TeSuCon

Technical Support & Consultancy

REPORT TURBINE INSPECTION

SN 15401267, WINDPARK SLUFTER WEST 1

Report No. GE15002015001

18-11-2015

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 1
Wind turbine type:	GE1.5S
Wind turbine S/N:	15401267
Location:	Rotterdam-Maasvlakte, NL
Hub height:	65
Nominal power [kW]:	1500
Year of installation:	2003
Date of inspection:	14-10-2015
Inspectors:	D. Lagerweij J. Langenbach

4 Wind turbine main components

Component	Type	Year	Serial number
Convertor	GE Power Convertor 151X1228KA02SA01	-	AY067SJV
Gearbox	Lohmann + Stolterfoht GPV 451	2003	1048177
Revision gearbox	BGS Gear Service	2014	12144
Gearbox oil	Mobilgear SHC XMP 320	2014	-
Generator	Winergy JFEA-500SR-04A	2002	5133067
Blade 1	GE Rotor Blades	-	2382
Blade 2	GE Rotor Blades	-	2366
Blade 3	GE Rotor Blades	-	2388

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	27-11-2012	2012
9½	½ year service	*no service record*	
10	1 year service	29-08-2013	2013
10½	½ year service	31-03-2014	
11	1 year service	10-11-2014	2014
11½	½ year service	28-04-2015	
12	1 year service	*no service record*	2015

7 Logbook: Notable events

Date	Event
21-09-2005	Gearbox exchange
28-05-2013	Gearbox exchange
01-2014	Gear oil exchange
11-04-2014	Gearbox exchange
29-10-2014	Generator bearings replaced
12-10-2015	Inspection rotor 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	Air outlets of the oil reservoirs are corroded.  	nok *Low*

10 Nacelle

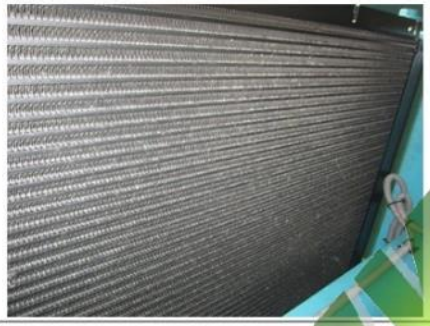
	Item	Remark	
1	Nacelle overview	 	*Info*
2	Frame	Turbine is equipped with a cast-iron frame. 	*Info*
3	Nacelle housing	Parts of the insulation are damaged. 	nok *Low*
4	Weather station		*Info*

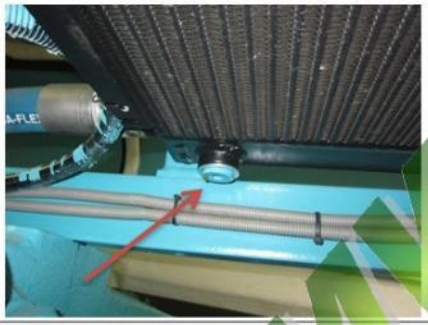
5	Controller overview			*Info*

11 Hydraulic system and brake

	Item	Remark	
1	Overview		*Info*
2	Leakage		ok
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		*Info*

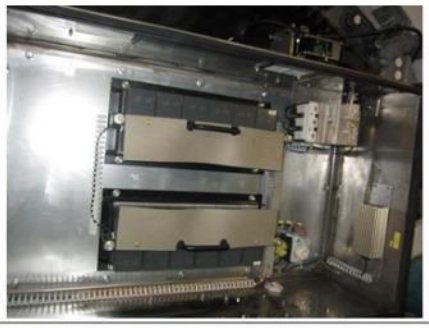
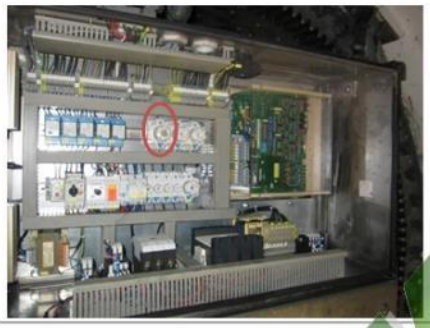
5	Hoses and pipes	Hose between the gearbox and the oil pump is in contact with the sharp edge of the frame. The steel webbing of the hose is visible.  	nok *High*
6	Paint / Corrosion		ok
7	General leakage	Drop of oil visible at the plug of the radiator. Main shaft of the gearbox is leaking some oil.  	nok *Low*
8	Slip ring for hub		*Info*

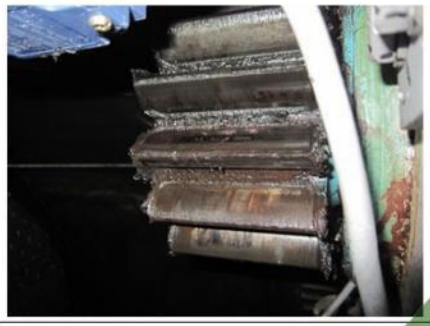
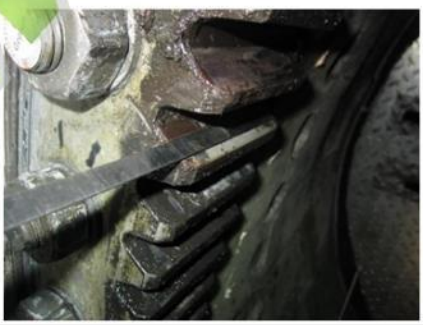
13 Generator and coupling

	Item	Remark	
1	Coupling	The coupling shows no irregularities.  	*Info*
2	Paint / Corrosion		ok
3	Slip ring	The slip ring shows no visual irregularities. 	*Info*

14 Hub

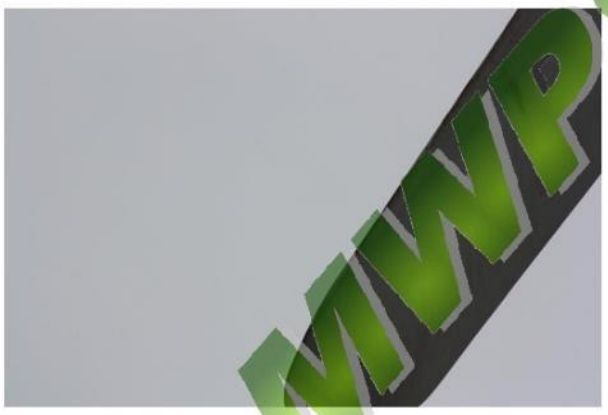
	Item	Remark	
1	Blade bearing	Some caps of the nuts of the bearing are missing and several caps show cracks. 	nok *Low*
2	Overview inside	In general, the hub is clean and there is no excessive corrosion present. 	*Info*
3	Hub cabinet overview		*Info*
4	Boxes blade 1	Control box and battery box show no irregularities.  	ok

5	Boxes blade 2	Control box and battery box show no irregularities.  	ok
6	Boxes blade 3	Sand is leaking at one fuse of the control box.  	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.  	nok *High*
10	Pitch teeth at zero of blade 2	The tooth at zero shows wear.  	nok *High*

11	Pitch teeth at zero of blade 3	The tooth at zero shows wear.  	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		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 has been exchanged in 2005, 2013 and 2014. The generator has not been exchanged and the generator bearings have been replaced in 2014.

The blades have been maintained in 2015.

The wear of the zero-tooth of the pitch ring is serious, but it is possible to solve this problem by assigning another tooth to be the zero-tooth. Dismounting and remounting of the blades is necessary to achieve this. The same thing can be done with the pinions, although replacing the pitch gears (with the pinions) is also an option.

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

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18-11-2015

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TeSuCon

Technical Support & Consultancy

REPORT GEARBOX INSPECTION

SN 15401267, WINDPARK SLUFTER WEST 1

Report no. GE15002015011

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

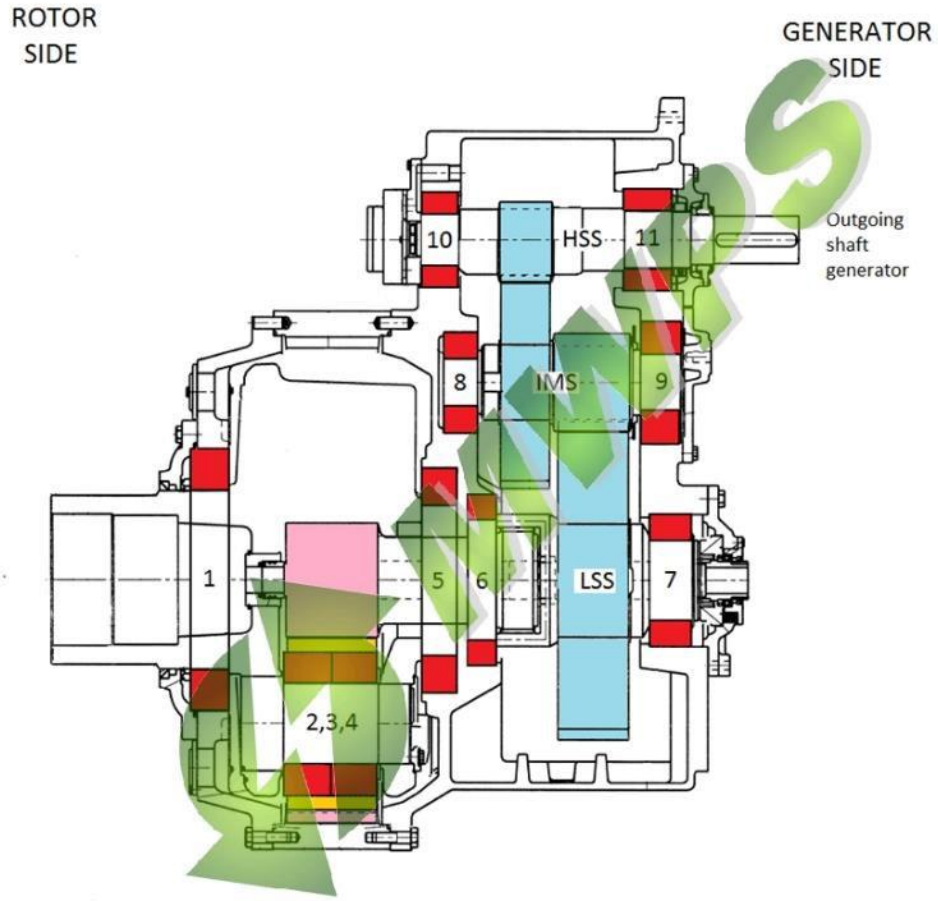
Turbine Information	
Wind turbine name:	Windpark Slufter West 1
Wind turbine type:	GE1.5S
Wind turbine serial no:	15401267
Location:	Rotterdam-Maasvlakte, NL
Hub height:	65
Nominal power [kW]:	1500
Year of installation:	2003
Date of inspection:	14-10-2015
Inspectors:	D. Lagerweij J. Langenbach

Gearbox Information	
Gearbox type:	Lohmann + Stolterfoht GPV 451 *i = 88,81*
Gearbox serial number:	1048177
Production year gearbox:	2003
Revision:	BGS Gear Service 27-01-2014
Revision number:	12144
Oil type:	Mobilgear SHC XMP 320
Date of last oil change:	at revision

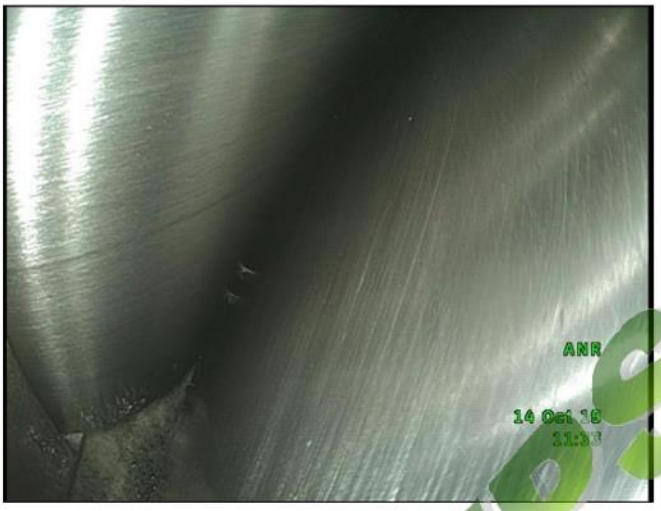
- **Gearbox has been exchanged in 2014**

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.

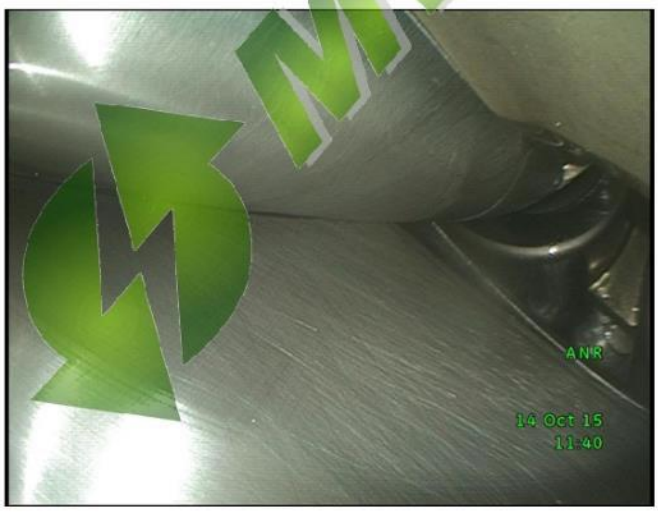


4. Inspection results



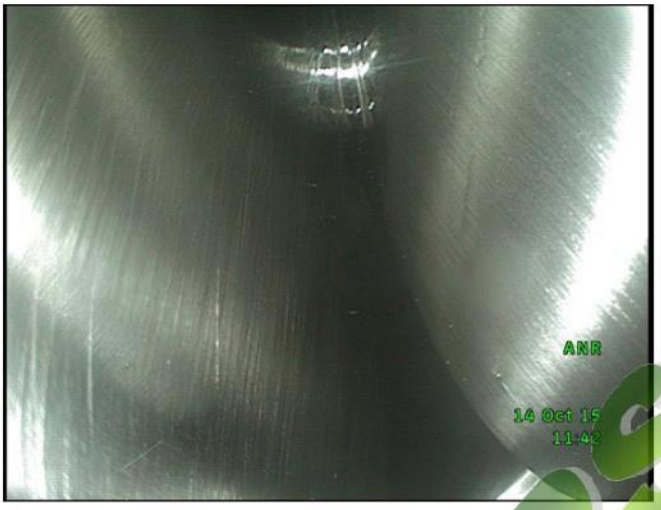
Picture 1

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.

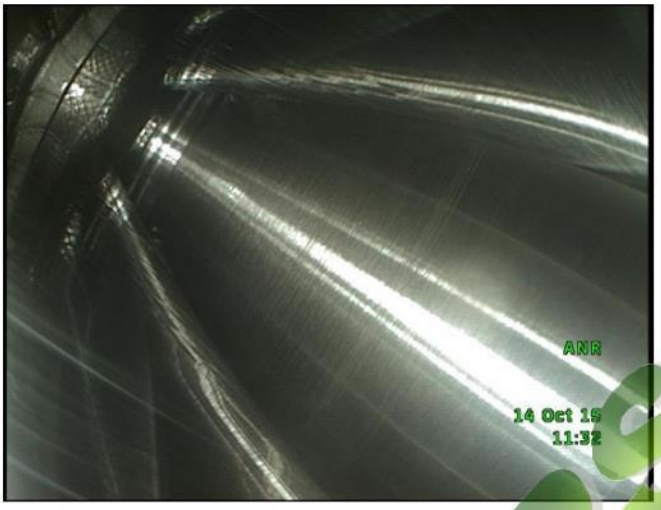


Picture 3

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

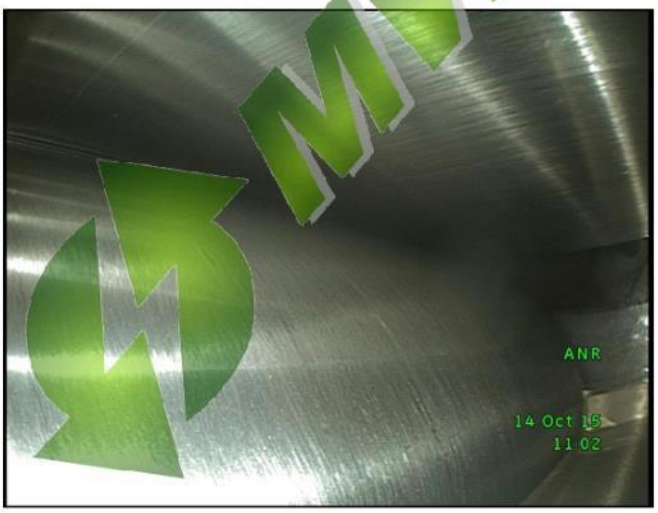
Picture 4

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



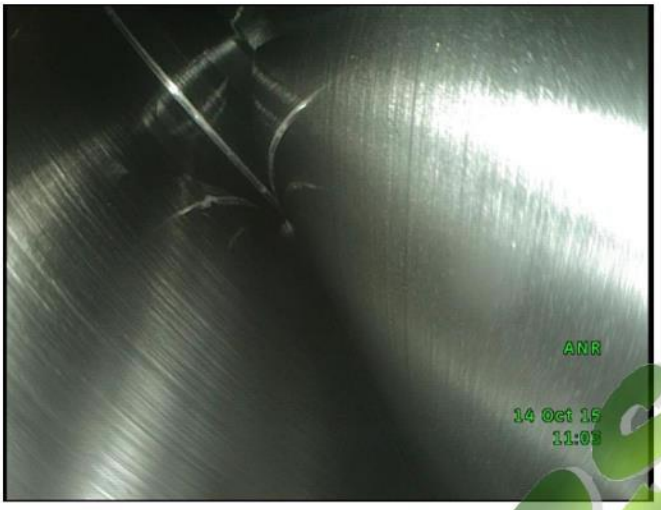
Picture 5

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



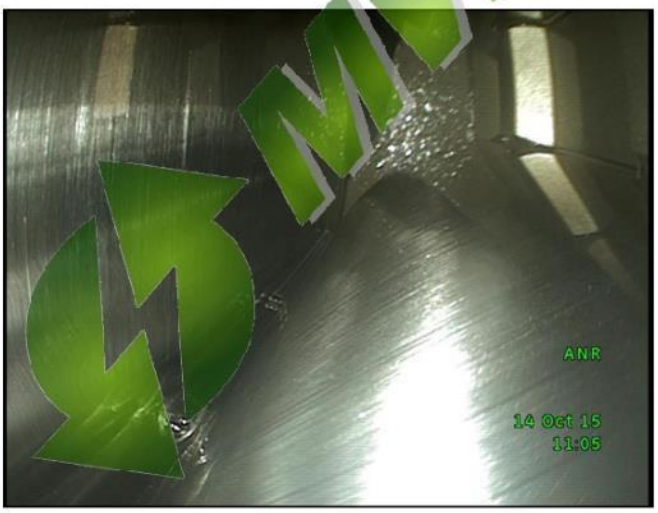
Picture 6

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



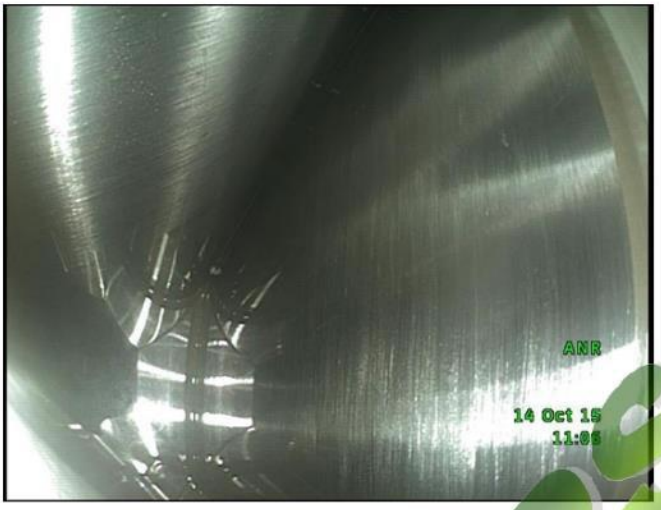
Picture 7

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



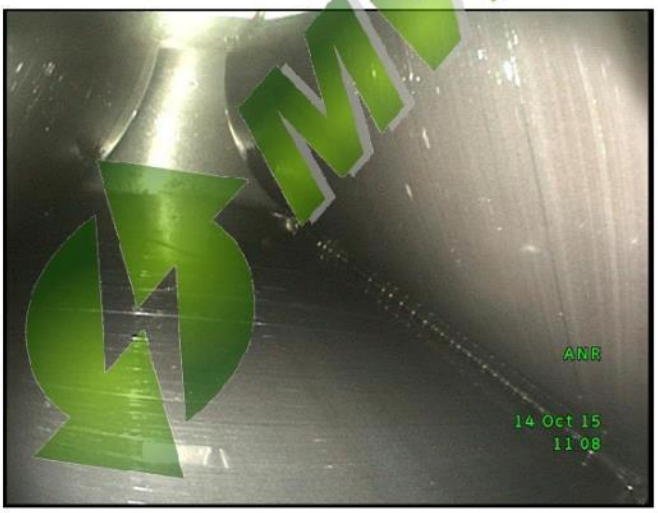
Picture 8

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. 9, the bearing of the intermediate shaft at generator side. The bearing shows no irregularities.

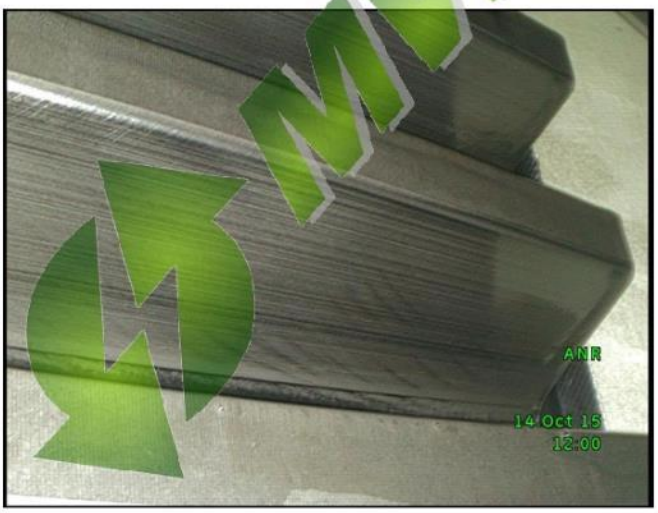


Picture 10

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

Picture 11

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

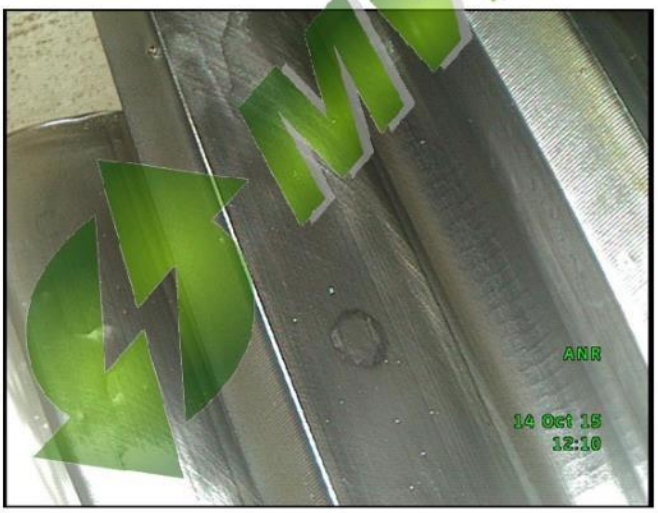


Picture 12

Picture 12 shows the active flank of the ring gear. No irregularities.

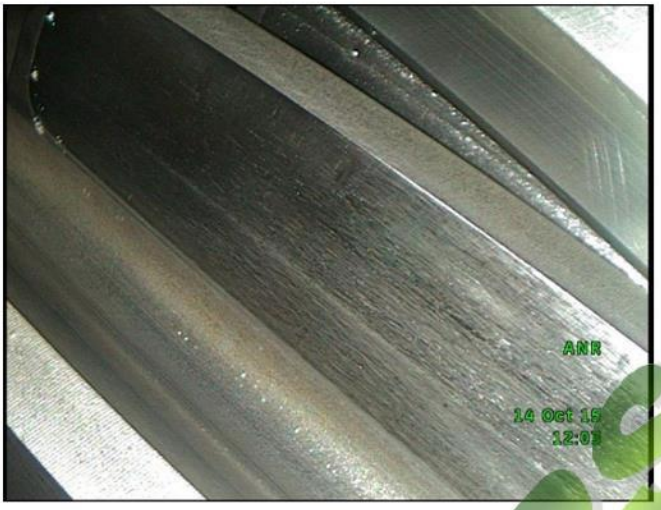
Picture 13

Picture 13 shows the active flank of the ring gear again. Small indentation visible at one of the flanks.



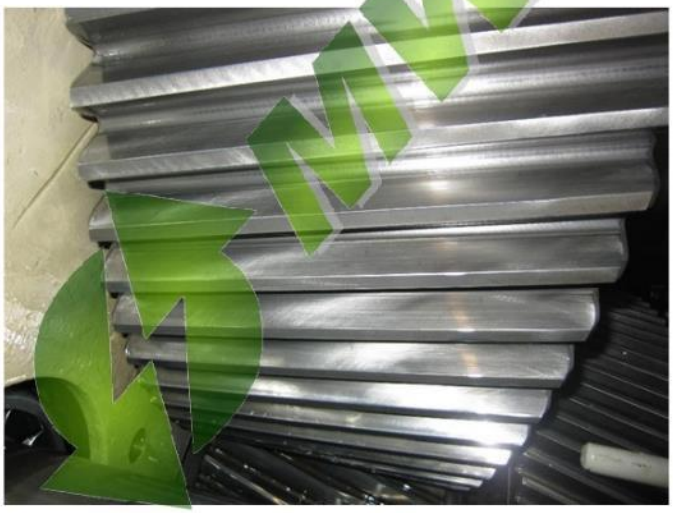
Picture 14

Picture 14 shows one of the planet wheels. One planet wheel shows an irregularity at the flank.



Picture 15

Picture 15 shows the active flanks of the sun pinion. No irregularities.



Picture 16

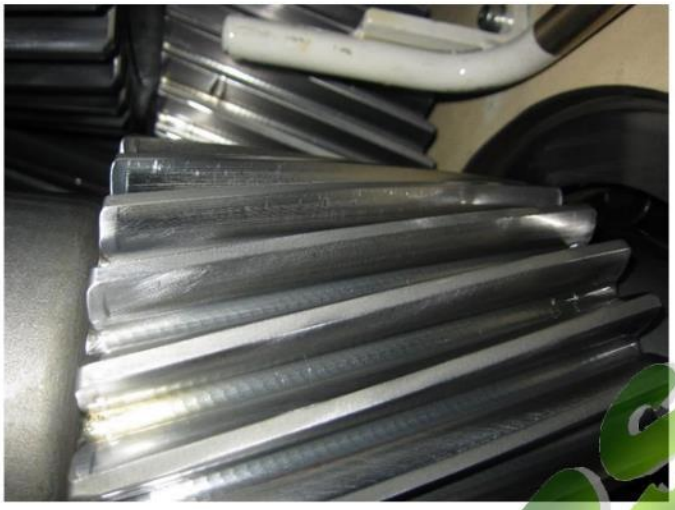
Picture 16 shows the active flanks of the wheel of the low speed shaft in the linear stage. No irregularities.

Picture 17

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

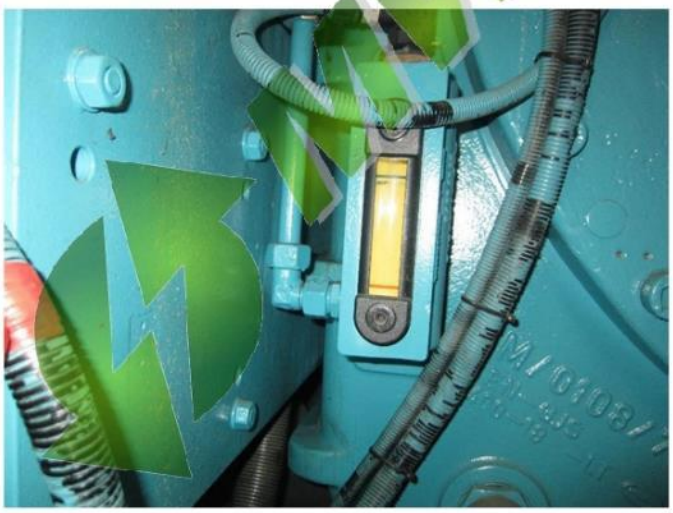
Picture 18

Picture 18 shows the active flanks of the wheel of the intermediate shaft in the linear stage. No irregularities.



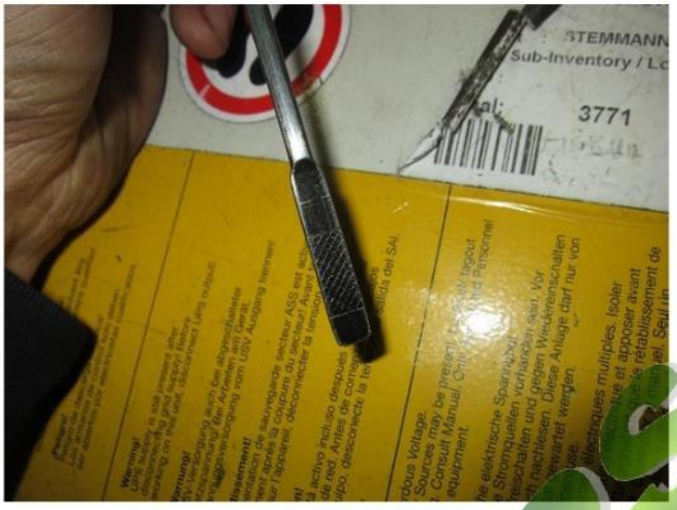
Picture 19

Picture 19 shows the active flanks of the pinion of the high speed shaft in the linear stage. Small scratches visible on the flanks of the pinion.



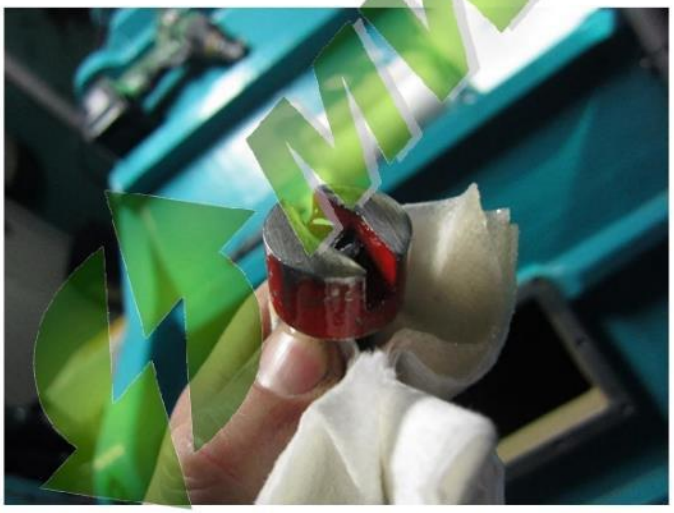
Picture 20

Picture 20 shows the oil level of the gearbox.



Picture 21

Picture 21 shows the oil dip stick of the gear box. The dip stick is dry.



Picture 22

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

5. Summary

The active flank of the ring gear shows a small indentation at one of the flanks.

One of the planet wheels shows an irregularity at the flank.

The active flanks of the pinion of the high speed shaft in the linear stage show small scratches on the pinion.

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

The oil dip stick of the gearbox is dry.

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 pinion of the high speed shaft were probably generated before the gearbox was revised in 2014. 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.

The oil level is correct according to the glass, but the dip stick is dry. It is recommended to fill up the gearbox.

Dennis Lagerweij

Barneveld, 24-11-2015

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