TeSuCon

Technical Support & Consultancy

REPORT TURBINE INSPECTION

SN 15401269, WINDPARK SLUFTER WEST 3

Report No. GE15002015003

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 3
Wind turbine type:	GE1.5S
Wind turbine S/N:	15401269
Location:	Rotterdam-Maasvlakte, NL
Hub height:	65
Nominal power [kW]:	1500
Year of installation:	2003
Date of inspection:	15-10-2015
Inspectors:	D. Lagerweij J. Langenbach

4 Wind turbine main components

Component	Type	Year	Serial number
Convertor	GE Power Convertor 151X1228KA02SA01	-	AY123SJV
Gearbox	Lohmann + Stolterfoht GPV 451	2003	1044371
Revision gearbox	-	-	-
Gearbox oil	Castrol Optigear Synthetic X320	2015	-
Generator	VEM DASAA 5023-4UF	2003	2345003
Blade 1	GE Rotor Blades	-	2391
Blade 2	GE Rotor Blades	-	2389
Blade 3	GE Rotor Blades	-	2384

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	17-11-2012	2012
9½	½ year service	19-03-2013	
10	1 year service	13-09-2013	2013
10½	½ year service	03-04-2014	
11	1 year service	18-11-2014	2014
11½	½ year service	30-04-2015	
12	1 year service	*no service record*	2015

7 Logbook: Notable events

Date	Event
15-09-2010	Generator bearings exchanged
30-10-2012	Gearbox HSS bearing replaced
13-09-2013	NDE generator bearing exchanged
09-05-2014	Slip ring hub exchanged
20-08-2014	Battery packs blade 2 replaced
10-09-2014	DE and NDE generator bearings exchanged
13-04-2015	Dismounted and mounted blades again (regarding the worn pitch teeth)
14-04-2015	Three pitch gears exchanged
09-07-2015	Gear oil exchange

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	Part of the main switch is covered with duct-tape (2nd picture).  	nok *High*
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	Several bolts between the gear and the frame are corroded (1st picture). Several air outlets of the oil reservoirs are corroded.  	nok *Low*

10 Nacelle

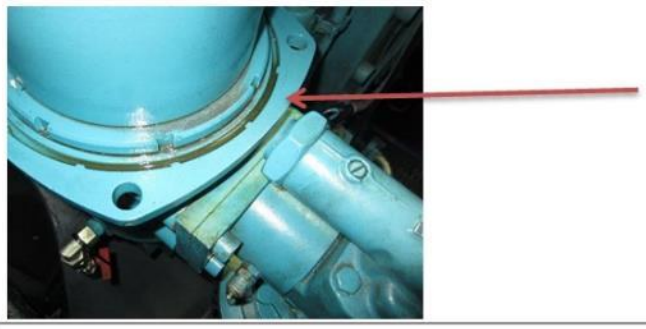
	Item	Remark	
1	Nacelle overview		ok
2	Frame	Turbine is equipped with a cast-iron frame.	*Info*
3	Nacelle housing	Parts of the insulation are damaged. 	nok *Low*
4	Weather station		ok
5	Controller overview		*Info*

11 Hydraulic system and brake

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

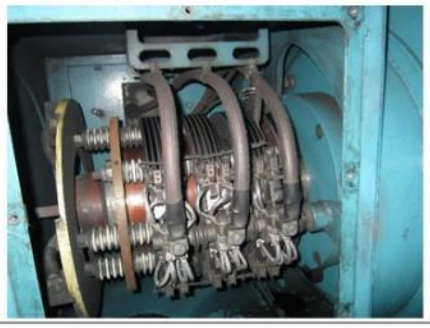
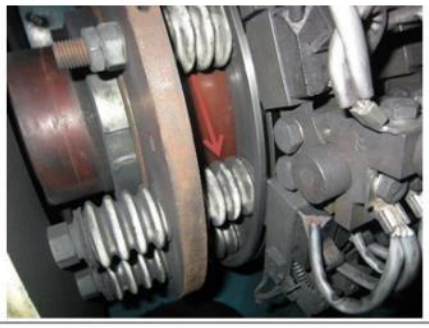
12 Gearbox and main shaft

	Item	Remark	
1	Main shaft bearings	Grease of the main bearing is not magnetic.  	ok
2	Radiators	The radiator is polluted with dust. 	nok *Low*
3	CCJ-unit	A CCJ-filter is 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

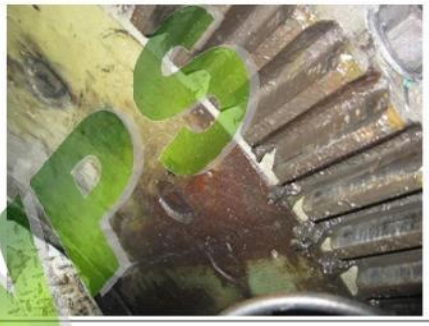
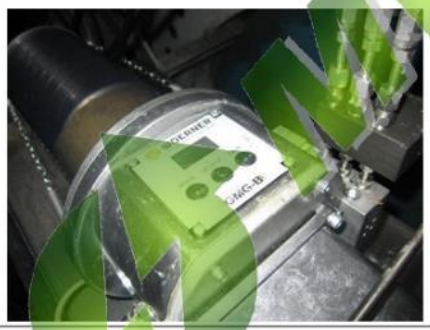
3	Slip ring	The insulating parts between the phases are covered with black carbon dust.  	nok *High*

14 Hub

	Item	Remark	
1	Blade bearing	Several caps of the nuts of the bearing are worn. Cracks visible at the paint at the root of the blade (2nd picture).  	nok *High*
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	Control box and battery box show no irregularities.  	ok

7	Mounting of the electrical boxes	The mounting of the boxes shows no irregularities. 	ok
8	Pinions of pitch gears	One tooth of the pinions of the pitch gears shows wear, but the condition is acceptable.   	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		ok
14	Miscellaneous	The light in the hub is defect. 	nok *Low*

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 original gearbox is present in the turbine and the high speed shaft bearings of the gearbox have been replaced in 2012. The original generator is also present in the turbine and the generator bearings have been replaced in 2014.

The blades have been maintained recently, but there are some cracks visible at the paint at the root of one of the blades.

Although the pitch rings have been turned in 2015, there is already some wear visible at the zero-tooth of the pitch rings. The pinions of the pitch gears have been replaced in 2015 and are also starting to wear again. 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 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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19-11-2015

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Technical Support & Consultancy

REPORT GEARBOX INSPECTION

SN 15401269, WINDPARK SLUFTER WEST 3

Report no. GE15002015013

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.

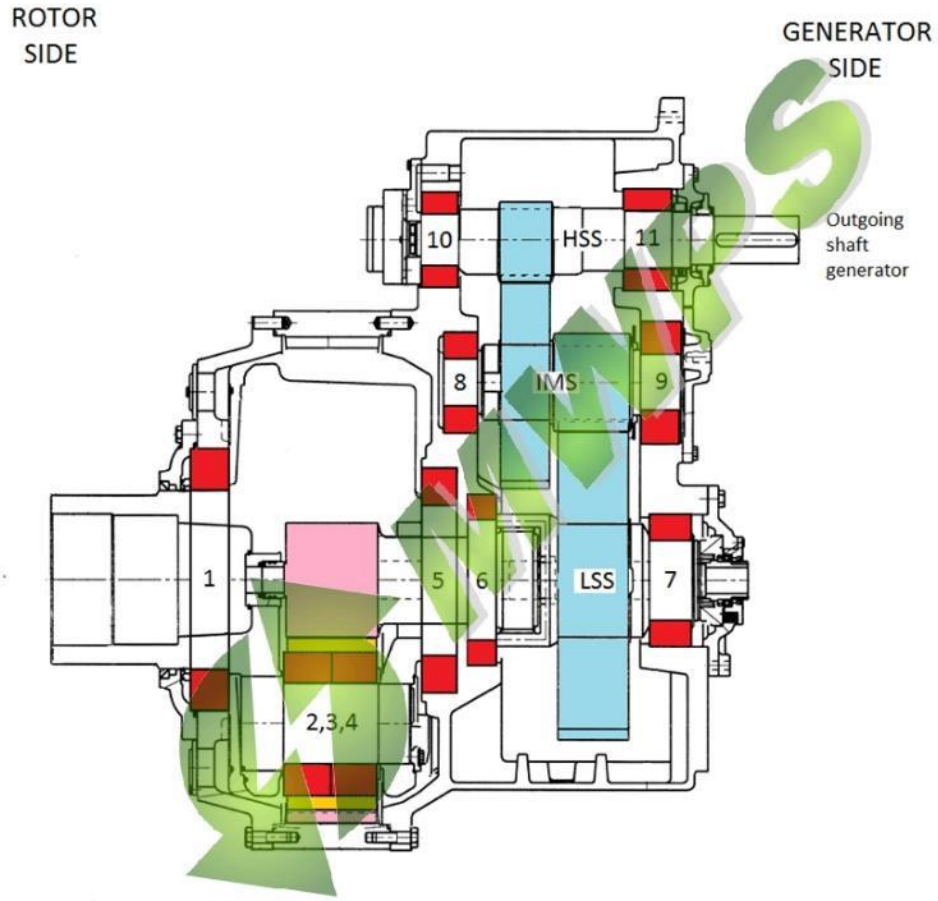
2. General Information

Turbine Information	
Wind turbine name:	Windpark Slufter West 3
Wind turbine type:	GE1.5S
Wind turbine serial no:	15401269
Location:	Rotterdam-Maasvlakte, NL
Hub height:	65
Nominal power [kW]:	1500
Year of installation:	2003
Date of inspection:	15-10-2015
Inspectors:	D. Lagerweij J. Langenbach

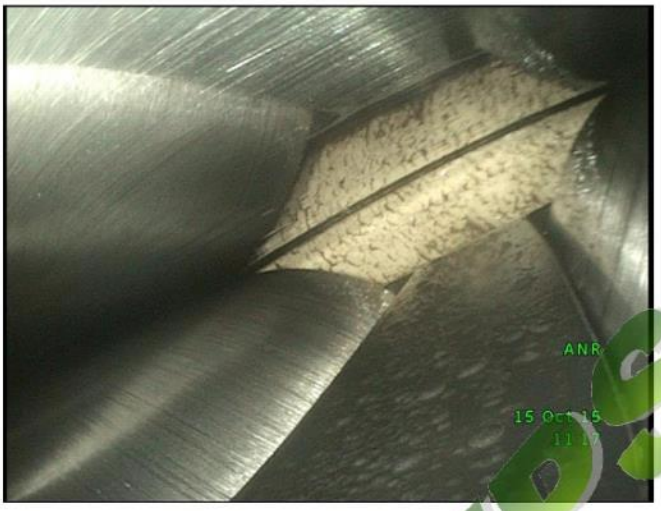
Gearbox Information	
Gearbox type:	Lohmann + Stolterfoht GPV 451 *i = 88,81*
Gearbox serial number:	1044371
Production year gearbox:	2003
Revision:	-
Revision number:	-
Oil type:	Castrol Optigear Synthetic X320
Date of last oil change:	09-07-2015

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

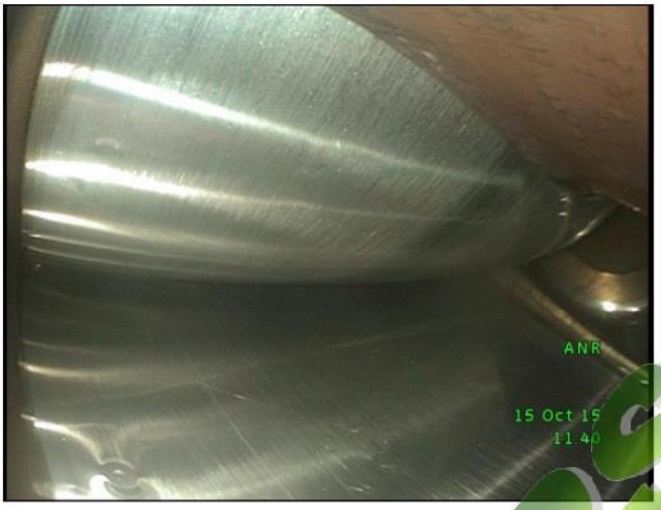


Picture 1

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

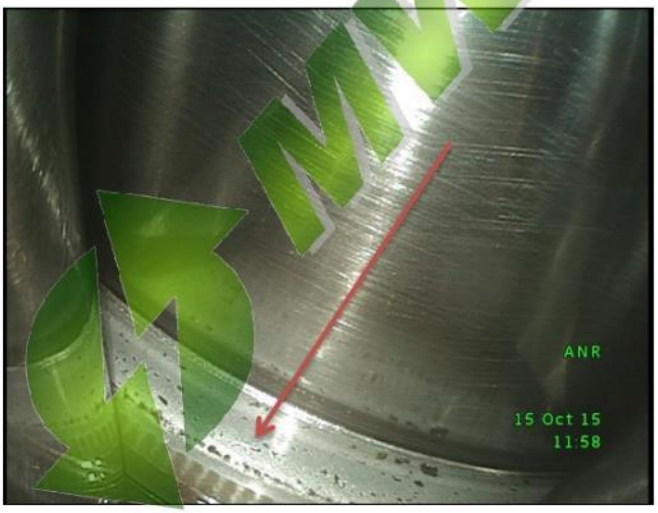
Picture 2

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.

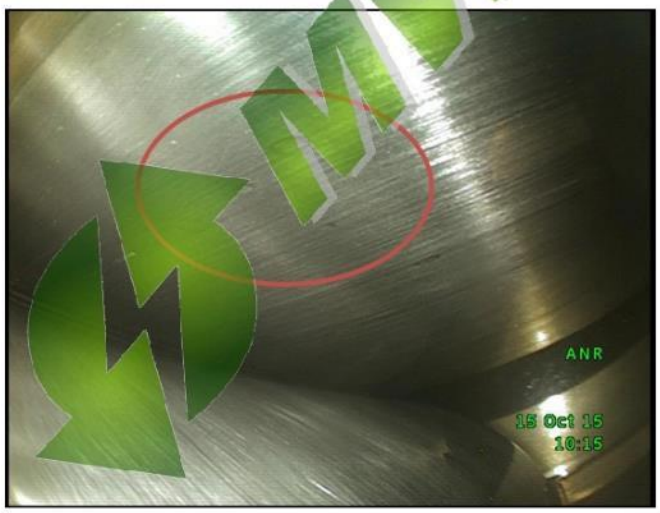


Picture 4

Picture 4 shows the bearing of the third planet wheel. Surface of the inner guide ring is roughened.

Picture 5

Picture 5 shows bearing position no. 5, the bearing of the planet carrier at generator side. Small indentation visible at the raceway.

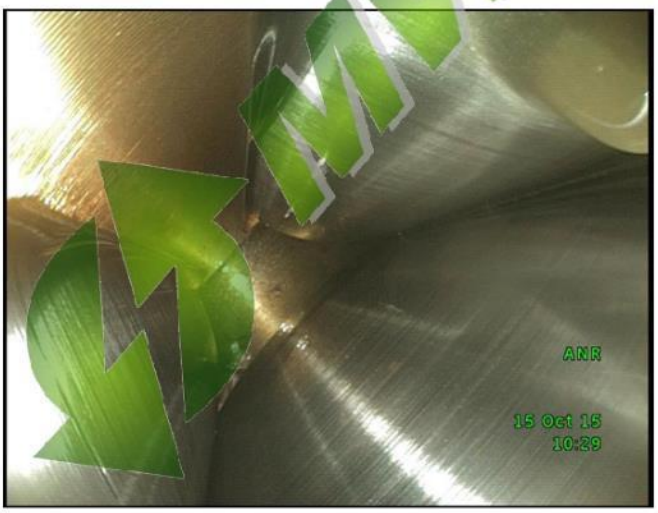


Picture 6

Picture 6 shows bearing position no. 6, the bearing of the low speed shaft at rotor side. Small indentations visible at the raceway.

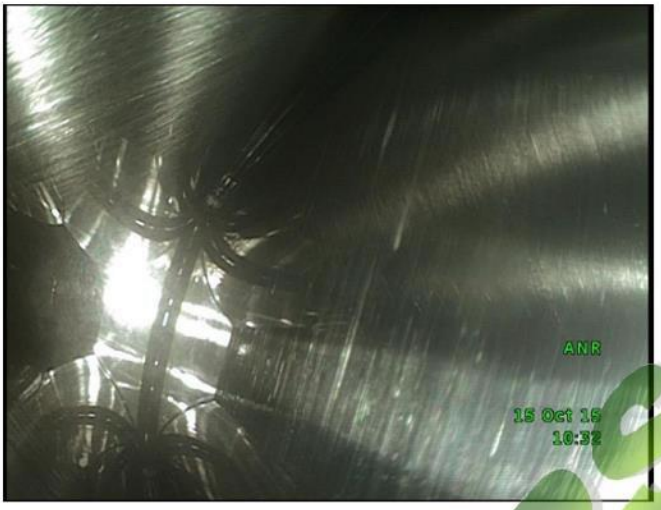
Picture 7

Picture 7 shows bearing position no. 7, the bearing of the low speed shaft at generator side. Small indentation visible at the raceway.



Picture 8

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

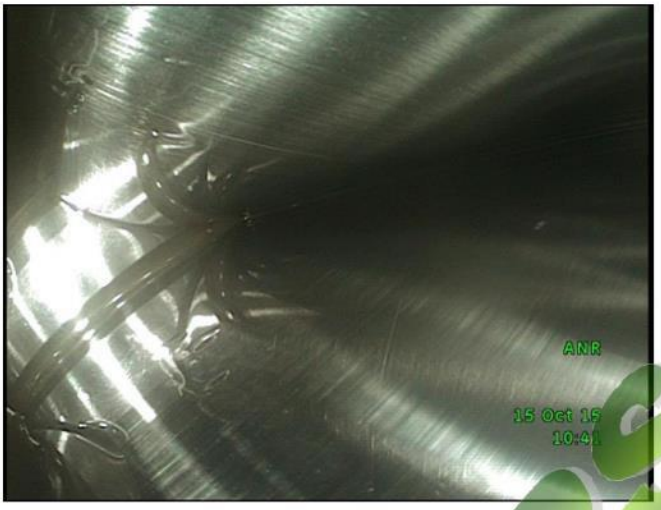


Picture 9

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

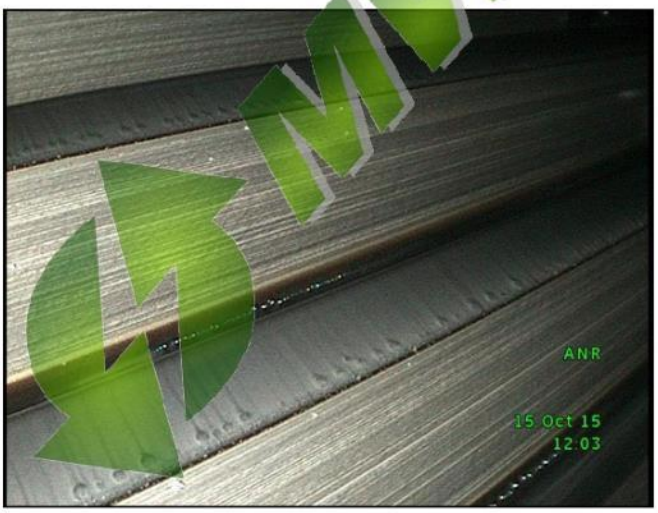
Picture 10

Picture 10 shows bearing position no. 10, the bearing of the high speed shaft at rotor side. Small indentations visible at the rolling element.



Picture 11

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

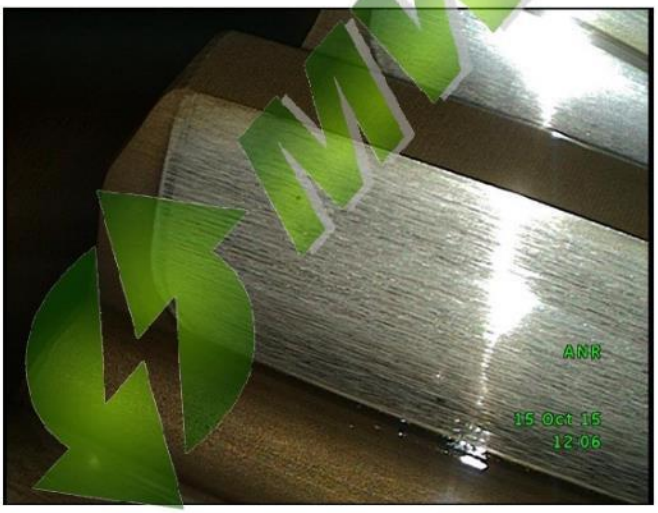


Picture 12

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

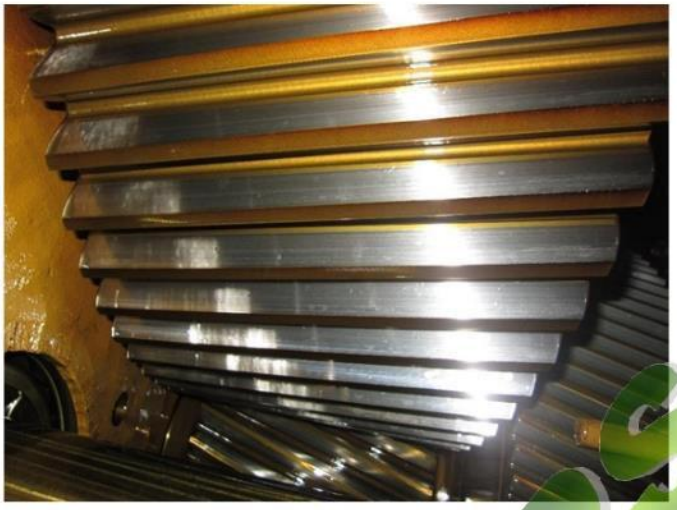
Picture 13

Picture 13 shows one of the planet wheels. None of the planet wheels show irregularities.



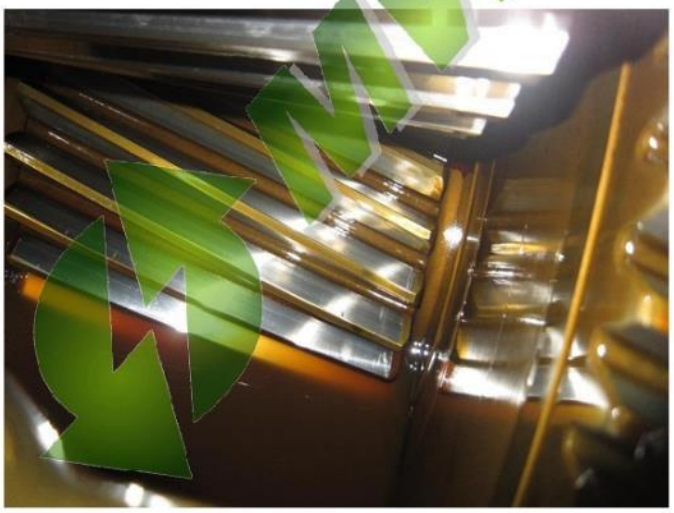
Picture 14

Picture 14 shows the active flanks of the sun pinion. No irregularities.



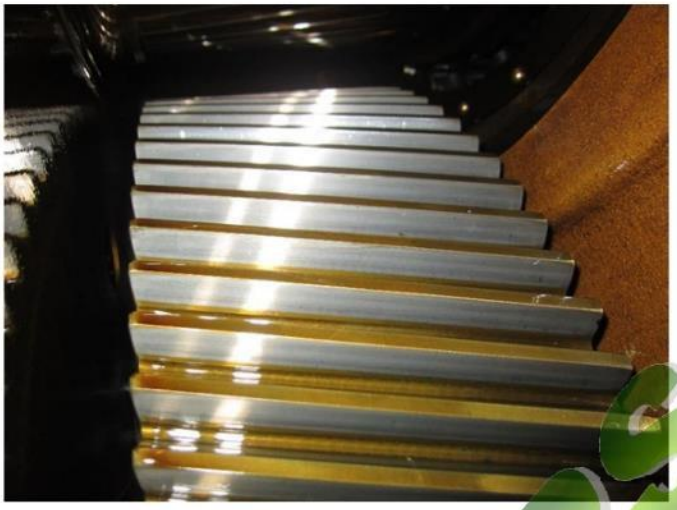
Picture 15

Picture 15 shows the active flanks of the wheel of the low speed shaft in the linear stage. No irregularities.



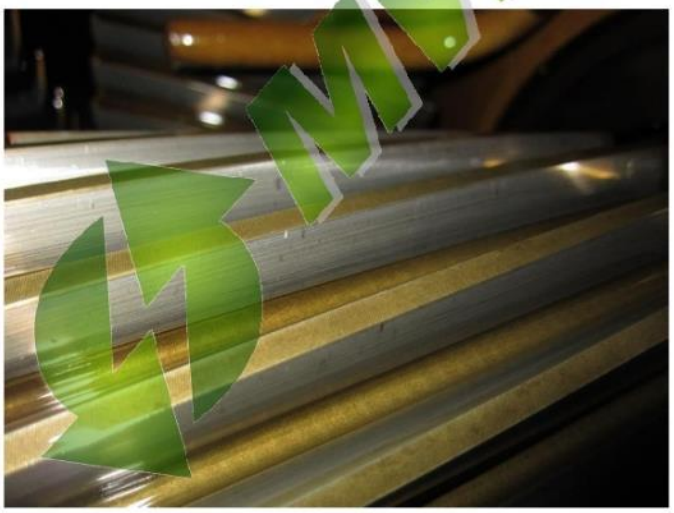
Picture 16

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



Picture 17

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

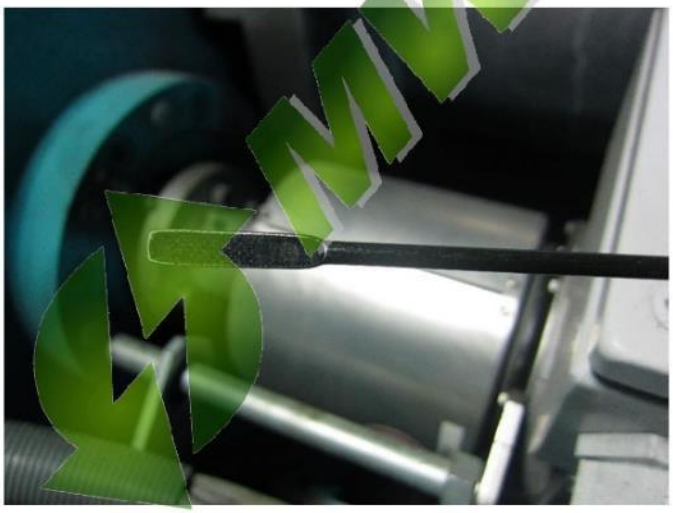


Picture 18

Picture 18 shows the active flanks of the pinion of the high speed shaft in the linear stage. No irregularities.

Picture 19

Picture 19 shows the oil level of the gearbox.



Picture 20

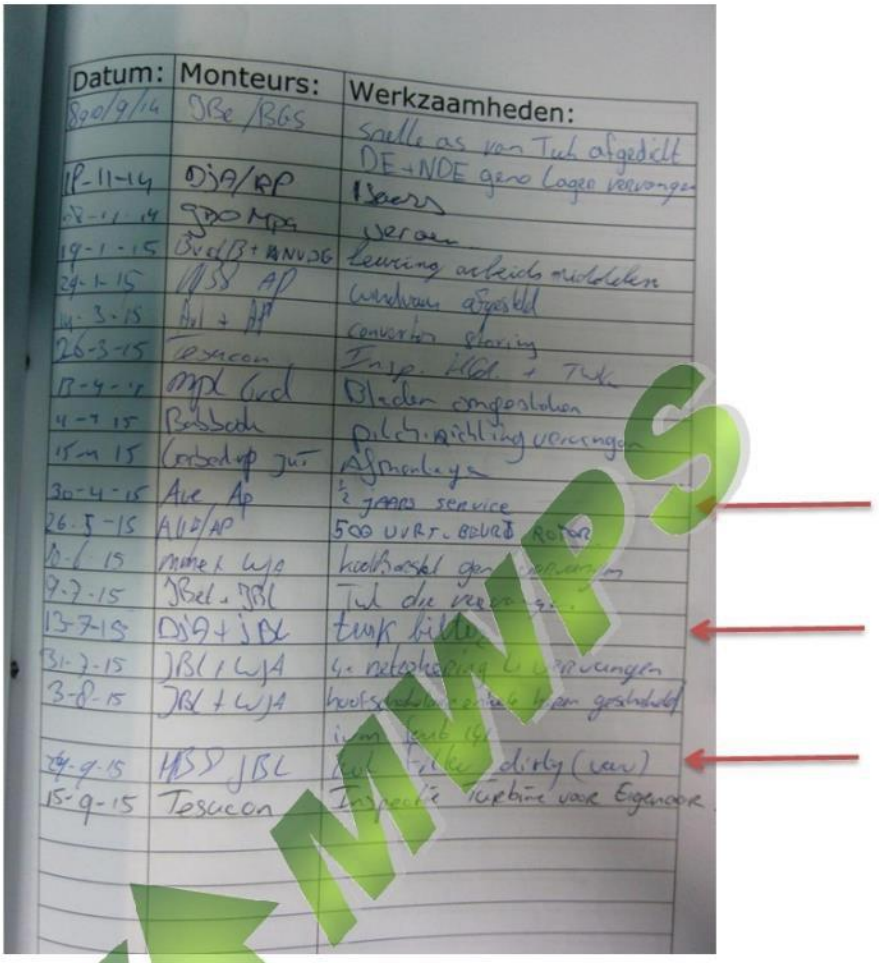
Picture 20 shows the oil dip stick of the gear box. The dip stick is dry.

Picture 21

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

Picture 22

The inside of the gearbox is covered with black sludge.



The logbook shows that the gear oil filter has been replaced quite often in the last year.

5. Summary

The surface of the inner guide ring of the bearing of the first planet wheel is roughened.

The bearing of the planet carrier at generator side shows a small indentation at the raceway.

The bearing of the low speed shaft at rotor side shows small indentations at the raceway.

The bearing of the low speed shaft at generator side shows a small indentation at the raceway.

The bearing of the high speed shaft at rotor side shows small indentations at the rolling element.

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.

The inside of the gearbox is covered with black sludge.

The logbook shows that the gear oil filter has been replaced quite often in the last year.

6. Conclusion

The condition of the gearbox is good enough to keep the gearbox in operation.

The irregularities at the planet bearing are remarkable and it is recommended to keep monitoring this bearing closely in the future.

The small indentations on the other bearings have probably been caused by damaged high speed bearings in 2012.

The gear oil filter has been replaced quite often this year, which is probably caused by sludge in the gearbox.

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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