PO.ID 121

Condition Monitoring of Offshore Wind Turbines with Multilevel Severity Assessment of Potential Faults

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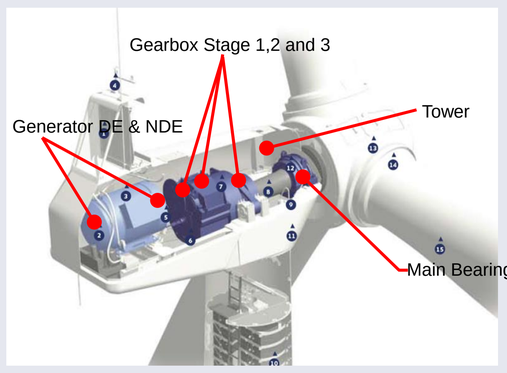
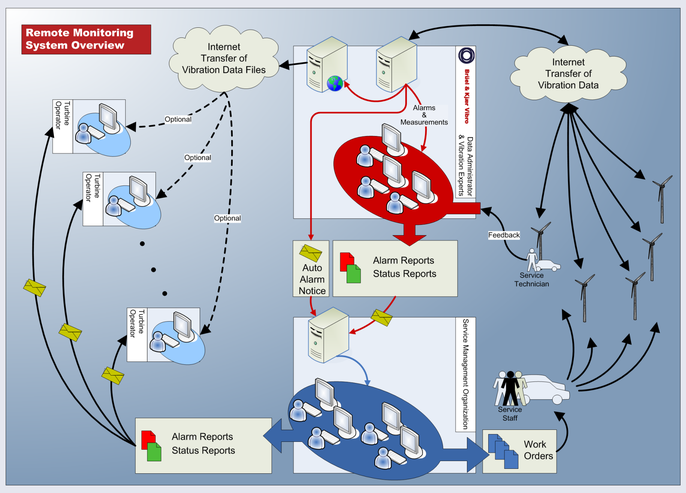
Abstract

Having condition monitoring system (CMS) in offshore wind turbines is vital for planning maintenance in case a machine component fault occurs. The turbines may not always be accessible all year round. A fault detected as early as possible at its development stage is crucial so that inspection and maintenance can be planned ahead of time, and maintenance is performed when weather condition allows it. Better maintenance plan can be done by monitoring the progress of a fault and assessing the lead time to maintenance at different stages of the fault. Four different stages (severities) are shown to be effective for maintenance planning.

Monitoring Method

Install accelerometers at various locations to pick up vibration signatures and online monitoring





4 Levels of Severity Assessment

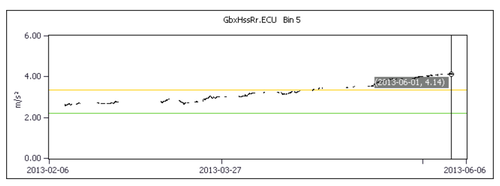
Lead time assessment for maintenance planning

Severity	Type	Description	Required Action
1	Danger	Severe progressing failure	Immediate action. Operating the turbine has serious risk of functional loss and possible severe consequential damage.
2	Alert	Considerable progressing failure	Action as soon as possible. Recommended within 2 to 4 weeks.
3	Alert	Progressing failure	Action when convenient. Recommended within 2 to 4 months.
4	Alert	Small or none progressing failure	Action at next service.

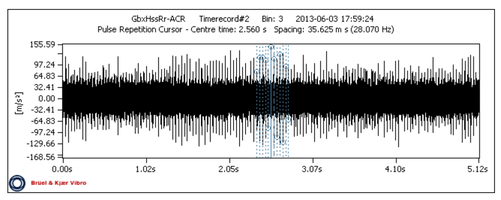
Case Story 1 – High Speed Stage Bearing

Severity 4 Assessment

Inner race defect at high speed stage rear bearing was identified. A report was issued early June 2013, recommeding inspection at the next scheduled visit to the turbine.



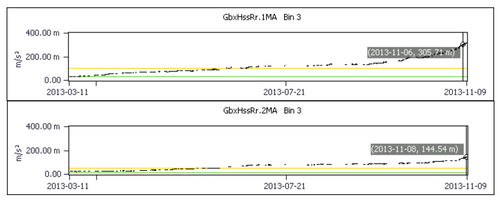
Vibration Trend



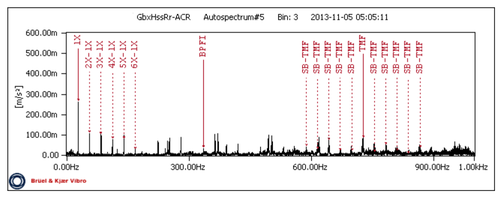
Time Waveform

Severity 3 Assessment

A severity 3 alarm report was issued early November 2013, recommeding inspection within 2 to 4 months.



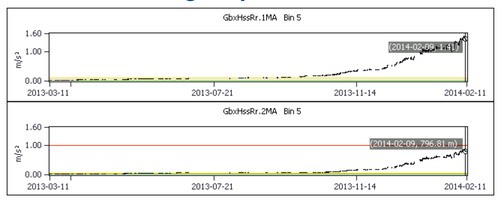
Vibration Trend



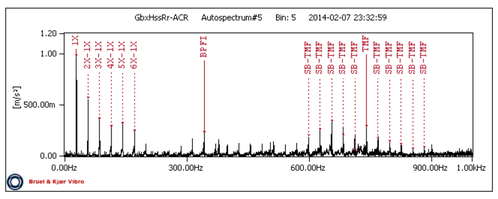
Autospectrum

Severity 2 Assessment

Signs of excessive looseness developed further. A severity 2 alarm report was issued early February 2014, recommeding inspection within 2 to 4 weeks.



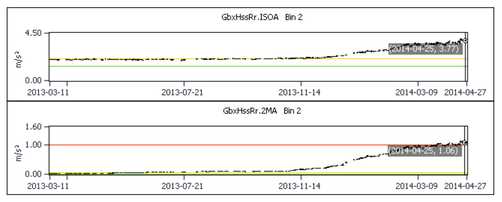
Vibration Trend



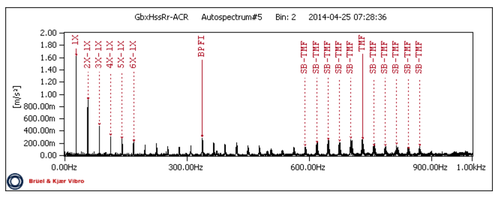
Autospectrum

Severity 1 Assessment

Vibration became severe. A severity 1 alarm report was issued late April 2014, recommeding immediate maintenance.



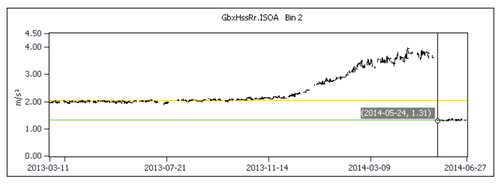
Vibration Trend



Autospectrum

Bearing Replaced

Vibration returned to normal level after bearing replacement.



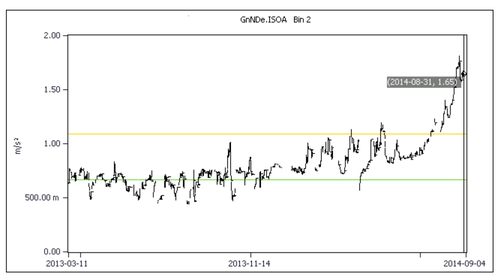
Vibration Trend

Example of Damaged Bearing

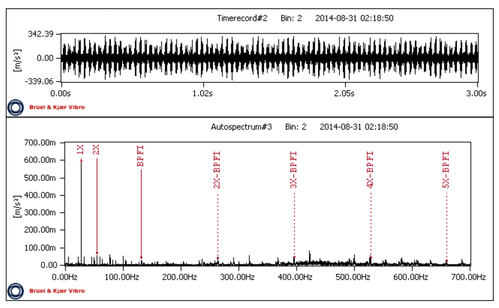
Case Story 2 – Generator Bearing

Severity 3 Assessment

After a severity 4 alarm report issued in early June 2014 for possible inner race defect, a severity 3 alarm report was issued in late August 2014, recommending inspection within 2 to 4 months.



Vibration Trend



Autospectrum

Bearing Replaced

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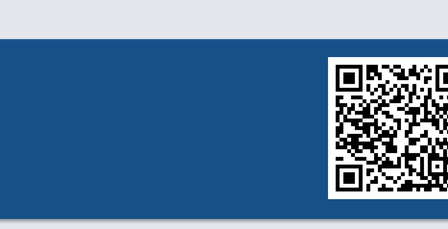
Vibration Trend



Example of Damaged Bearing

Conclusions

- As a fault develops, different levels of severity assessment and estimating the lead time at each severity level will support relevant action plan.
- Maintenance can be perfomed at the most optimal time that minimizes downtime and loss of production.
- Cost effective maintenace can be achieved due to better planning.