TeSuCon

Technical Support & Consultancy

REPORT TURBINE INSPECTION

SN 15401271, WINDPARK SLUFTER WEST 5

Report No. GE15002015005

19-11-2015

Contents

1 Purpose

On behalf of Vattenfall an inspection has been executed on the wind turbine. The purpose of the inspection is to determine the technical state of the wind turbine.

2 Abbreviations

ok	okay
nok	not okay
na	not applicable
nav	not available
nc	not checked
info	for information purpose

Items marked with "ok" and "info" show no visual irregularities. All issues which are not acceptable are marked with "nok". Items which are "nok" will be classified in three different classes.

Class	***Clarification***	***Description in report***
Priority Low	An irregularity, which is not a safety issue, and is relatively easy to solve.	*Low*
Priority High	An irregularity, which is not a safety issue, and is more serious and is more time and/or money consuming to solve.	*High*
Safety Issue	Issues which concern the safety of the people working in the turbine.	*Safe*

3 General information

Wind turbine name:	Windpark Slufter West 5
Wind turbine type:	GE1.5S
Wind turbine S/N:	15401271
Location:	Rotterdam-Maasvlakte, NL
Hub height:	65
Nominal power [kW]:	1500
Year of installation:	2003
Date of inspection:	16-10-2015
Inspectors:	D. Lagerweij J. Langenbach

4 Wind turbine main components

Component	Type	Year	Serial number
Convertor	ABB Oy ACS600 WTD	2003	71546/030
Gearbox	Rexroth GPV 451 T 50Hz 88.8	2005	1070884
Revision gearbox	BGS Gear Service	2013	12131
Gearbox oil	Mobilgear SHC XMP 320	2013	-
Generator	Winergy JFEA-500SR-04A	2003	5133493
Blade 1	GE Rotor Blades	-	2335
Blade 2	GE Rotor Blades	-	2435
Blade 3	GE Rotor Blades	-	2436

5 Documents

	Component	Remark	
1	Operator manual	Operating manual is available at the turbine. Machine directive 2006/45/EC, 1.7.4.2 states as part of the Contents of instructions: *"(e) the drawings, diagrams, descriptions and explanations necessary for the **use, maintenance and repair** of the machinery and for checking its correct functioning;"*	ok
2	Wiring diagram	Wiring diagrams are not available at the turbine. Machine directive 2006/45/EC, 1.7.4.2 states as part of the Contents of instructions: *"(e) the drawings, diagrams, descriptions and explanations necessary for the **use, maintenance and repair** of the machinery and for checking its correct functioning;"*	ok
3	Hydraulic diagram	Hydraulic diagrams are not available at the turbine. Machine directive 2006/45/EC, 1.7.4.2 states as part of the Contents of instructions: *"(e) the drawings, diagrams, descriptions and explanations necessary for the **use, maintenance and repair** of the machinery and for checking its correct functioning;"*	nok
4	Maintenance manual	Maintenance manual is not available at the turbine. Machine directive 2006/45/EC, 1.7.4.2 states as part of the Contents of instructions: *"(e) the drawings, diagrams, descriptions and explanations necessary for the **use, maintenance and repair** of the machinery and for checking its correct functioning;"*	nok
5	Logbook	Logbook is available at the turbine.	ok

6 Logbook: Overview of recent maintenance

Year	Type of maintenance	Date of execution	Maintenance schedule
	Commissioning	09-2003	2003
...	...	...	...
9	1 year service	28-11-2012	2012
9½	½ year service	20-03-2013	
10	1 year service	18-09-2013	2013
10½	½ year service	16-04-2014	
11	1 year service	08-12-2014	2014
11½	½ year service	08-07-2015	
12	1 year service	*no service record*	2015

7 Logbook: Notable events

Date	Event
18-07-2006	Slip ring generator exchanged
09-05-2011	Main bearing exchanged
28-08-2013	Gearbox and main bearing exchange
23-06-2015	Replaced one blade bearing (blade 3) and turned two blades (blade 1 and 2)
08-10-2015	Maintenance blades

8 Tower and towerbase

	Item	Remark	
1	Tower outside	Light at the outside is broken and has damaged the paint of the tower. 	nok *Low*
2	Controller overview	 	*Info*
3	Tower inside	 	*Info*
4	Miscellaneous		ok

9 Yaw system

	Item	Remark	
1	Yaw section		ok
2	Yaw ring teeth	Yaw ring shows no irregularities. 	ok
3	Yaw pinions	Yaw pinions show no irregularities.  	ok
4	Yaw gears	Some corrosion present at the yaw gears.  	nok *Low*

10 Nacelle

	Item	Remark	
1	Nacelle overview		*Info*
2	Frame	Turbine is equipped with a cast-iron frame.	*Info*
3	Nacelle housing	Parts of the insulation are damaged. 	nok *Low*
4	Weather station		ok
5	Controller overview		ok

11 Hydraulic system and brake

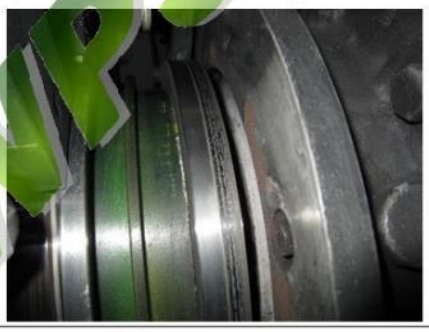
	Item	Remark	
1	Overview	 	*Info*
2	Leakage	The hose of the brake-system shows minor leakage. 	nok *Low*
3	Miscellaneous		ok

12 Gearbox and main shaft

	Item	Remark	
1	Main shaft bearings	Grease of the main bearing is not magnetic.  	ok

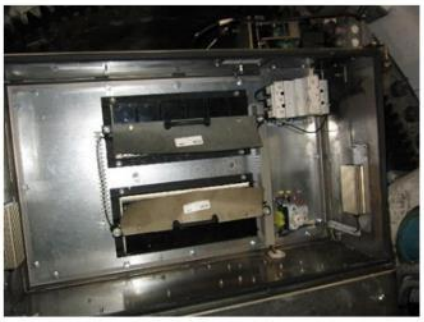
2	Radiators		*Info*
3	CCJ-unit	No CCJ-filter present in the turbine.	*Info*
4	Gear oil system	Leakage present at the gear oil system.  	nok *High*
5	Hoses and pipes		ok
6	Paint / Corrosion		ok
7	General leakage		ok
8	Slip ring for hub		*Info*

13 Generator and coupling

	Item	Remark	
1	Coupling	The coupling shows no irregularities. 	*Info*
2	Paint / Corrosion		ok
3	Slip ring	Raceway of the earth connection is not completely smooth (2th picture).  	nok *High*

14 Hub

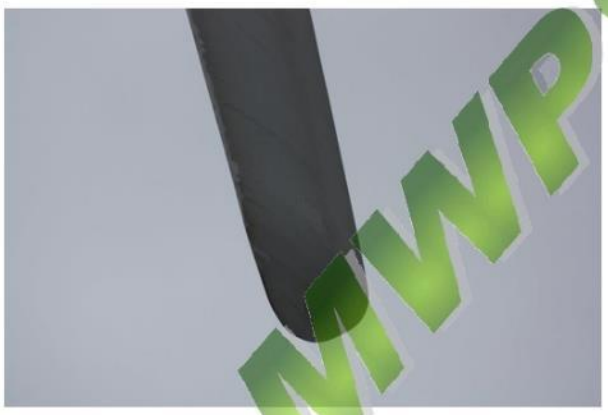
	Item	Remark	
1	Blade bearing	A few caps of the nuts of the bearing are missing and several small cracks are visible at the caps of the blade bearing bolts.  	nok *Low*
2	Overview inside	In general, the hub is clean. The blade bearing of blade 3 however, shows a lot excessive grease (arrow).  	nok *Low*
3	Hub cabinet overview		*Info*

4	Boxes blade 1	Control box and battery box show no irregularities on the inside. One bolt connection from the cover is broken (3rd picture).   	nok *Low*
5	Boxes blade 2	Control box and battery box show no irregularities.  	ok
6	Boxes blade 3	Control box and battery box show no irregularities on the inside. One bolt connection from the cover is broken (2nd picture).  	nok *Low*

7	Mounting of the electrical boxes	The mounting of the boxes shows no irregularities. 	ok
8	Pinions of pitch gears	Wear on one tooth of the pinions of the pitch gears.   	nok *High*
9	Pitch teeth at zero of blade 1	The tooth at zero shows wear, but the condition is acceptable.  	nok *High*

10	Pitch teeth at zero of blade 2	The tooth at zero shows wear, but the condition is acceptable.  	nok *High*
11	Pitch teeth at zero of blade 3	The tooth at zero shows wear, but the condition is acceptable. 	nok *High*
12	Grease system pitch teeth	There is an automatic grease system present in the hub. The system is not operational.  	nok *High*
13	Pitch gears	The pitch gears look acceptable.  	ok
14	Miscellaneous		ok

15 Rotor blades

1	Blades	Repaired parts are visible on the leading edges of the blades.   	*Info*

16 Conclusion

The logbook shows that the turbine has been maintained on a regular basis, according to the maintenance schedule of GE.

The gearbox and the main shaft have been replaced in 2013. The original generator is present in the turbine.

The blades have been maintained in 2015.

Although the pitch rings have been turned in 2015 (and one was replaced), there is already some wear visible at the zero-tooth of the pitch rings. The pinions of the pitch gears are also showing wear. The reason for the wear is the absent of a functioning grease system for the pitch gear and pitch ring.

The overall condition of the turbine is quite acceptable for a twelve year old turbine. There are however several issues (marked as hok in this report) present and it is recommended to solve these, in order to improve the condition of the turbine.

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19-11-2015

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Technical Support & Consultancy

REPORT GEARBOX INSPECTION

SN 15401271, WINDPARK SLUFTER WEST 5

Report no. GE15002015015

24-11-2015

Contents

1. Purpose

On behalf of Vattenfall an inspection has been executed on the wind turbine gearbox. The purpose of the inspection is to determine the technical state of the gearbox. The visual inspection of the gearbox has been executed with a GE Everest XLG3 Videoscoop.

2. General Information

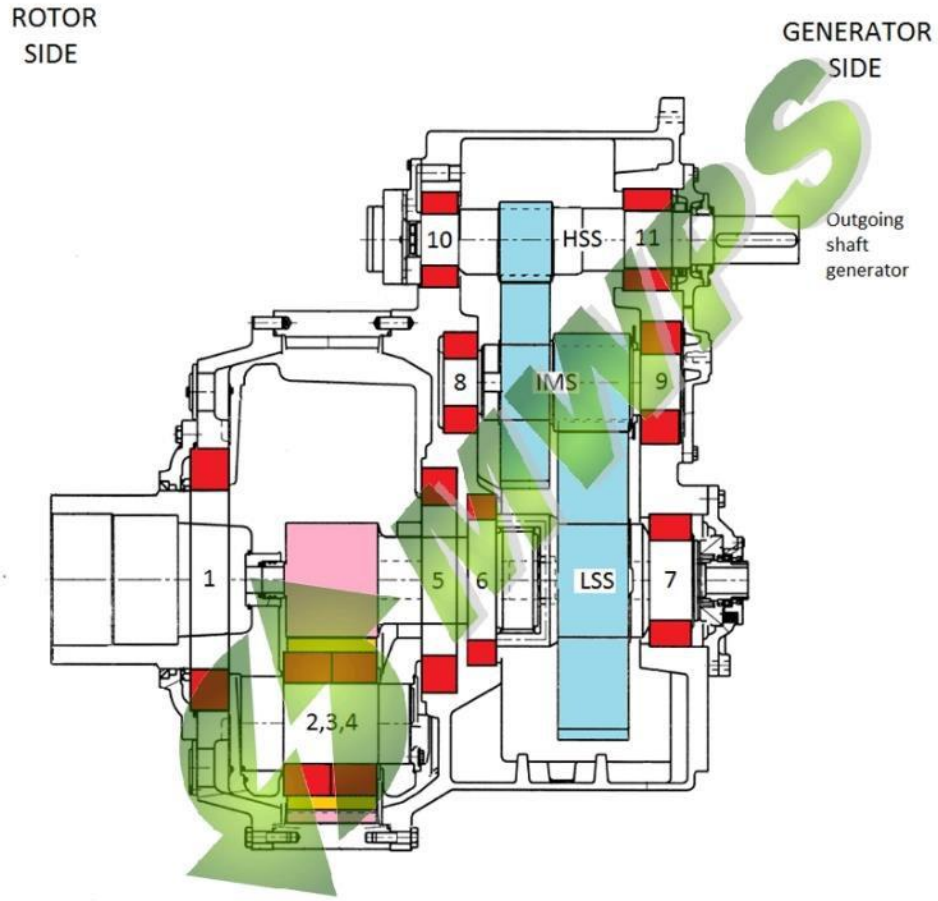
Turbine Information	
Wind turbine name:	Windpark Slufter West 5
Wind turbine type:	GE1.5S
Wind turbine serial no:	15401271
Location:	Rotterdam-Maasvlakte, NL
Hub height:	65
Nominal power [kW]:	1500
Year of installation:	2003
Date of inspection:	16-10-2015
Inspectors:	D. Lagerweij J. Langenbach

Gearbox Information	
Gearbox type:	Rexroth GPV 451 T 50Hz 88.8 *i = 88,81*
Gearbox serial number:	1070884
Production year gearbox:	2005
Revision:	BGS Gear Service 22-07-2013
Revision number:	12131
Oil type:	Mobilgear SHC XMP 320
Date of last oil change:	at revision

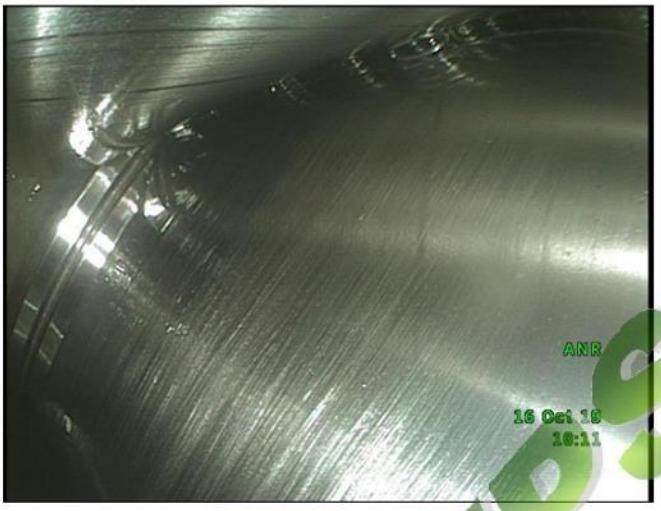
- **Gearbox has been exchanged in 2013**

3. Reporting setup

The next drawing shows a cross-section of a planetary gearbox with two linear stages with corresponding bearing positions. The drawing should be used as a reference for the bearing position only.



4. Inspection results

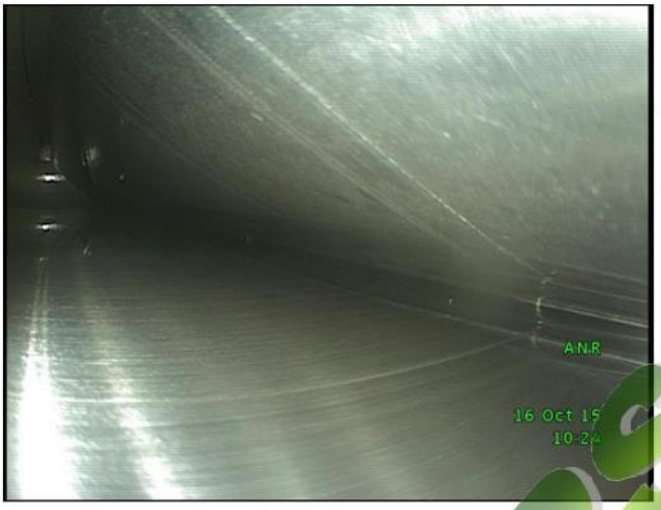


Picture 1

Picture 1 shows bearing position no. 1, the bearing of the planet carrier at rotor side. No irregularities.

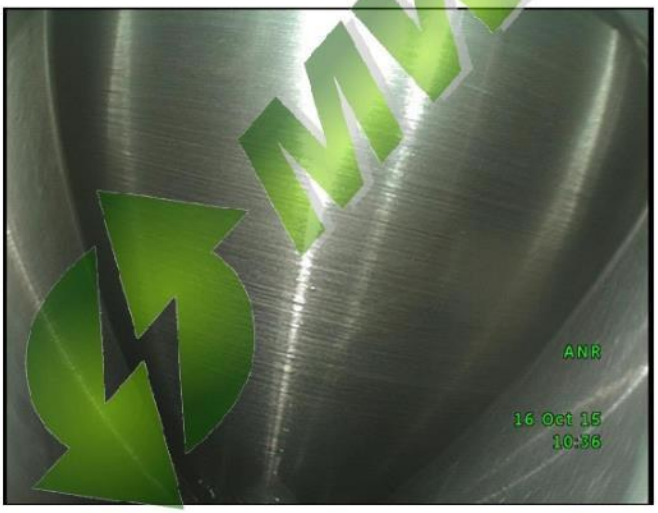
Picture 2

Picture 2 shows the bearing of the first planet wheel. No irregularities.



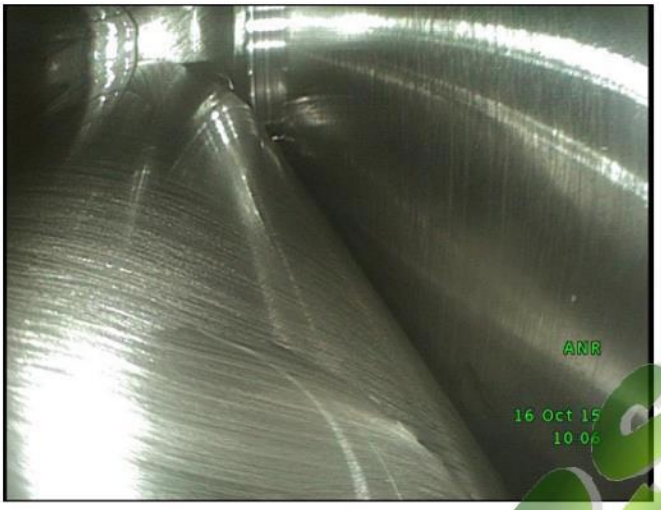
Picture 3

Picture 3 shows the bearing of the second planet wheel. No irregularities.



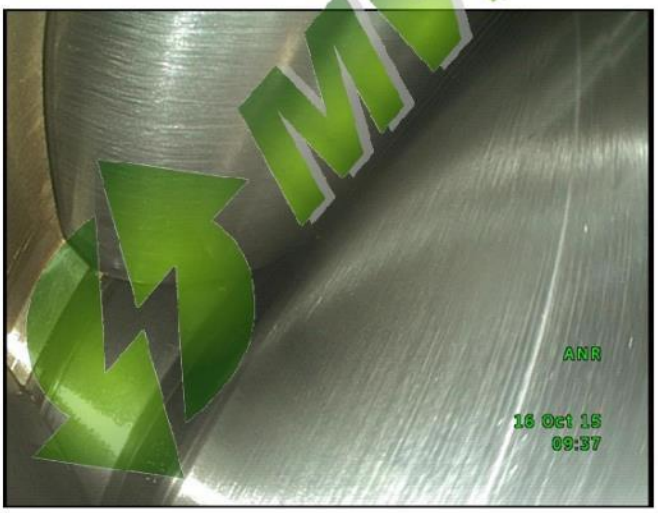
Picture 4

Picture 4 shows the bearing of the third planet wheel. No irregularities.



Picture 5

Picture 5 shows bearing position no. 5, the bearing of the planet carrier at generator side. The bearing shows no irregularities.

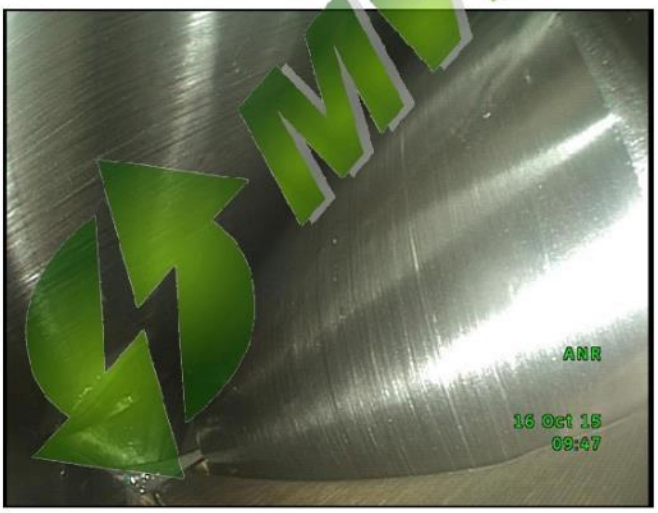


Picture 6

Picture 6 shows bearing position no. 6, the bearing of the low speed shaft at rotor side. The bearing shows no irregularities.

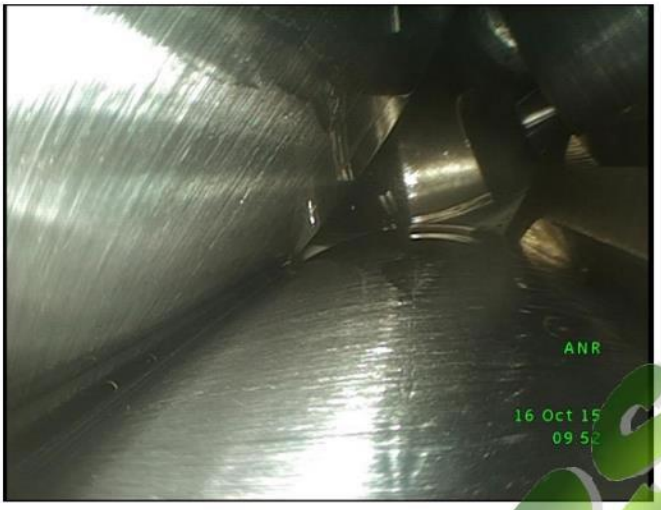
Picture 7

Picture 7 shows bearing position no. 7, the bearing of the low speed shaft at generator side. The bearing shows no irregularities.



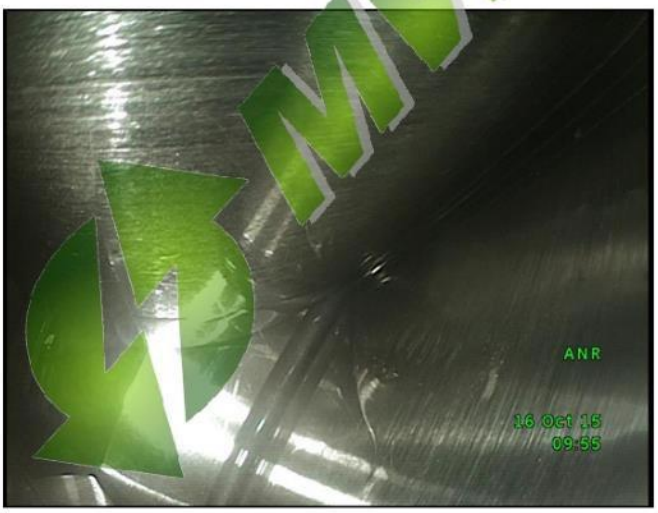
Picture 8

Picture 8 shows bearing position no. 8, the bearing of the intermediate shaft at rotor side. The bearing shows no irregularities.



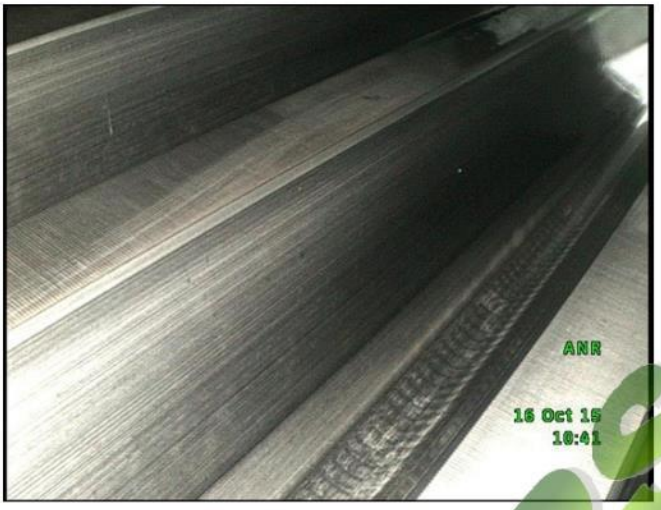
Picture 9

Picture 9 shows bearing position no. 10, the bearing of the high speed shaft at rotor side. The bearing shows no irregularities.



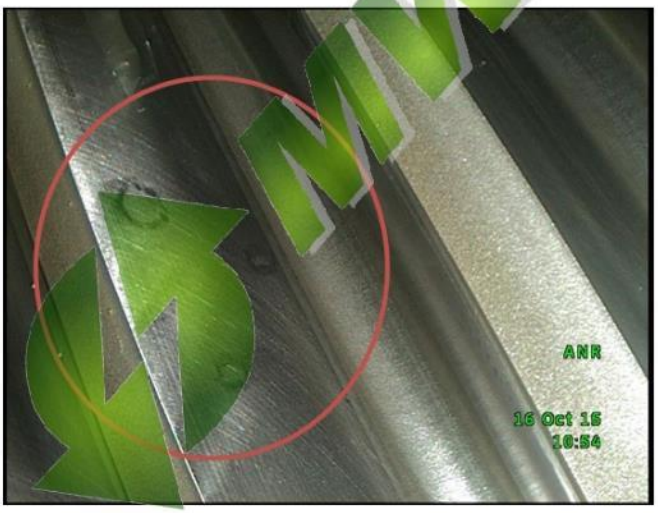
Picture 10

Picture 10 shows bearing position no. 11, the bearing of the high speed shaft at generator side. The bearing shows no irregularities.



Picture 11

Picture 11 shows the active flank of the ring gear. No irregularities.

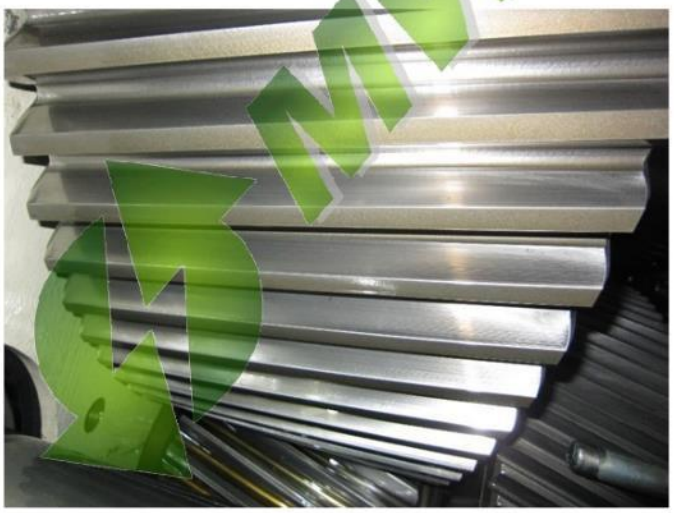


Picture 12

Picture 12 shows one of the planet wheels. One planet wheel shows a few irregularities at the flank.

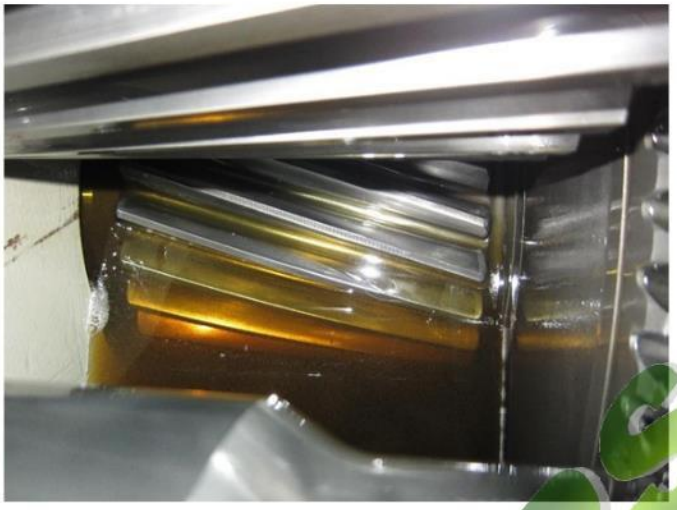
Picture 13

Picture 13 shows the active flanks of the sun pinion. Several scratches visible at the active flank of the sun pinion.



Picture 14

Picture 14 shows the active flanks of the wheel of the low speed shaft in the linear stage. No irregularities.



Picture 15

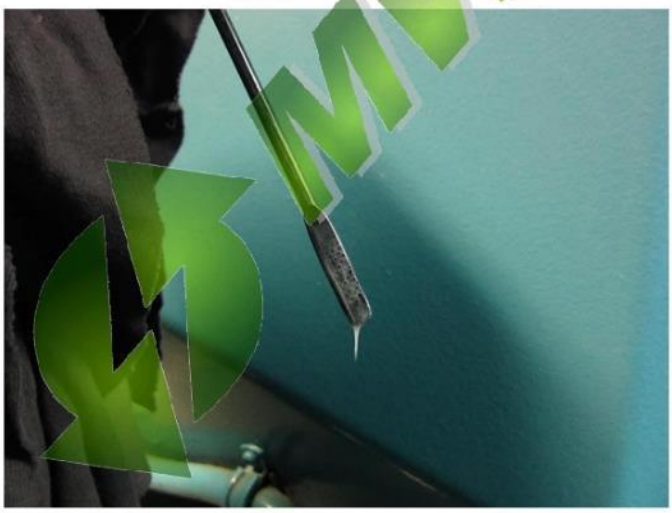
Picture 15 shows the active flanks of the pinion of the intermediate shaft in the linear stage. No irregularities.

Picture 16

Picture 16 shows the active flanks of the wheel of the intermediate shaft in the linear stage. No irregularities.

Picture 17

Picture 17 shows the active flanks of the pinion of the high speed shaft in the linear stage. No irregularities.



Picture 18

Picture 18 shows the dip stick of the gearbox. The oil level is correct.

Picture 19

The inside and bottom of the gearbox have been searched with a magnet. The magnet shows no steel particles.

5. Summary

One planet wheel shows a few irregularities at the flank.

Several scratches visible at the active flank of the sun pinion.

No irregularities were found at the other inspected bearings and gears.

The oil level is correct and no steel particles were found in the gearbox.

6. Conclusion

The condition of the gearbox is acceptable.

The small irregularities in the planetary stage and the small scratches at the sun pinion were probably generated before the gearbox was revised in 2013. It is likely that the gears have been reused. There is no reason to assume that an active defect is present at this moment. The clean magnet supports this conclusion.

Dennis Lagerweij

Barneveld, 24-11-2015

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