TeSuCon

Technical Support & Consultancy

REPORT TURBINE INSPECTION

SN 15401268, WINDPARK SLUFTER WEST 2

Report No. GE15002015002

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 2
Wind turbine type:	GE1.5S
Wind turbine S/N:	15401268
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 151X1228KA025A01	-	DS008VIA
Gearbox	Lohmann + Stolterfoht GPV 451	2003	1044369
Revision gearbox	-	-	-
Gearbox oil	Castrol Optigear Syn A320 *(according to label in towerbase)*	2012	-
Generator	VEM DASAA 5023-4UF	2003	2345001
Blade 1	GE Rotor Blades	-	2398
Blade 2	GE Rotor Blades	-	2297
Blade 3	GE Rotor Blades	-	2404

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	26-11-2012	2012
9½	½ year service	20-03-2013	
10	1 year service	05-09-2013	2013
10½	½ year service	02-04-2014	
11	1 year service	17-11-2014	2014
11½	½ year service	07-05-2015	
12	1 year service	*no service record*	2015

7 Logbook: Notable events

Date	Event
...	...
13-12-2010	Gear oil pump exchange
29-06-2012	Exchange HSS bearings
08-05-2015	6 battery packs exchanged blade 1,2 and 3

8 Tower and towerbase

	Item	Remark	
1	Tower outside	Light at the outside is broken and has damaged the paint of the tower. Caps from a few bolts of the bottom flange are missing.  	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	Several bolts between the gear and the frame are corroded (1st picture). Several air outlets of the oil reservoirs are corroded.  	nok *Low*

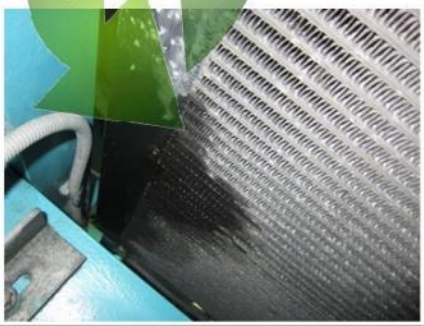
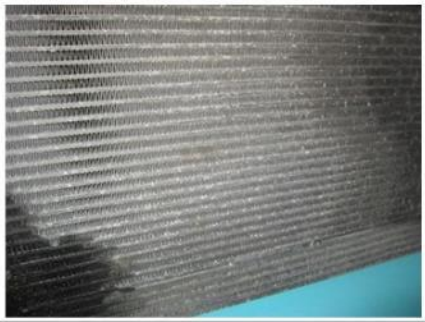
10 Nacelle

	Item	Remark	
1	Nacelle overview		*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		*Info*

11 Hydraulic system and brake

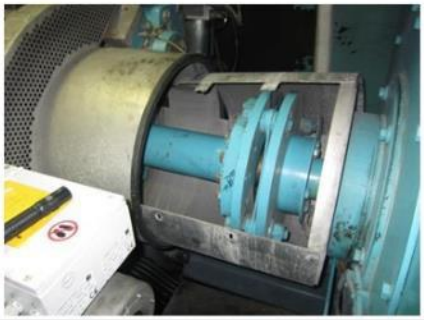
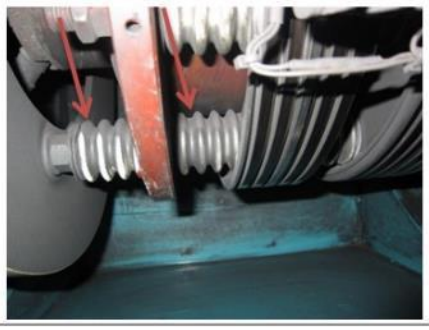
	Item	Remark	
1	Overview	 	*Info*
2	Leakage		ok
3	Miscellaneous		ok

12 Gearbox and main shaft

	Item	Remark	
1	Main shaft bearings	Grease of the main bearing is not magnetic.  	ok
2	Radiators	Leakage at the radiator.  	nok *High*
3	CCJ-unit	No CCJ-filter present in the turbine.	*Info*

4	Gear oil system	Leakage visible at the filter unit and on the frame under the unit.  	nok *High*
5	Hoses and pipes		ok
6	Paint / Corrosion		ok
7	General leakage		ok
8	Slip ring for hub		*Info*

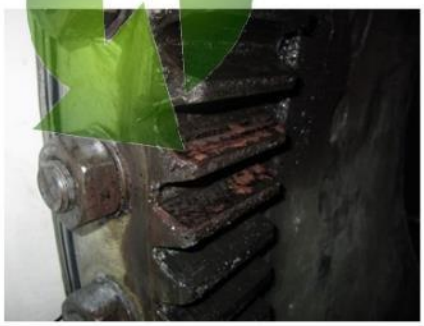
13 Generator and coupling

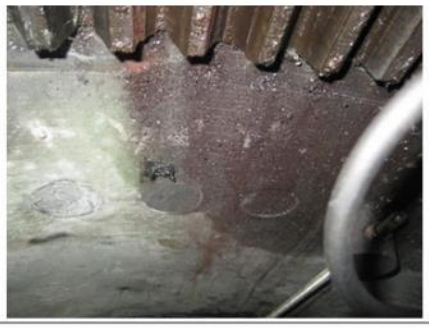
	Item	Remark	
1	Coupling	The coupling shows no irregularities.  	*Info*
2	Paint / Corrosion		ok
3	Slip ring	Raceway of the earth connection is not completely smooth (3th picture). The insulating parts between the phases are covered with black carbon dust (arrows in 4th picture).    	nok *High*

14 Hub

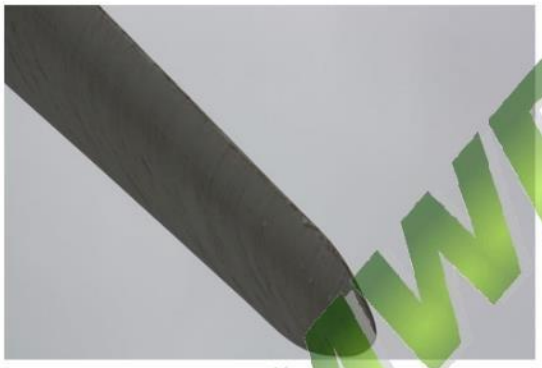
	Item	Remark	
1	Blade bearing	Small cracks visible at the caps of the blade bearing bolts (2nd picture).  	nok *Low*
2	Overview inside	In general, the hub is clean and there is no excessive corrosion present. 	*Info*
3	Hub cabinet overview		*Info*
4	Boxes blade 1	Control box and battery box show no irregularities.  	ok

5	Boxes blade 2	Control box and battery box show no irregularities.  	ok
6	Boxes blade 3	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	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 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.

The blades have been maintained recently.

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 15401268, WINDPARK SLUFTER WEST 2

Report no. GE15002015012

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.

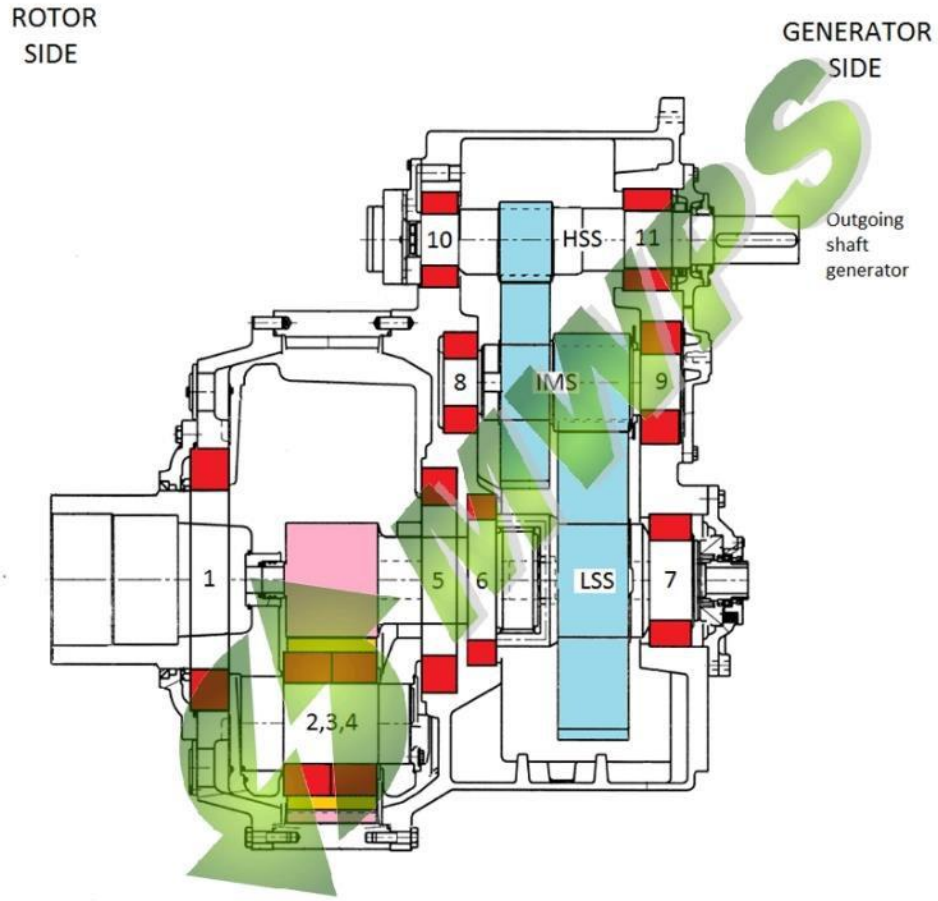
2. General Information

Turbine Information	
Wind turbine name:	Windpark Slufter West 2
Wind turbine type:	GE1.5S
Wind turbine serial no:	15401268
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

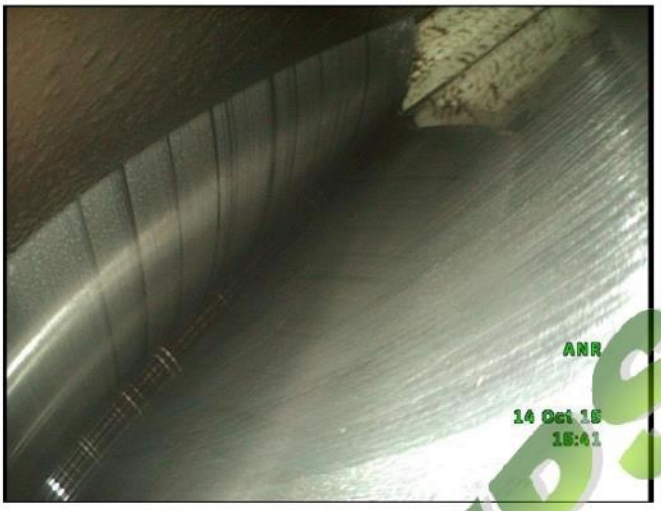
Gearbox Information	
Gearbox type:	Lohmann + Stolterfoht GPV 451 *i = 88,81*
Gearbox serial number:	1044369
Production year gearbox:	2003
Revision:	-
Revision number:	-
Oil type:	Castrol Optigear Syn A320 *(according to label in towerbase)*
Date of last oil change:	29-06-2012

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.

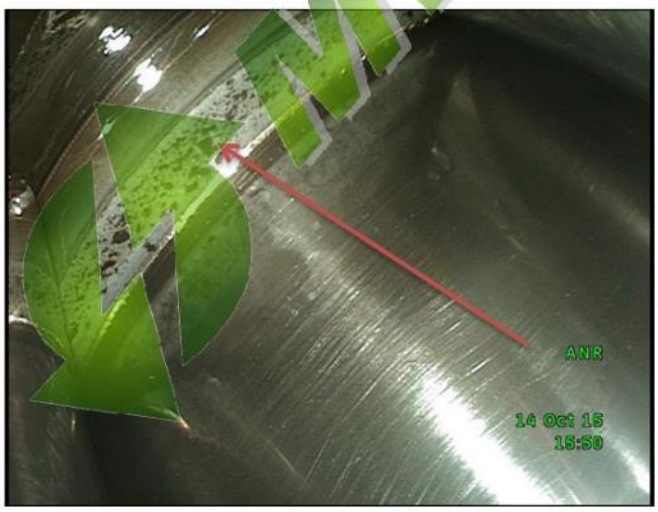


4. Inspection results



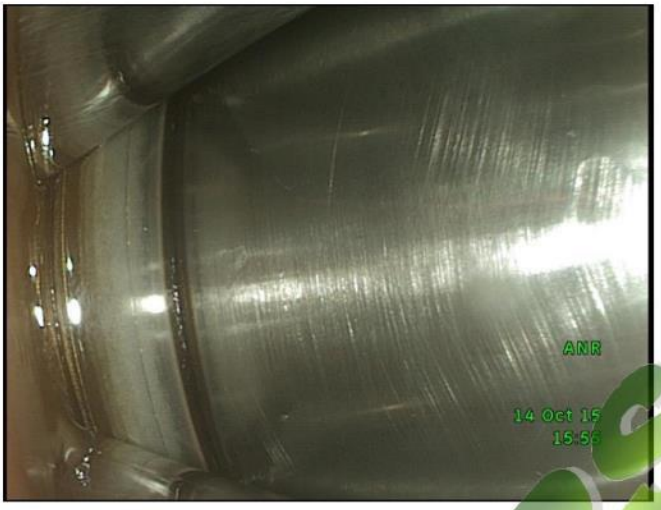
Picture 1

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



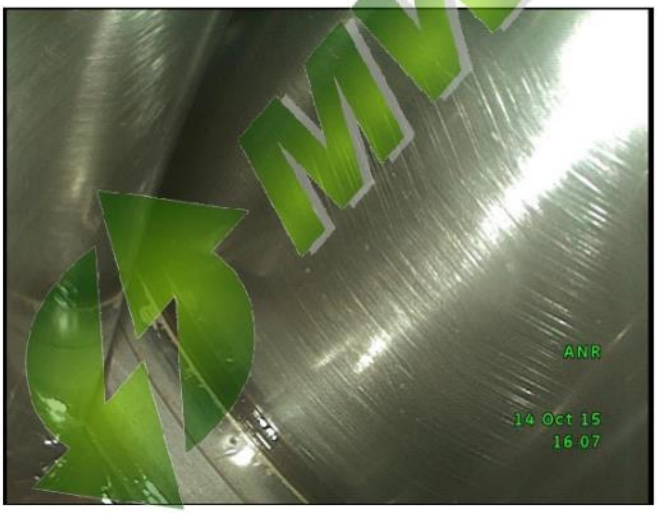
Picture 2

Picture 2 shows the bearing of the first planet wheel. Surface of the inner guide ring is roughened.



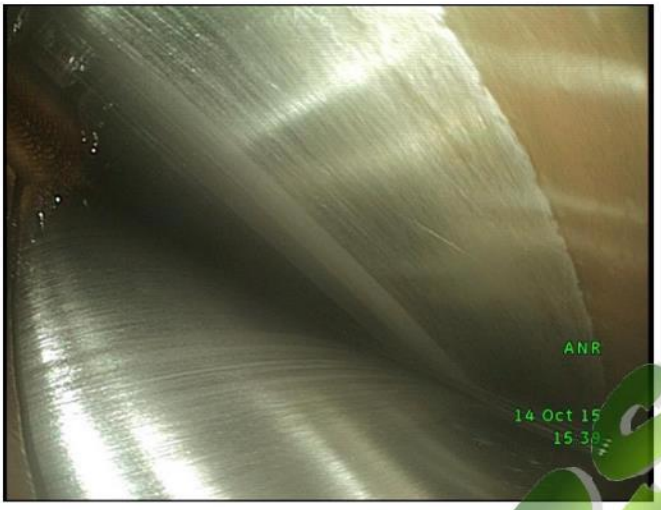
Picture 3

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



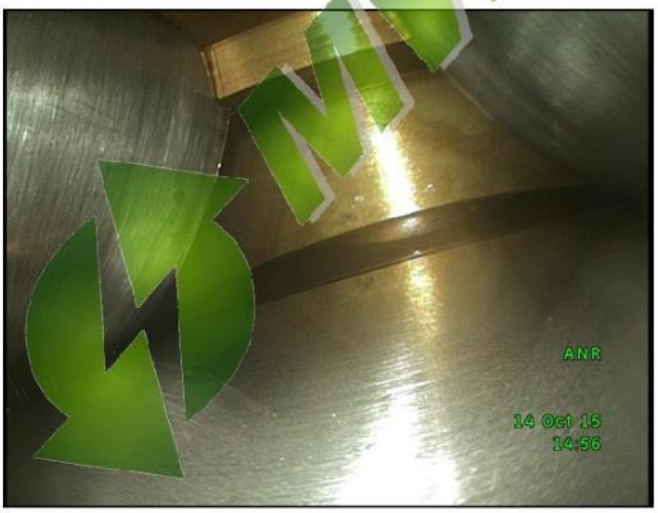
Picture 4

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



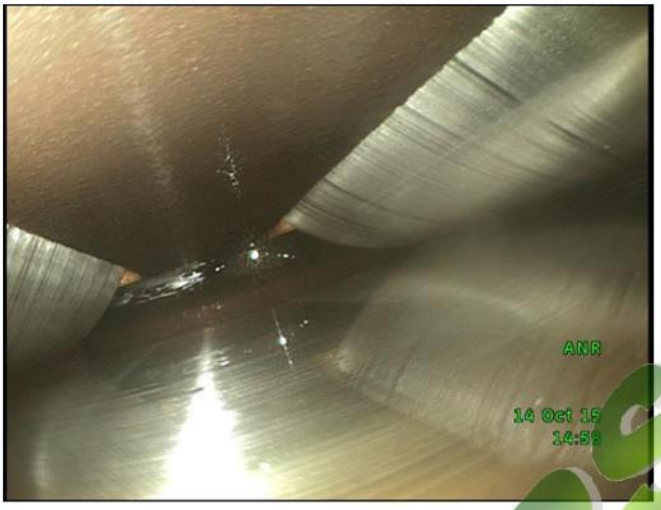
Picture 5

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.

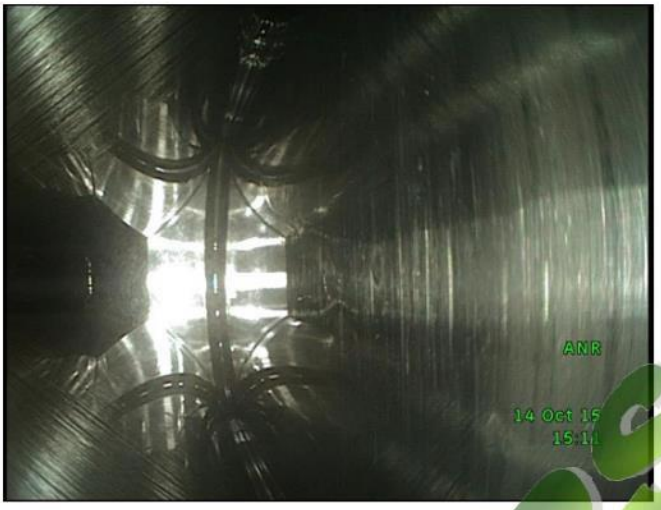


Picture 7

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

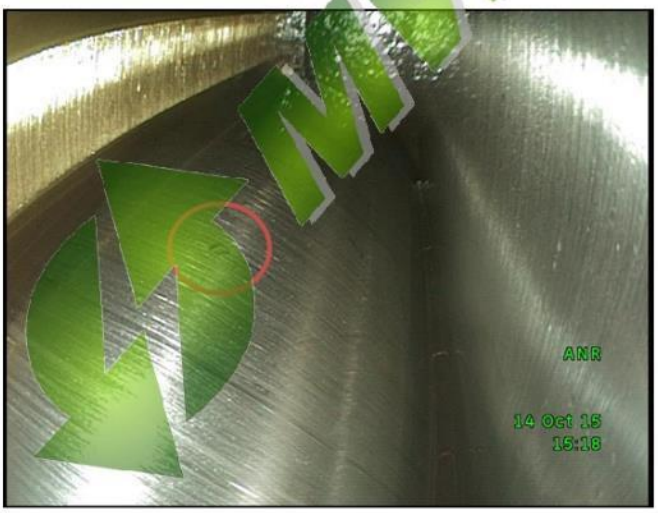
Picture 8

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.

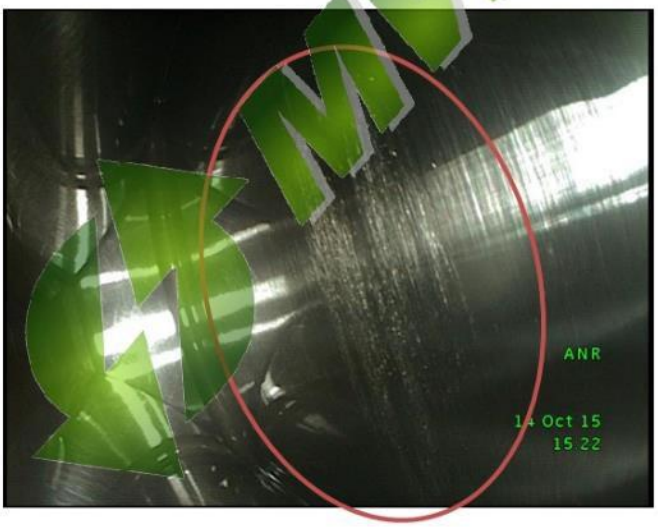


Picture 10

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

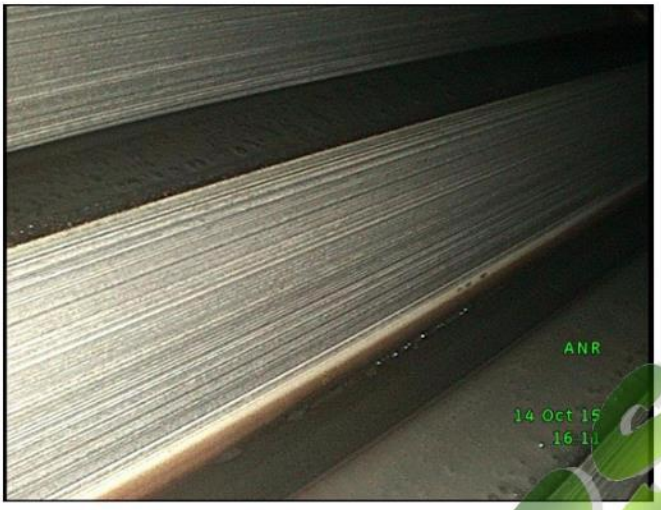
Picture 11

Picture 11 shows bearing position no. 11, the bearing of the high speed shaft at generator side. Several indentations visible at the raceway.



Picture 12

Picture 12 shows bearing position no. 11 again, the bearing of the high speed shaft at generator side. The bearing shows an area on the raceway where the surface is roughened.

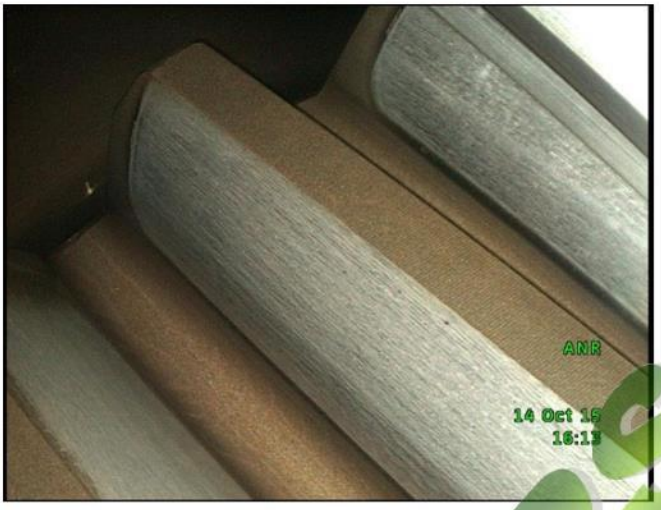


Picture 13

Picture 13 shows the active flank of the ring gear. No irregularities.

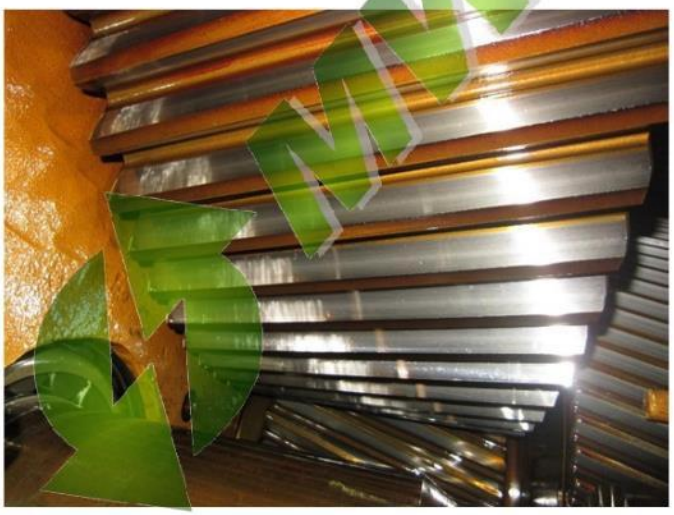
Picture 14

Picture 14 shows one of the planet wheels. None of the planet wheels show irregularities.



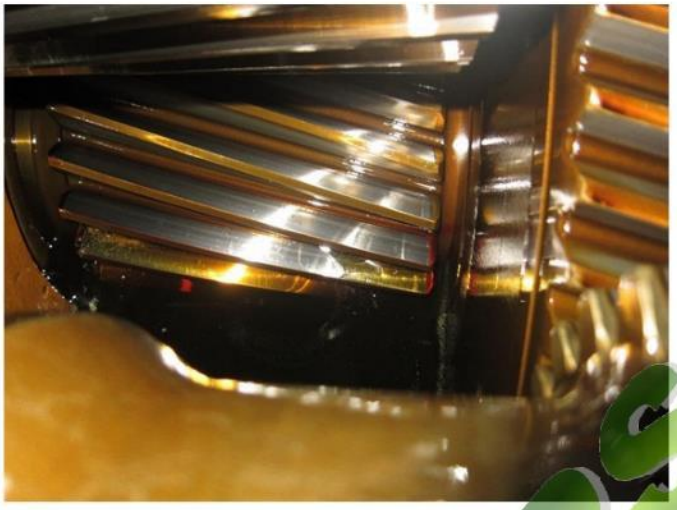
Picture 15

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. No irregularities.

Picture 20

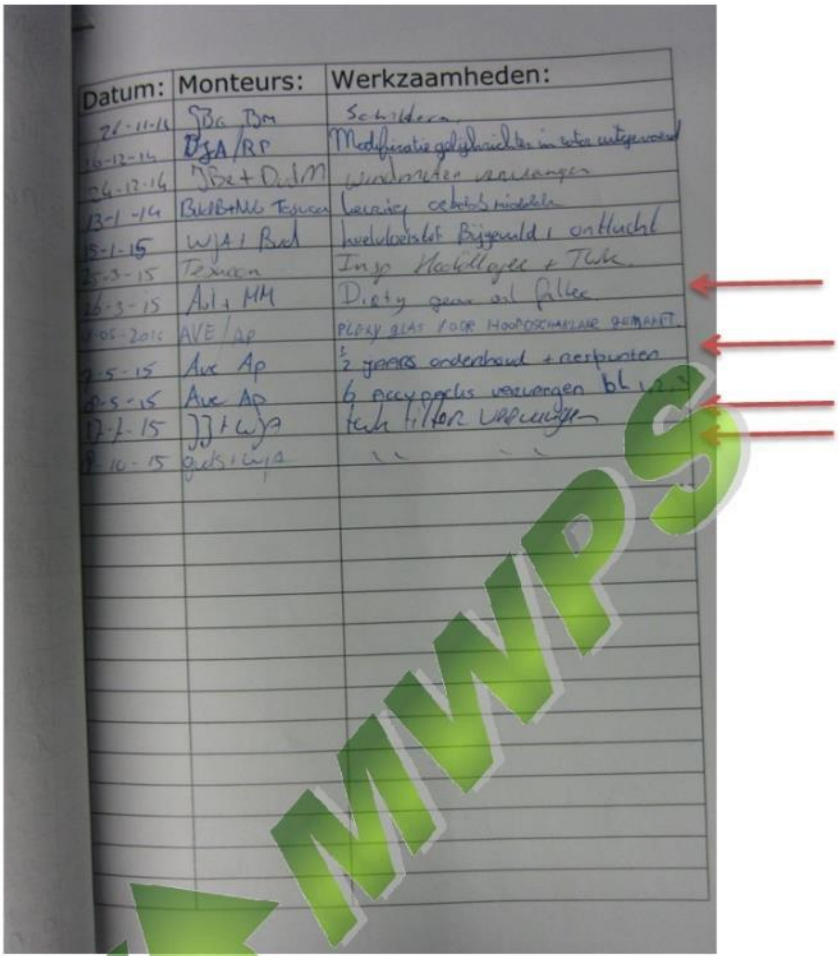
Picture 20 shows the oil level of the gearbox.

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.



Datum:	Monteurs:	Werkzaamheden:
26-11-14	JBa BM	Schilderen
16-12-14	DJA/RP	Modificatie [illegible] uitgevoerd
24-12-14	JBe + DdM	windmeter vervangen
13-1-14	[illegible] Tesucon	[illegible]
15-1-15	WJA + Bvd	[illegible] Bijgevuld + ontlucht
25-3-15	Tesucon	Insp [illegible]
26-3-15	AdJ + MM	Dirty gear oil filter
[illegible]-05-2015	AVE/AP	PLEXY GLAS VOOR HOOFDSCHAKELAAR GEMAAKT.
[illegible]-5-15	Ave Ap	½ jaars onderhoud + nerfpunten
[illegible]-5-15	Ave Ap	6 accupacks vervangen bl [illegible]
17-7-15	JJ + WJA	[illegible] filter vervangen
[illegible]-10-15	[illegible] + WJA	" "

Picture 23

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 high speed shaft at rotor side shows small indentation at the rolling element.

The bearing of the high speed shaft at generator side shows several indentations and a roughened surface at the raceway.

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 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 and the high speed bearings are remarkable and it is recommended to keep monitoring these bearings closely in the future.

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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