

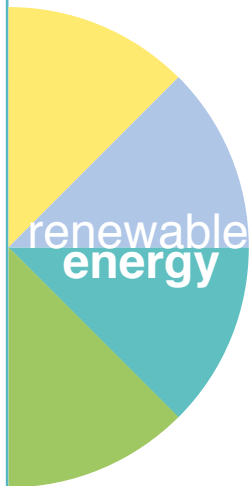
Heavy seas can delay service boats to offshore wind farms.



Early, reliable fault detection is paramount for wind turbines

Offshore wind farms are some of the most environmentally friendly and efficient methods to generate electricity in the world, but the maintenance costs are high because of their inaccessible location. This can amount to as much as 25 to 30% of the total energy production costs [1]. An effective machine condition monitoring solution is absolutely vital to reduce these costs, and a dedicated system is what is needed to do it.

Conventional monitoring systems used in industrial applications are not suitable for wind turbine applications, as they are not able to detect many of the developing faults in a complex planetary gearbox. Moreover, the widely varying wind loading on a wind turbine results in a vibration and operation parameter response that is completely different from one operating condition to the next. This will result in false alarms! A wind turbine study recently done concludes that by improving a monitoring system's reliability (i.e. increasing the number of faults detected and reducing false alarms), it will result in an exponential decrease in



maintenance costs and downtime. Brüel & Kjær Vibro's Type 3652 system was developed in close cooperation with some major wind turbine manufacturers and research institutes in order to provide an effective monitoring solution for wind turbines. The adaptive monitoring strategy [2] functionality coupled with the unique alarm manager – both described in detail in the last issue of Uptime magazine – allows our system to detect faults early, reliably and accurately. The result? Reduced wind turbine maintenance costs, consequential damage and downtime.

Case Story – Wind turbine coupling defect

A 2 MW wind turbine is monitored using the remote monitoring and diagnostic service provided by Brüel & Kjær Vibro's Surveillance Centre in Denmark. A coupling defect was detected with more than a half-year lead-time to repair, using the adaptive monitoring strategy and the alarm manager functionality.

This case story is based on the actual diagnostic report.

Observations

There was an increase in the generator driven end (DE) 1st order magnitude that exceeded the Alert limit in power classes 3, 4, and 5 (see Figure 2). There was also an increase in the generator DE overall vibration and the generator non-driven end (NDE) 1st order magnitude, but below the Alert limit. In addition to this, there was also a small increase in the generator DE 2nd order magnitude (below the Alert limit) and an increase in the 3rd stage gearbox overall vibration for the same power classes.

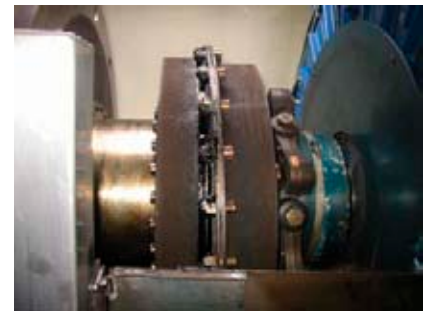


Figure 1 Damaged coupling.

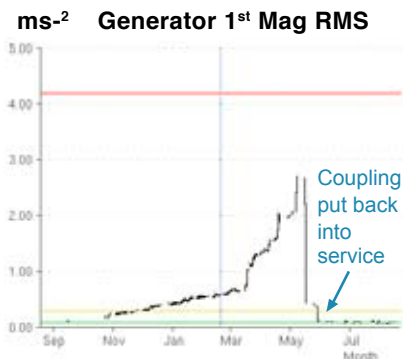


Figure 2 Generator driven end accelerometer vibration amplitude exceeds the Alert alarm limit. The vibration amplitude after repair is shown on the right side of the plot.

Interpretation

The unchanged generator DE upper bandpass frequencies suggest there is no problem with the bearing. Simultaneous increase of the generator DE and NDE 1st order magnitude indicates rotor unbalance. The increasing 3rd stage gearbox overall vibration indicates the problem is related to the generator-gearbox coupling.

Advice/action

Inspect the generator rotor, coupling and DE/NDE bearings for loose components.

Feedback after service

Figure 1 shows a damaged coupling half on the gearbox side of the coupling. The trend plot in Figure 2 shows the 1st order magnitude vibration trend both before and after servicing the coupling. ■

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[1] Operation and Maintenance costs compared and revealed, Wind Stats Vol.19, No.3, 2006

[2] The Brüel & Kjær Vibro adaptive monitoring strategy for wind turbines is described in Uptime 2007 no. 2



Accelerometer

Generator - DE

Accelerometer

Gearbox - 3rd Stage

Accelerometer

Generator - NDE

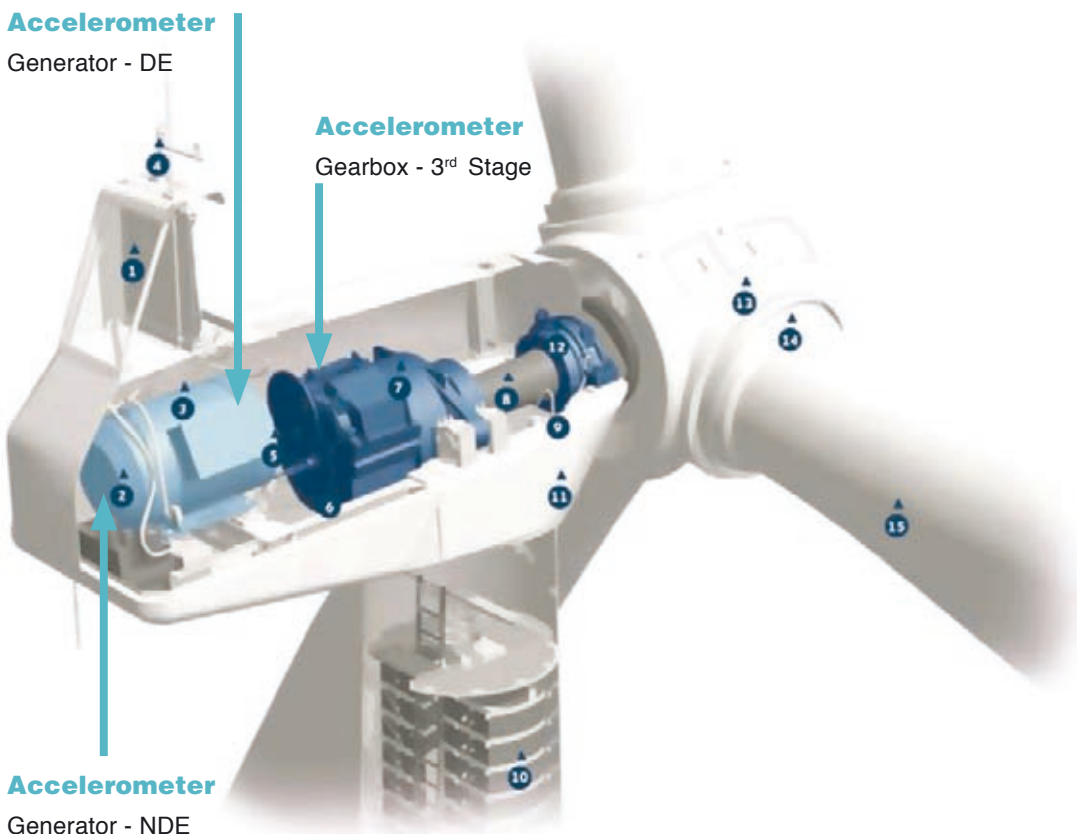


Figure 3 The three accelerometers shown have signals that exceeded alarm limits or showed significant change in the case story. The numbers in the drawing refer to the wind turbine components. Those components that are applicable to the case story are the generator (2), coupling (5) and gearbox (7).