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# REPORT TURBINE INSPECTION

# SN 15401270, WINDPARK SLUFTER WEST 4

Report No. GE15002015004

19-11-2015

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## 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* |

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## 3 General information

| | |
|---|---|
| Wind turbine name: | Windpark Slufter West 4 |
| Wind turbine type: | GE1.5S |
| Wind turbine S/N: | 15401270 |
| Location: | Rotterdam-Maasvlakte, NL |
| Hub height: | 65 |
| Nominal power [kW]: | 1500 |
| Year of installation: | 2003 |
| Date of inspection: | 15-10-2015 |
| Inspectors: | D. Lagerweij<br>J. Langenbach |

## 4 Wind turbine main components

| Component | Type | Year | Serial number |
|---|---|---|---|
| Convertor | ABB Oy ACS600 WTD | 2003 | 71546/050 |
| Gearbox | Eickhoff EBN 793 A02 R00A / G 48640XB | 2010 | 25025 |
| Revision gearbox | - | - | - |
| Gearbox oil | Castrol Optigear Synthetic. A 320 | 2010 | - |
| Generator | Winergy JFEA-500SR-04A | 2003 | 5133485 |
| Blade 1 | GE Rotor Blades | - | 2400 |
| Blade 2 | GE Rotor Blades | - | 2308 |
| Blade 3 | GE Rotor Blades | - | 2390 |



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## 5 Documents

| | Component | Remark | |
|---|---|---|---|
| 1 | Operator manual | Operating manual is available at the turbine.<br><br>Machine directive 2006/45/EC, 1.7.4.2 states as part of the Contents of instructions:<br><br>*"(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.<br><br>Machine directive 2006/45/EC, 1.7.4.2 states as part of the Contents of instructions:<br><br>*"(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.<br><br>Machine directive 2006/45/EC, 1.7.4.2 states as part of the Contents of instructions:<br><br>*"(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.<br><br>Machine directive 2006/45/EC, 1.7.4.2 states as part of the Contents of instructions:<br><br>*"(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 |

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## 6 Logbook: Overview of recent maintenance

| Year | Type of maintenance | Date of execution | Maintenance schedule |
|---|---|---|---|
| | Commissioning | 09-2003 | 2003 |
| ... | ... | ... | ... |
| 9 | 1 year service | 24-11-2012 | 2012 |
| 9½ | ½ year service | 06-03-2013 | |
| 10 | 1 year service | 18-09-2013 | 2013 |
| 10½ | ½ year service | 15-04-2014 | |
| 11 | 1 year service | 26-11-2014 | 2014 |
| 11½ | ½ year service | 13-05-2015 | |
| 12 | 1 year service | *no service record* | 2015 |

## 7 Logbook: Notable events

| Date | Event |
|---|---|
| 16-07-2008 | Dismounted and mounted blades again (regarding the worn pitch teeth) |
| 15-10-2010 | Gearbox exchanged |
| 09-11-2011 | Slip ring exchanged (record does not show which one) |
| 14-03-2013 | Replaced battery packs blade 1 |
| 23-08-2013 | Generator bearings exchanged |
| 21-11-2013 | Main bearing exchanged |
| 21-05-2015 | Replaced battery packs blade 2 |
| 08-10-2015 | Maintenance of the blades |

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## 8 Tower and towerbase

| | Item | Remark | |
|---|---|---|---|
| 1 | Tower outside | Light at the outside is broken and has damaged the paint of the tower.<br>Caps from a few bolts of the bottom flange are missing.<br>  <br>  | nok<br>*Low* |
| 2 | Controller overview |  <br>  | *Info* |
| 3 | Tower inside |  <br>  | *Info* |
| 4 | Miscellaneous | | ok |

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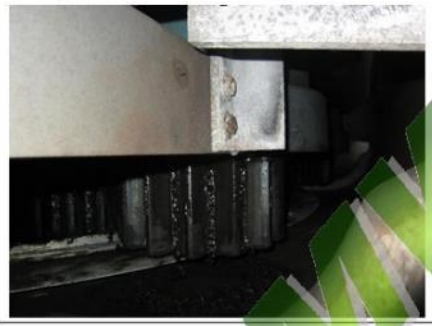
## 9 Yaw system

| | Item | Remark | |
|---|---|---|---|
| 1 | Yaw section | | ok |
| 2 | Yaw ring teeth | Yaw ring shows no irregularities.<br>  | ok |
| 3 | Yaw pinions | Yaw pinions show no irregularities.<br>  | ok |
| 4 | Yaw gears | Several bolts between the gear and the frame are corroded (1st picture).<br>Several air outlets of the oil reservoirs are corroded.<br>   | nok<br>*Low* |

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## 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.<br>Bolts of the nacelle support are corroded.<br>   | nok<br>*Low* |
| 4 | Weather station |  | *Info* |
| 5 | Controller overview |  | *Info* |



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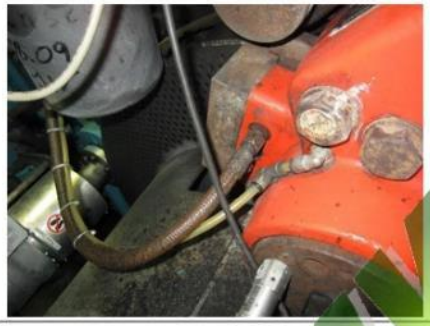
## 11 Hydraulic system and brake

| | Item | Remark | |
|---|---|---|---|
| 1 | Overview |  | *Info* |
| 2 | Leakage | The hose of the brake-system is leaking and is polluting the surroundings.<br>   | nok<br>*High* |
| 3 | Miscellaneous | | ok |

## 12 Gearbox and main shaft

| | Item | Remark | |
|---|---|---|---|
| 1 | Main shaft bearings | Grease of the main bearing is not magnetic.<br>   | ok |



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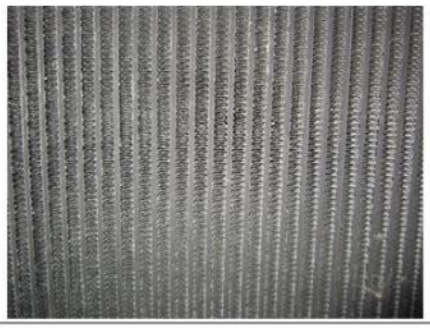
| | | | |
|---|---|---|---|
| 2 | Radiators |  | *Info* |
| 3 | CCJ-unit | No CCJ-filter present in the turbine. | *Info* |
| 4 | Gear oil system | Leakage present at the gear oil system.<br>   | nok<br>*High* |
| 5 | Hoses and pipes | | ok |
| 6 | Paint / Corrosion | | ok |
| 7 | General leakage | A lot of pollution visible around the brake disk at the back of the gearbox.<br>  | nok<br>*High* |
| 8 | Slip ring for hub |  | *Info* |



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## 13 Generator and coupling

| | Item | Remark | |
|---|---|---|---|
| 1 | Coupling | The coupling shows no irregularities.<br>  | *Info* |
| 2 | Paint / Corrosion | | ok |
| 3 | Slip ring | Small holes visible in one of the raceways of the slip ring.<br>   | nok<br>*Low* |



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## 14 Hub

| | Item | Remark | |
|---|---|---|---|
| 1 | Blade bearing | Several caps of the nuts of the bearing are worn and there are small cracks visible at the paint at the root of the blade  | nok *Low* |
| 2 | Overview inside | Minor pollution due to the grease from the teeth of the pitch gear.  | nok *Low* |
| 3 | Hub cabinet overview |  | *Info* |
| 4 | Boxes blade 1 | Control box and battery box show no irregularities.   | ok |



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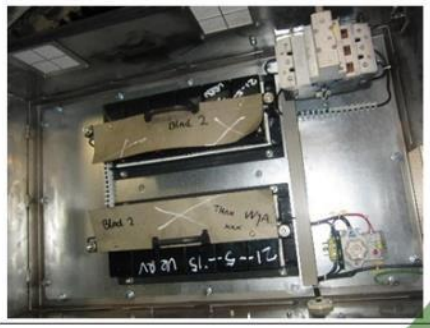
| | | | |
|---|---|---|---|
| 5 | Boxes blade 2 | Sand is leaking at one fuse of the control box.<br>    | nok<br>*Low* |
| 6 | Boxes blade 3 | Control box and battery box show no irregularities.<br>   | ok |
| 7 | Mounting of the electrical boxes | The mounting of the boxes shows no irregularities.<br>  | ok |



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| | | | |
|---|---|---|---|
| 8 | Pinions of pitch gears | Extreme wear on one tooth of the pinions of the pitch gears.<br>  <br>  <br>  | nok<br>*High* |
| 9 | Pitch teeth at zero of blade 1 | The tooth at zero shows wear.<br>  <br>  | nok<br>*High* |
| 10 | Pitch teeth at zero of blade 2 | The tooth at zero shows wear.<br>  <br>  | nok<br>*High* |

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| | | | |
|---|---|---|---|
| 11 | Pitch teeth at zero of blade 3 | The tooth at zero shows wear.<br>   | nok<br>*High* |
| 12 | Grease system pitch teeth | There is an automatic grease system present in the hub. The system is not operational.<br>   | nok<br>*High* |
| 13 | Pitch gears |  | ok |
| 14 | Miscellaneous | | ok |



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**15 Rotor blades**

| | | | | |
|---|---|---|---|---|
| 1 | Blades | Repaired parts are visible on the leading edges of the blades.<br>  | *Info* | |



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## 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 2010. The generator has not been exchanged and the generator bearings have been replaced in 2013.

The main bearing has also been replaced in 2013 and 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 (this has already been done in 2008). Dismounting and remounting of the blade is necessary to achieve this. The wear of the pinions is quite severe, so it is probably necessary to replace them.

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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# REPORT GEARBOX INSPECTION

# SN 15401270, WINDPARK SLUFTER WEST 4

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Report no. GE15002015014

24-11-2015

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## 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 4 |
| Wind turbine type: | GE1.5S |
| Wind turbine serial no: | 15401270 |
| Location: | Rotterdam-Maasvlakte, NL |
| Hub height: | 65 |
| Nominal power [kW]: | 1500 |
| Year of installation: | 2003 |
| Date of inspection: | 15-10-2015 |
| Inspectors: | D. Lagerweij<br>J. Langenbach |

| ***Gearbox Information*** | |
|---|---|
| Gearbox type: | Eickhoff EBN 793 A02 R00A/G 48640XB *i =90,3235* |
| Gearbox serial number: | 25025 |
| Production year gearbox: | 2010 |
| Revision: | - |
| Revision number: | - |
| Oil type: | Castrol Optigear Synthetic A 320 |
| Date of last oil change: | 2010 |

- **Gearbox has been exchanged in 2010**

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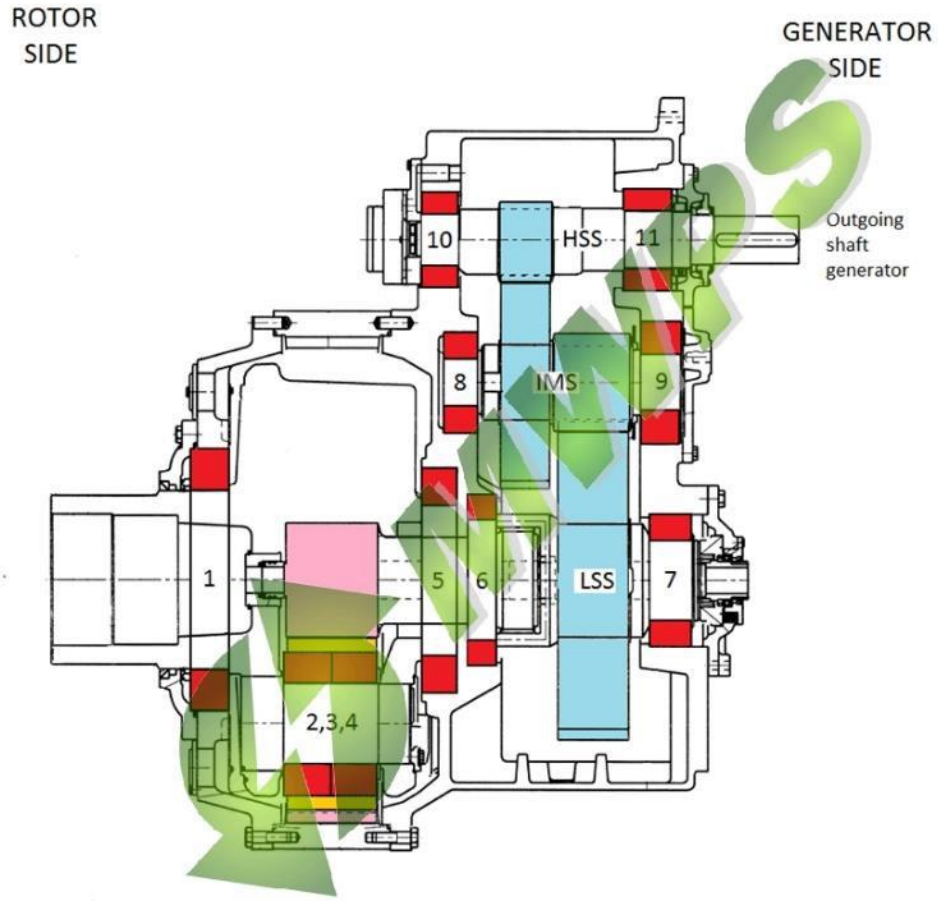
## 3. Reporting setup

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.



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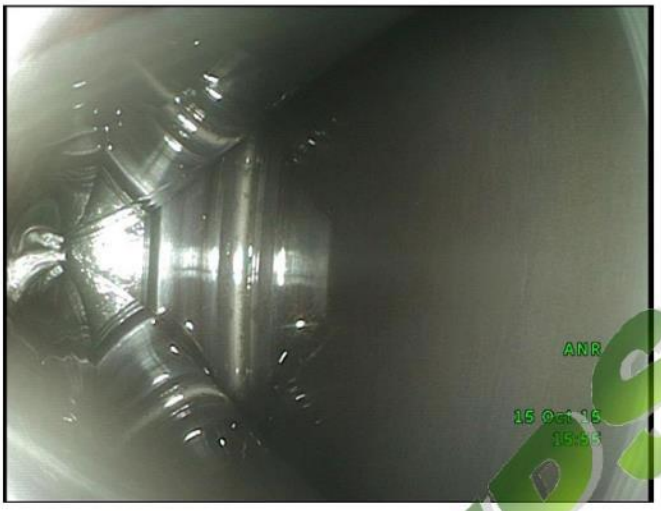
## 4. Inspection results




**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.



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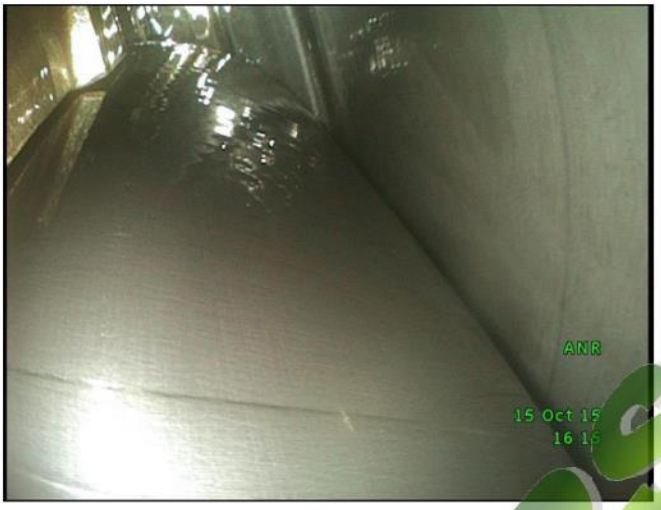
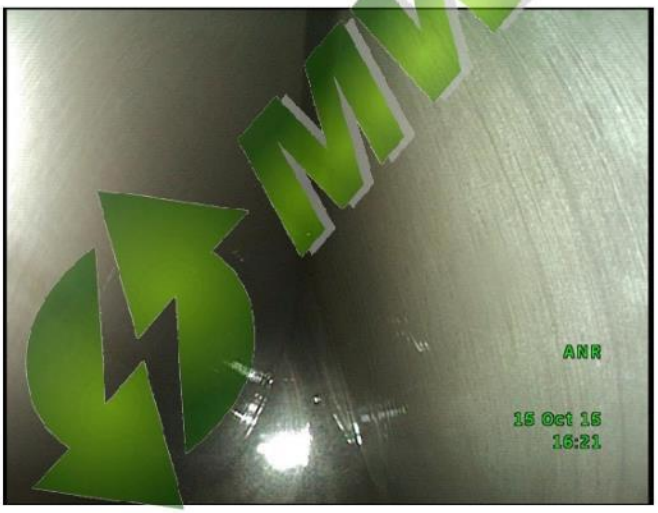



**Picture 3**

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.



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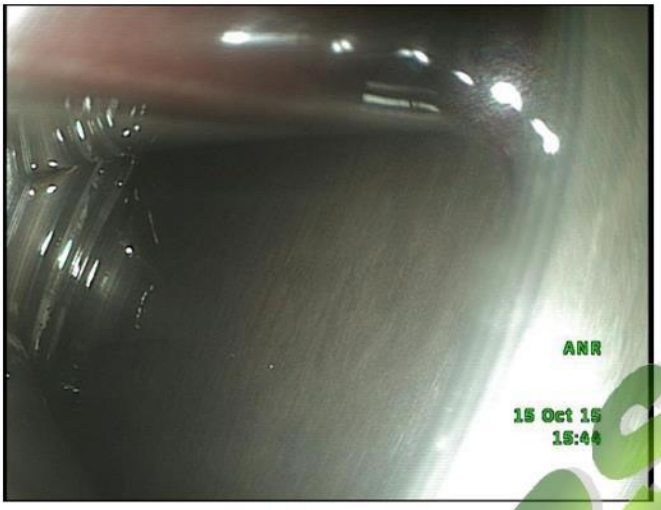
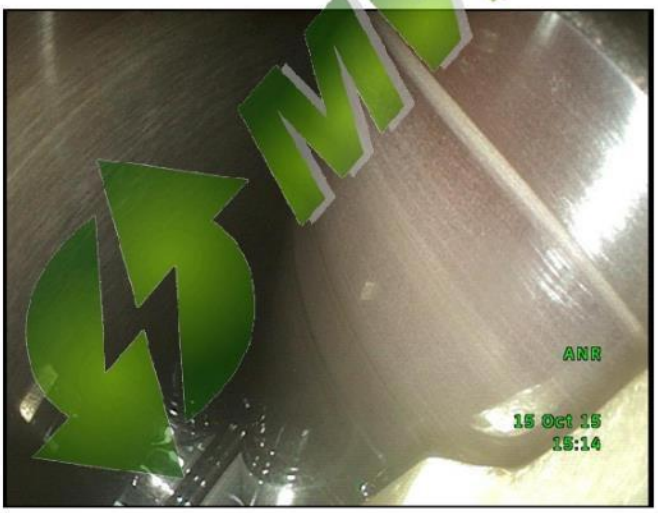



**Picture 5**

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.



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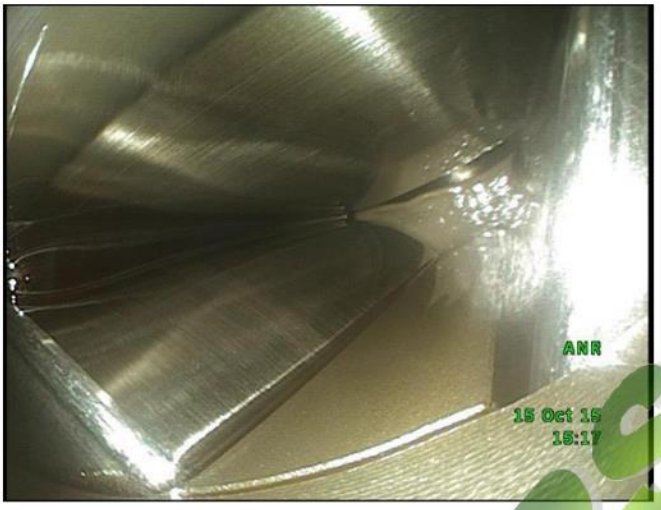


**Picture 7**

Picture 7 shows bearing position no. 8, the bearing of the intermediate shaft at rotor side. The bearing shows no irregularities.


**Picture 8**

Picture 8 shows bearing position no. 9, the bearing of the intermediate shaft at generator side. The bearing shows no irregularities.



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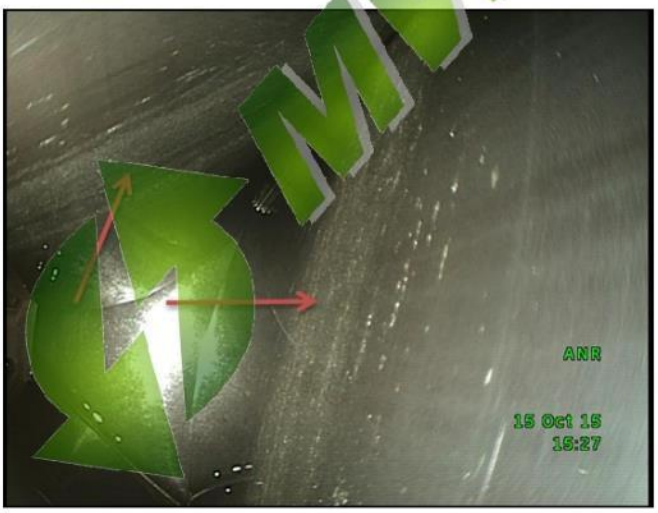
**Picture 9**

Picture 9 shows bearing position no. 10, the bearing of the high speed shaft at rotor side. The bearing shows an area on the raceway where the surface is roughened.




**Picture 10**

Picture 10 shows bearing position no. 10 again. This picture also shows a rough area at the rolling element of the bearing.

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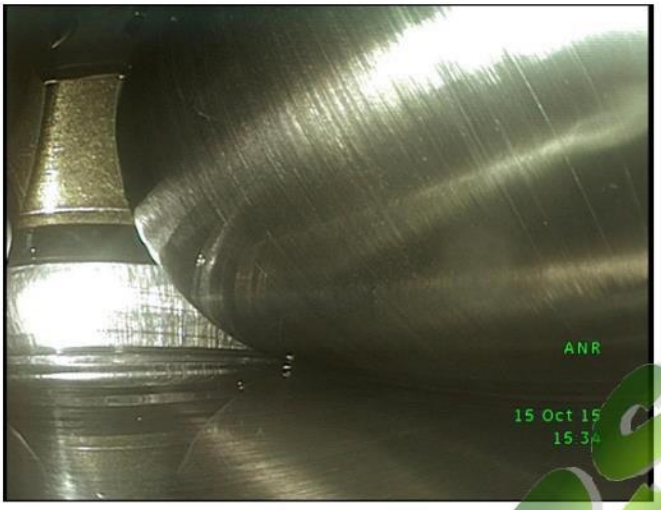


**Picture 11**

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


**Picture 12**

Picture 12 shows bearing position no. 11 again, the axial bearing of the high speed shaft at generator side. The bearing shows no irregularities.



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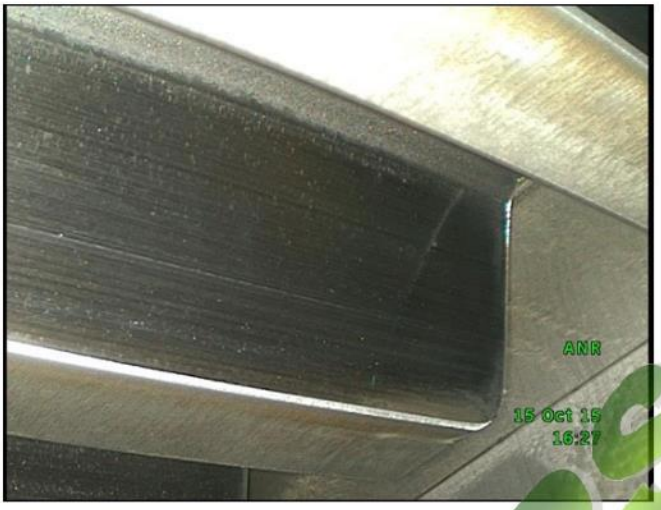
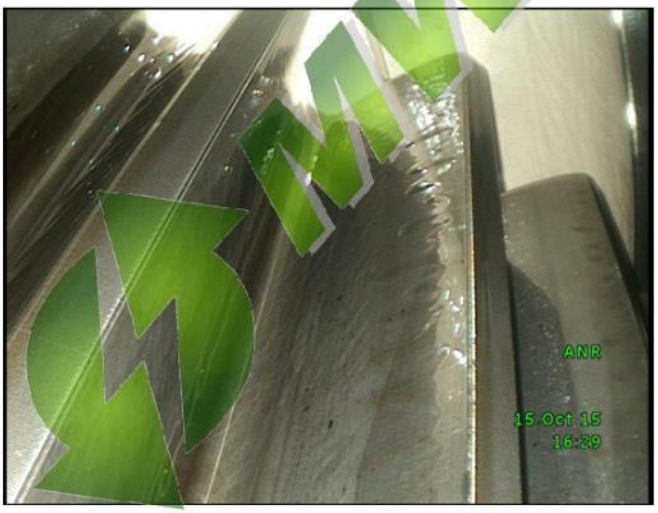



**Picture 13**

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.

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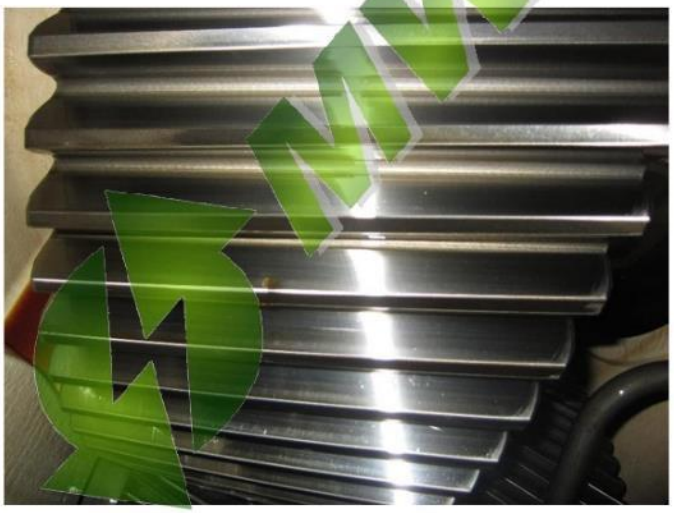
**Picture 15**

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.



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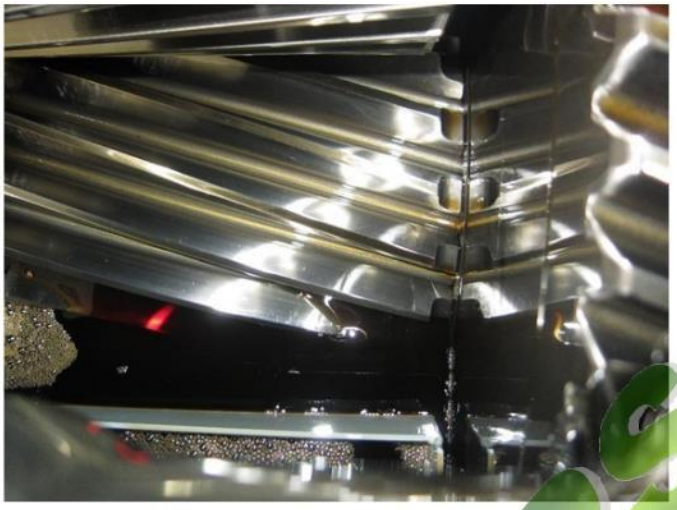
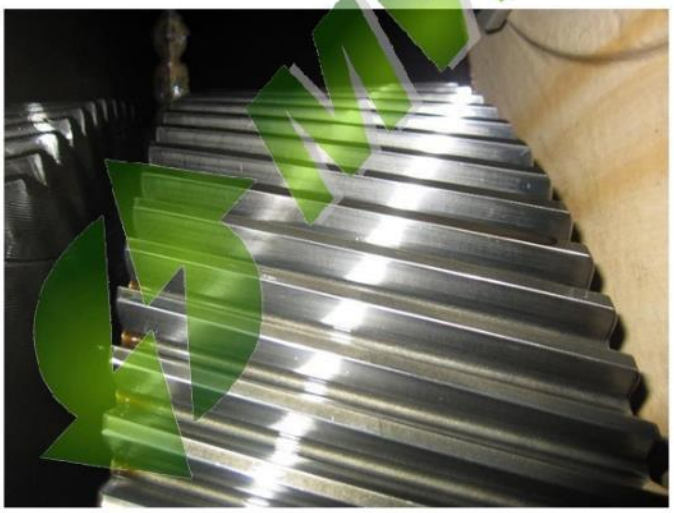


**Picture 17**

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.



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**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.



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**Picture 21**

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

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## 5. Summary

The bearing of the high speed shaft at rotor side shows rough areas on the raceway and the rolling elements.

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

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

## 6. Conclusion

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

The irregularities at the high speed bearing at rotor side are remarkable and it is recommended to keep monitoring this bearing closely in the future.

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Dennis Lagerweij

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