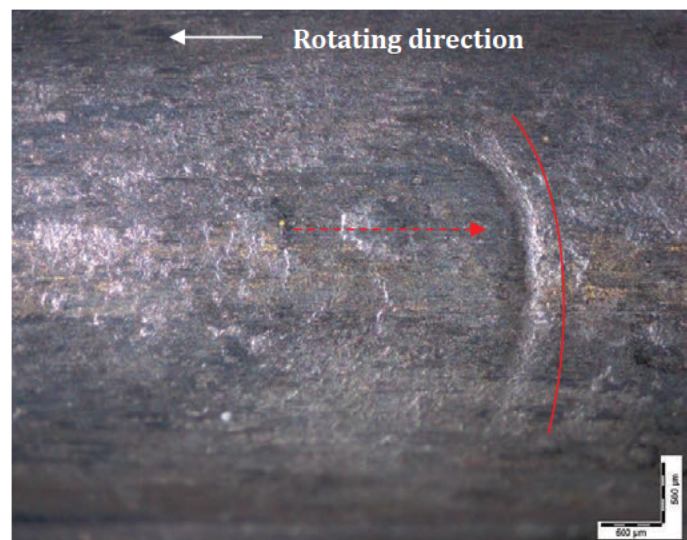
Presence of longitudinal scratches on the inner diameter (360°), of the inner ring. They were probably caused during assembly/disassembly of the bearing on the pulley support stud.

➤ Outer rings

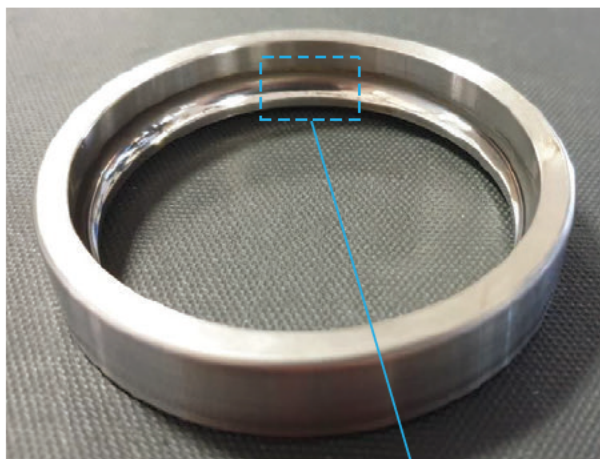
Outer ring - Drive shaft side



Plastic deformation of the surface of the raceway : pile up of material is observed probably due to locked balls which oppose the rotation of the outer ring.

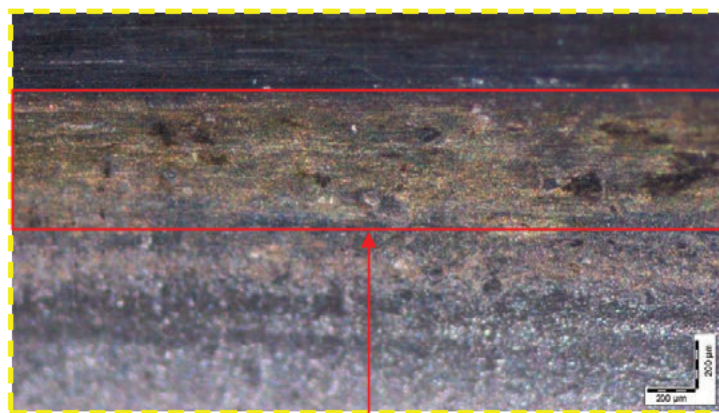
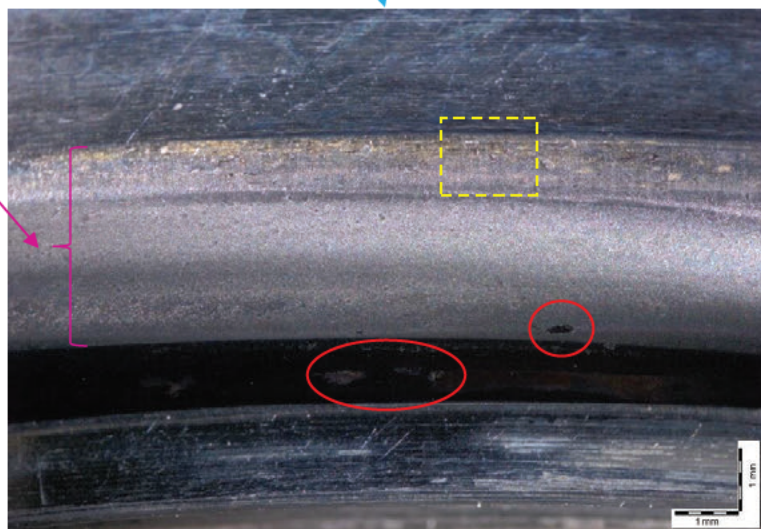


Outer ring - Pump side



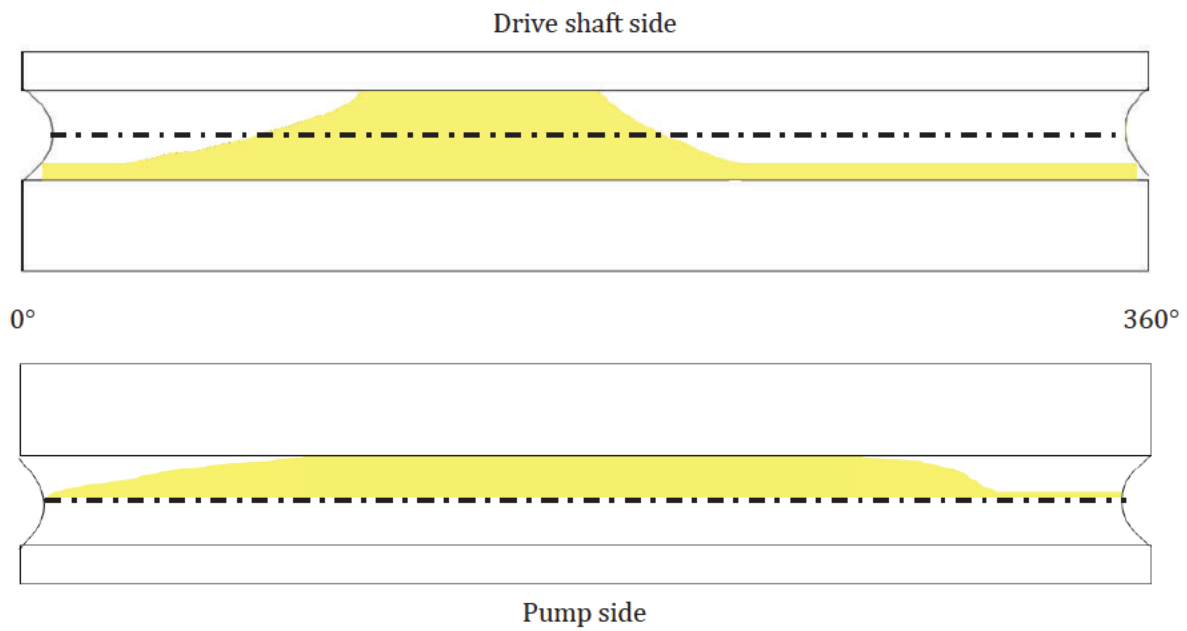
The preferential contact area presents abrasion wear.

Presence of coked grease on the raceway.

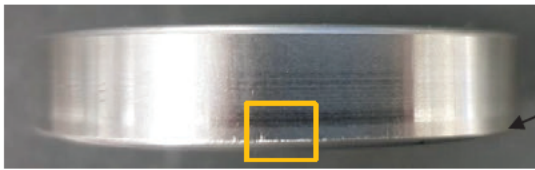


Particles coming from the cage are observed on the raceway.

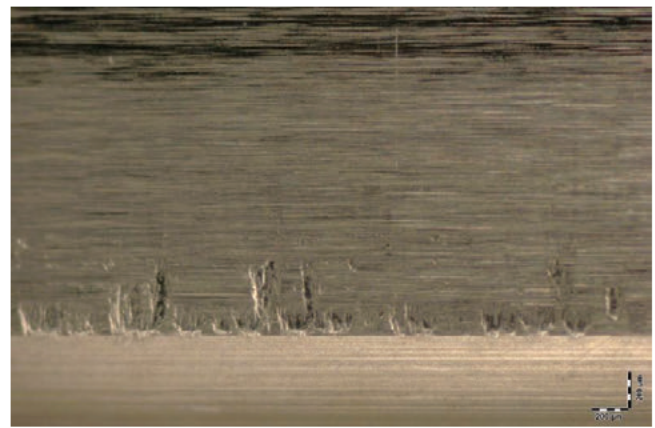
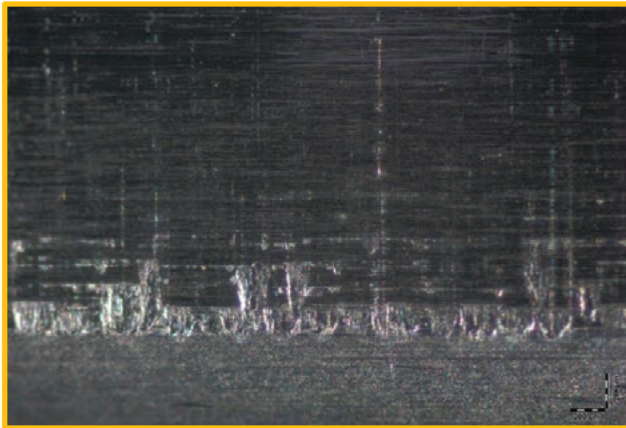
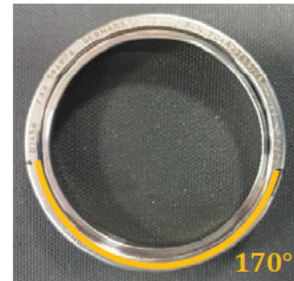
Morphology of abrasion wear on the raceway of the two outer rings :



Outer ring - Drive shaft side



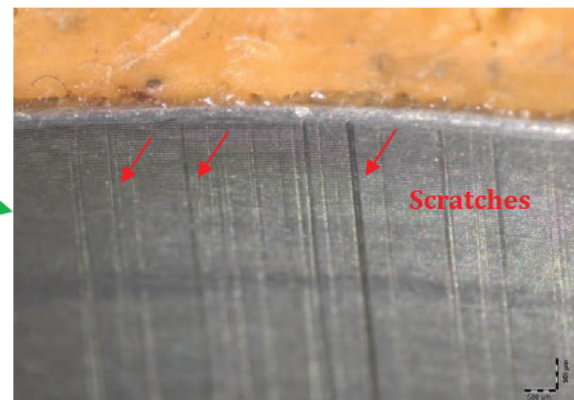
Pulley bottom side



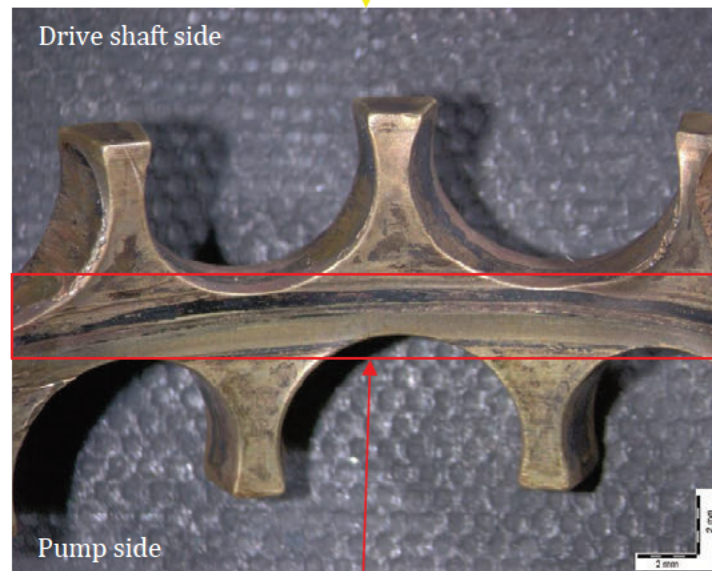
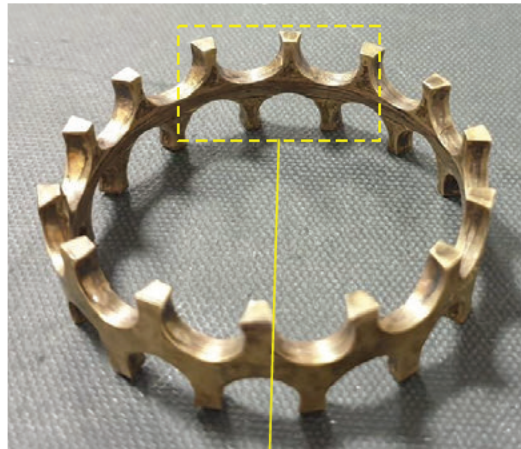
Backscattered light (used to show the material aggregates)

Longitudinal scratches (on 360°) are observed on the outer diameter of the outer ring, drive shaft side. In addition, material aggregates are present on the ends of the outer diameter. They are probably created when the bearing is fitted in the pulley, as shown in the picture below of the inner diameter of the pulley with scratches. It is possible that these aggregates are material transfers from the pulley to the outer ring.

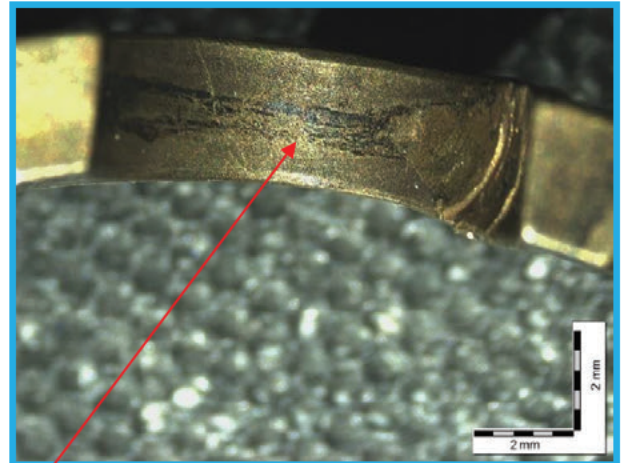
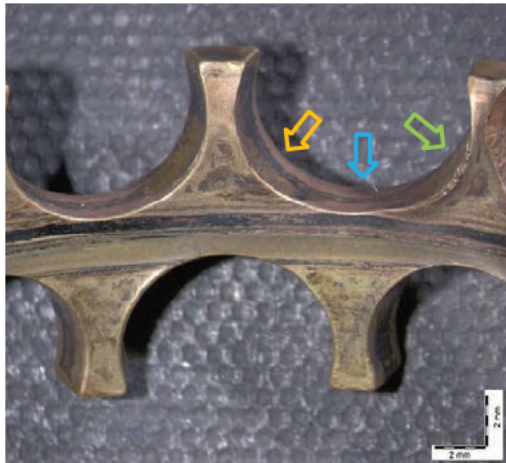
Slight longitudinal scratches but no aggregate are observed on the outer diameter of the other ring, pump side.



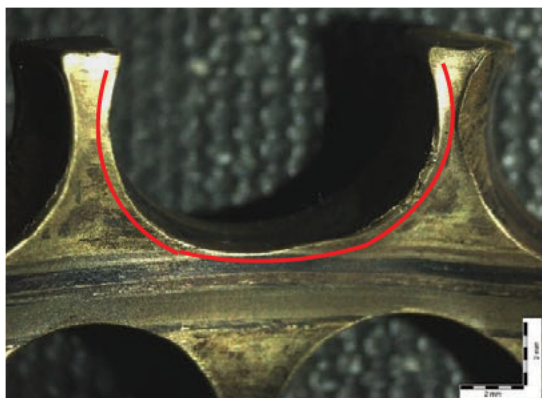
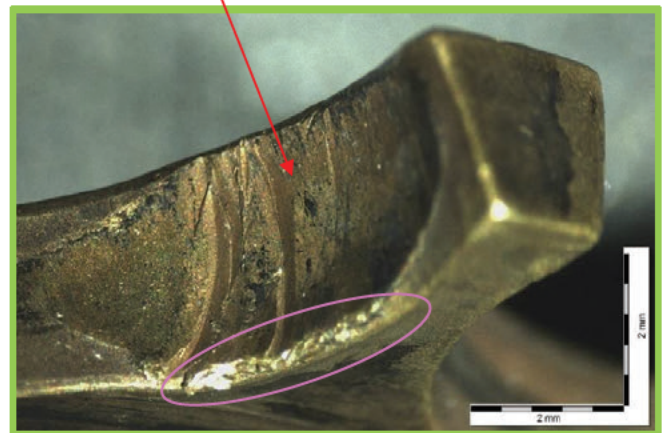
➤ Cage



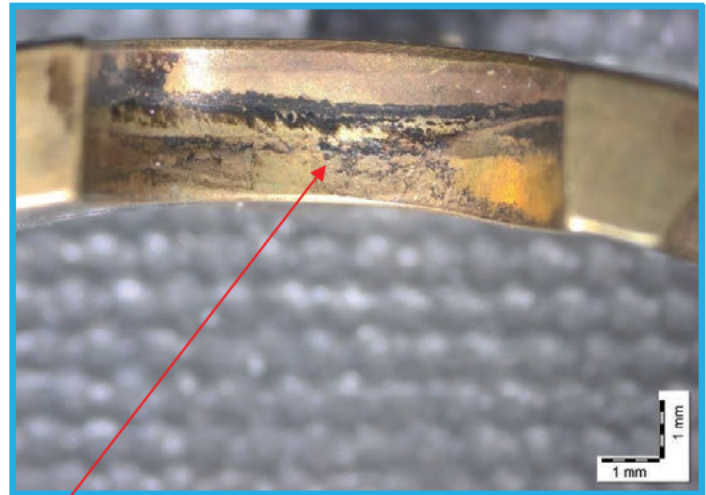
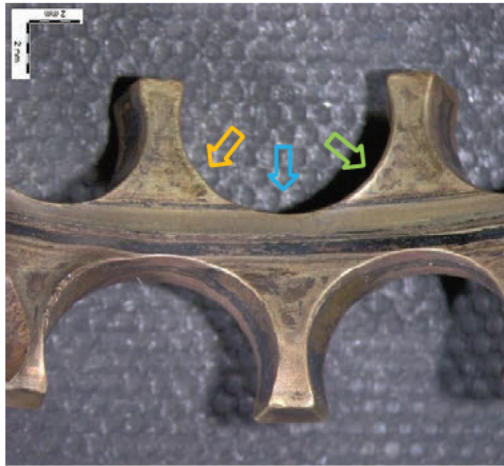
Operating wear on the entire inner diameter.

Observation on drive shaft side

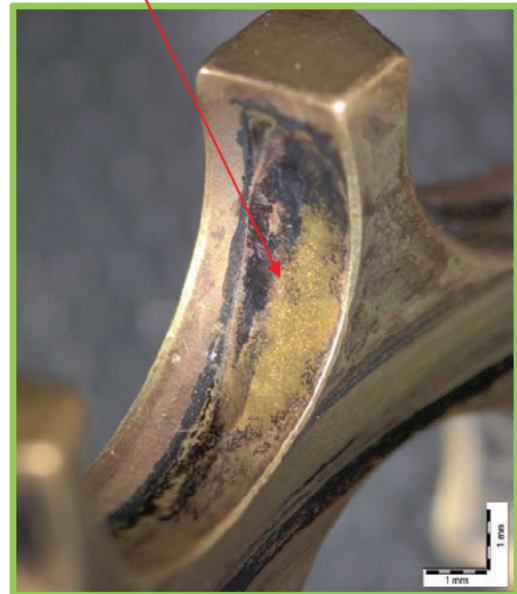
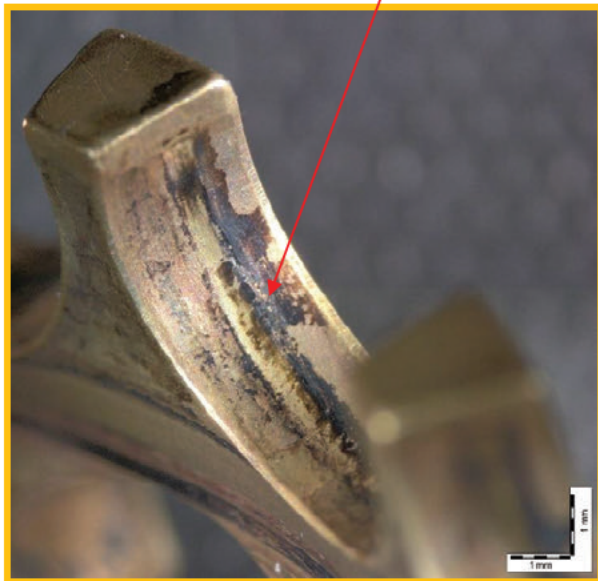
Operating wear due to the rotation of the balls in their cells.
Significant wear with material removal causing **material pile up**.



The pile up of material causes deformation of the cell and also material pick-up.

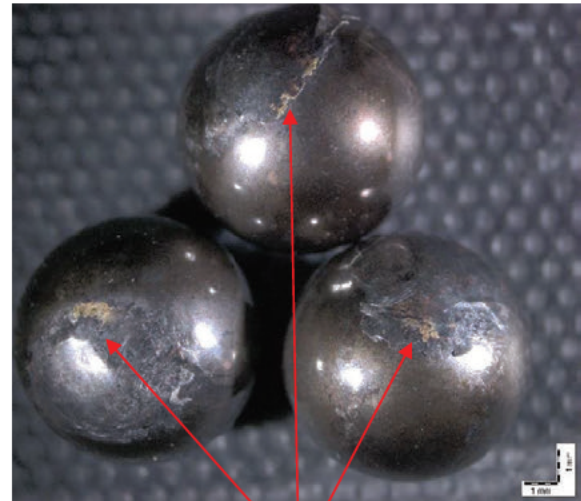
Observation on pump side

Operating wear due to the rotation of the balls in their cells.
Wear with start of material removal.



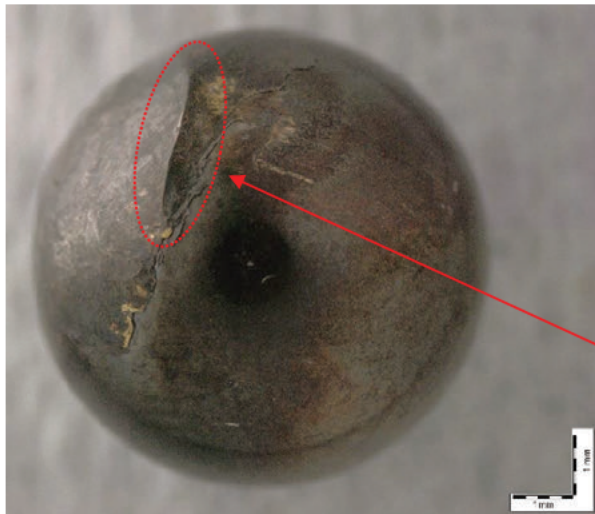
➤ Balls

Drive shaft side



Coked grease with particles of cage are present on all the balls.

In addition, the surface of the balls has an « orange peel » appearance due to abrasion wear.



Plastic deformation of the ball surface which can cause bad rolling / lock of the ball in the cage.

The locking of the ball leads to the pile up of material previously observed on the raceways.

Pump side

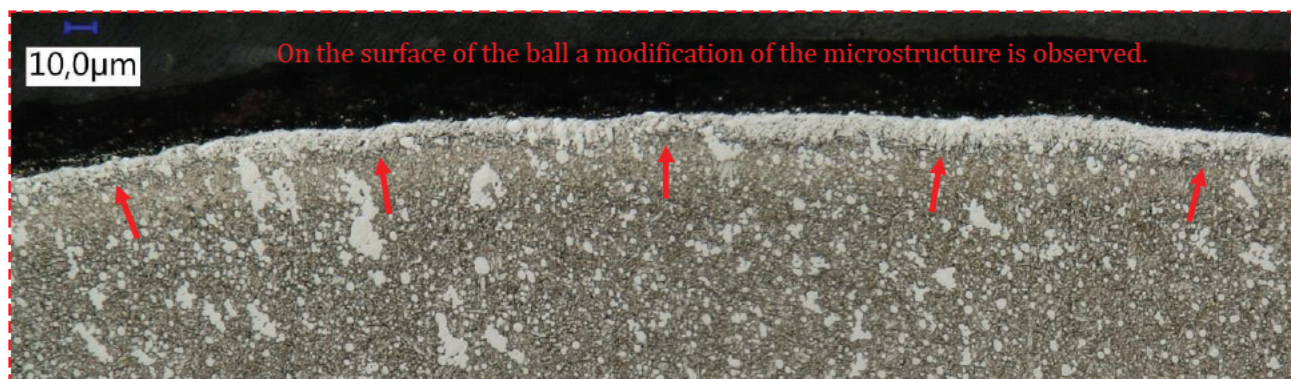
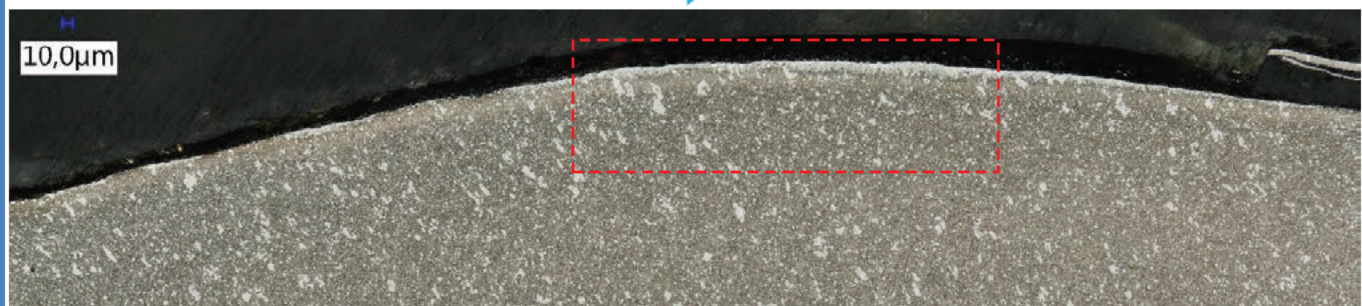
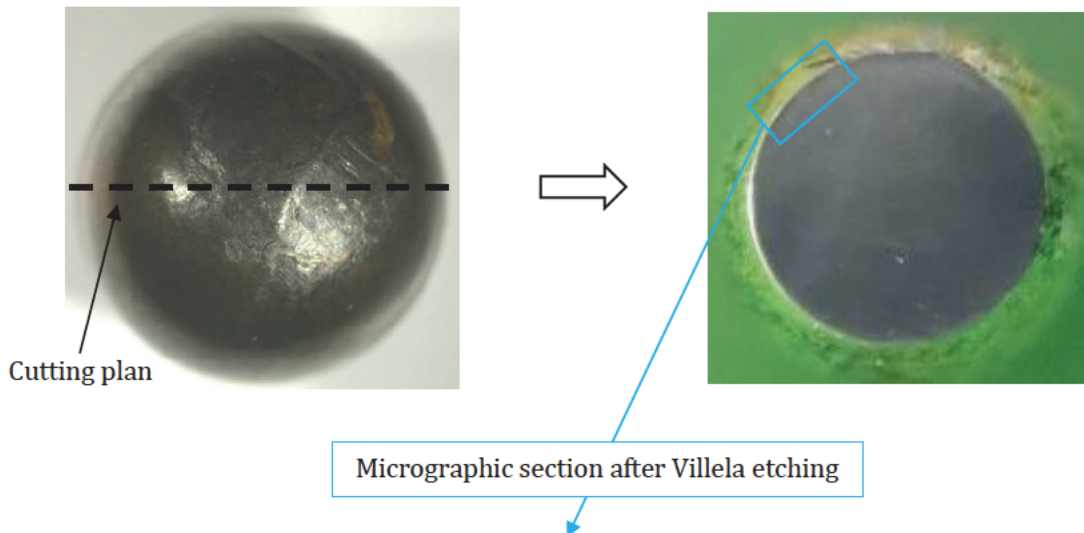


The surface of the balls has an « orange peel » appearance due to abrasion wear.

A pile up of material, due to plastic deformation, was observed on some balls and also on the raceways of the inner ring and outer ring, drive shaft side.

The presence of plastic deformations seems to show a modification in the properties of the material. To support this information, a micrographic section is made on a ball (drive shaft side) having a plastic deformation, to observe the microstructure.

No micrographic section has been made on the inner and outer rings (cut not allowed by the design office).



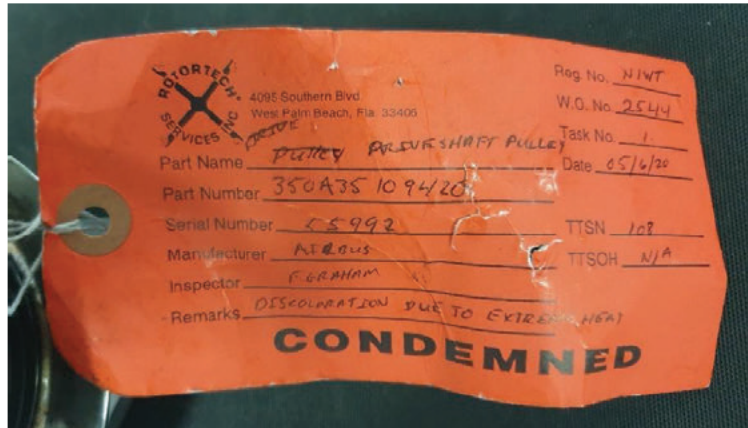
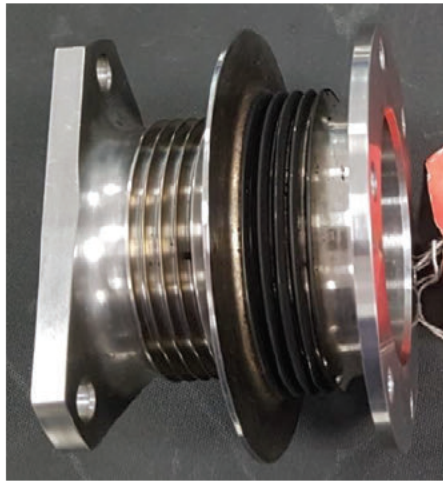
The tempering temperature of the balls material and also inner/outer rings () is about 140°C.

Following this observation, we can say that the bearing reached temperatures of a least 140°C, which resulted in a loss of mechanical properties of the material, as illustrated by the modification of the microstructure.

This loss of mechanical properties resulted in the observed plastic deformations observed on balls and also on the raceway of the inner ring and outer ring, drive shaft side.

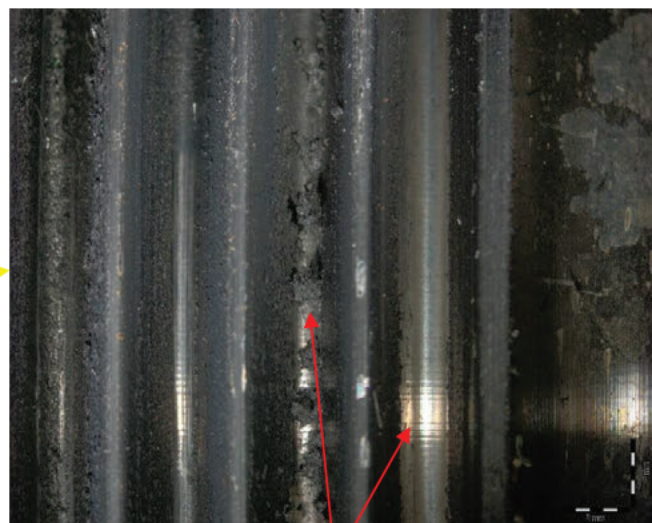
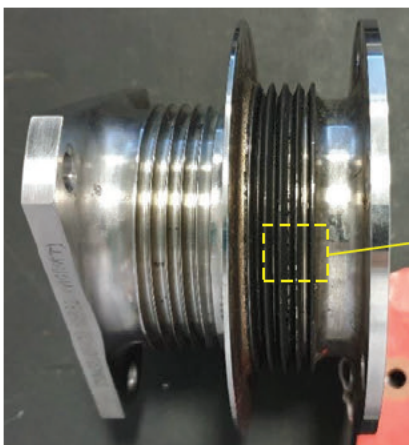
4.2.4 DRIVING PULLEY

➤ Identification



Marking on part : 350A35109420 55992 (MGP/KT)

➤ Damages observation



Black residues are found in the thread (360°), probably belt residues. In addition, surface oxidation is observed, probably due to overheating.

4.2.5 DRIVE SHAFT AND COVER

➤ Identification

Drive shaft



Marking on part : 350A35132520

54842

(MGP/JS)

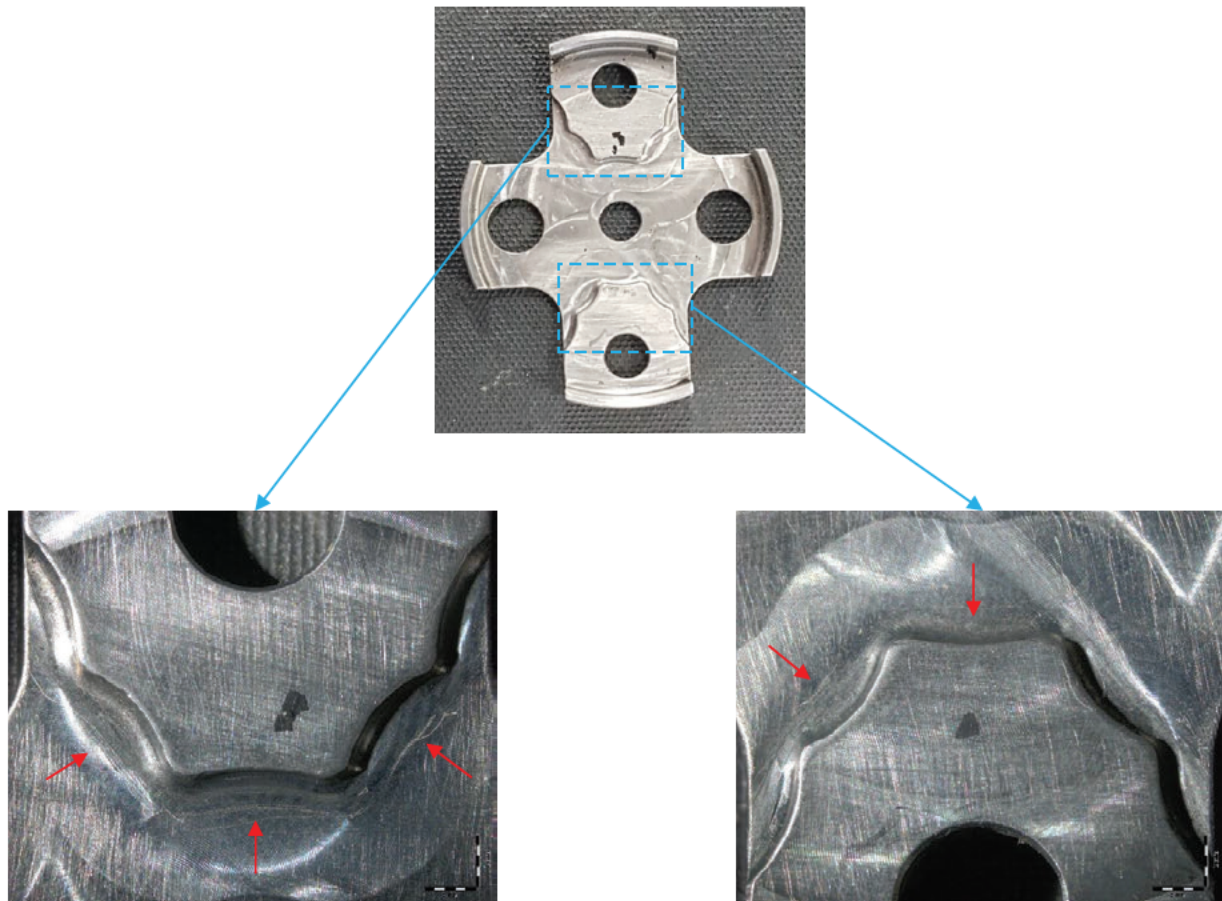
Cover



Marking on part : 350A35132020

46455 (MGP/LT)

➤ Observation of cover and drive shaft damages



Slight scratches are observed



No damage observed on the drive shaft.

4.2.6 MATERIAL COMPLIANCE

The hardness control (see report 2021-40137) shows that the average values of the surface hardness of the inner ring, outer rings and balls are compliant with the drawing.

5. APPENDIXES

Not applicable

END OF SYNTHESIS REPORT
