Wind Turbine Condition Monitoring at DONG Energy

Wind Turbine Condition Monitoring Workshop 8-9 Oct 2009

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DONG energy

Agenda

- Overview of DONG Energy
- Overview of Condition Monitoring at DONG Energy
- Example CM Cases
- Conclusion

Overview of DONG Energy

- DONG - Danish Oil and Natural Gas
- DONG Energy is one of the leading energy companies in Northern Europe.
- We are headquartered in Denmark. Our business is based on procuring, producing, distributing and trading in energy and related products in Northern Europe.
- We have designed, constructed and operate about 50% of all offshore wind power plants to date

Overview of DONG Energy

PRODUCTION		OPTIMISATION	SALES AND DISTRIBUTION	
NATURAL GAS	Exploration & Production	Energy Markets	Gas Distribution & Storage	PRIVATE CLIENTS
OIL			Sales & Distribution	PUBLIC CLIENTS
RENEWABLE ENERGY	Renewables			BUSINESS CLIENTS
COAL	Generation			WHOLE-SALE
BIOMASS				ENERGY EXCHANGES

Overview of DONG Energy

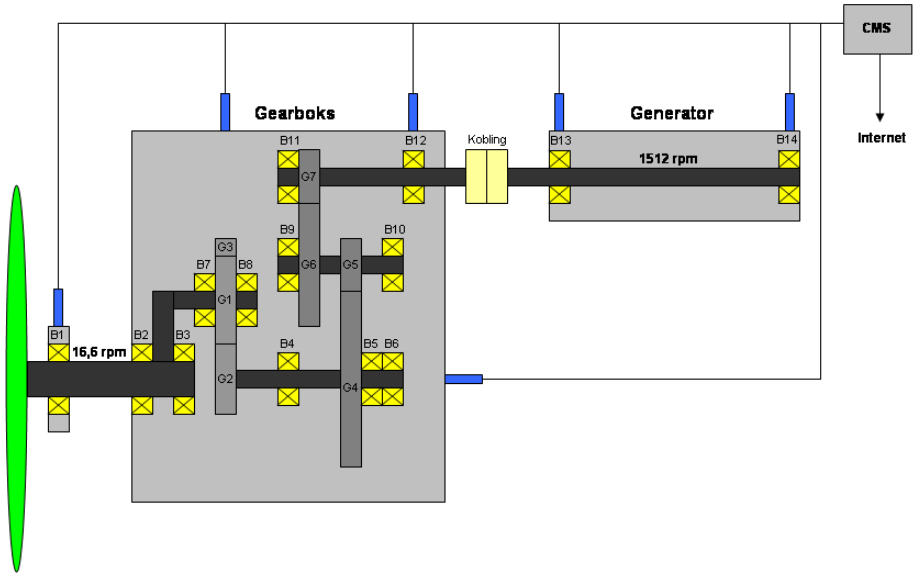
Installed Wind Turbine Capacity	
Offshore wind turbines	**768 MW**
Denmark	415 MW
UK	353 MW
Onshore wind turbines	**325 MW**
Denmark	194 MW
Poland	82 MW
Sweden	30 MW
Norway	10 MW
France	9 MW
Total installed capacity	**1093 MW**
Offshore under construction	**900 MW**

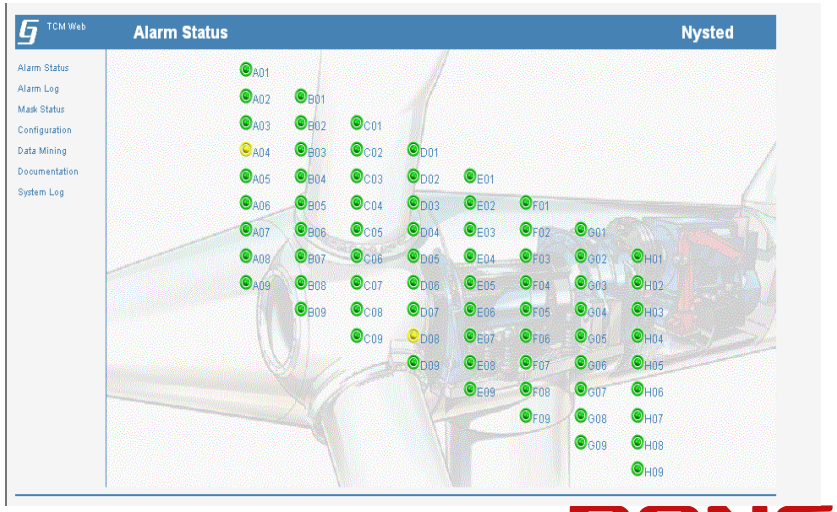
Offshore wind turbines

Onshore wind turbines

Overview of CM at DONG Energy

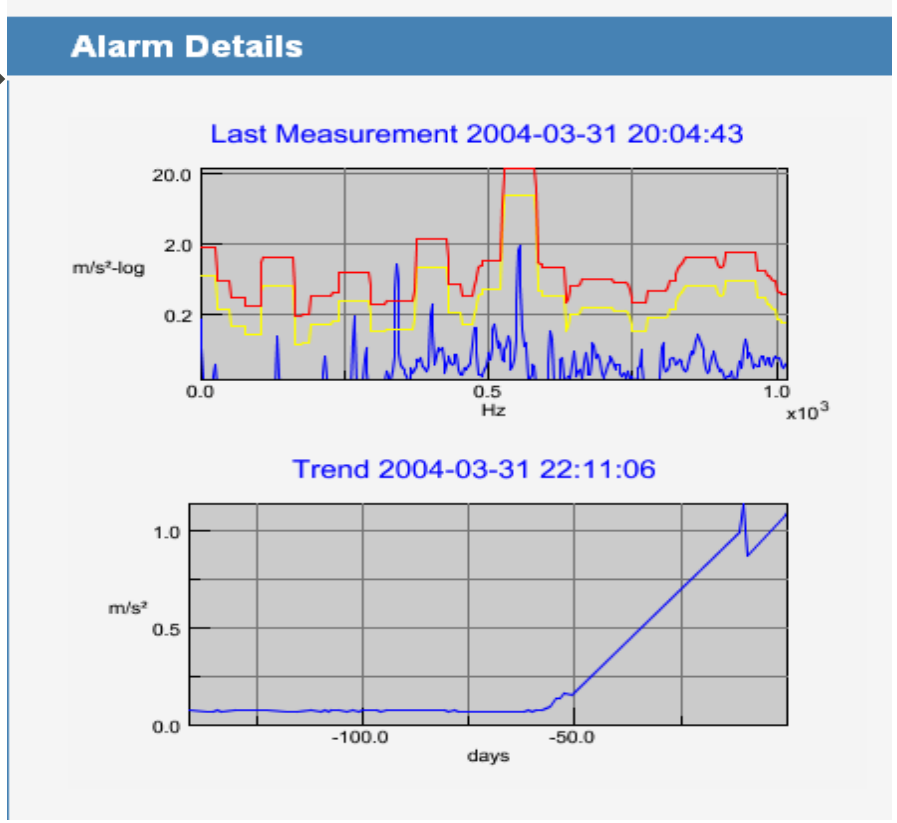
- Vibration based CM installed on over 1000MW
- Vibration based CM required on all new projects
- We require access to all raw CMS data
- Remote access to all CM data via DE's intranet
- 24 Hr surveillance center under development for both CMS and turbine alarm surveillance





Overview of CM at DONG Energy

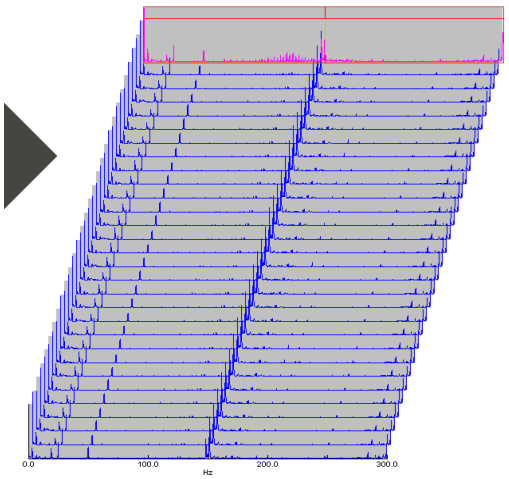
- Trigger(Alarm) levels are derived from experience with previous damages
- Trigging levels are typically a function of both frequency and power
- Automatic shutdown of turbine in certain conditions



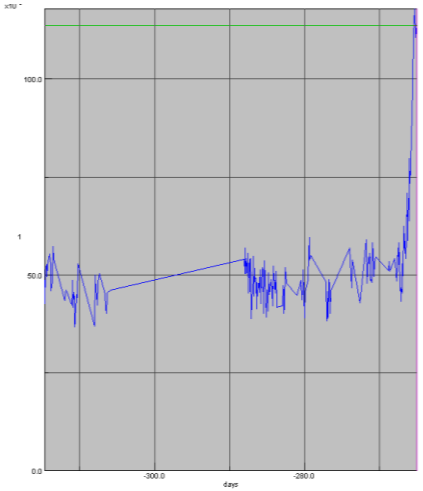
Amplitudes and triggering levels for one power level

Example 1: Planet Stage Gear Tooth Fracture

- Planetary stage measurements typically on 15min interval
- Experience shows that gear tooth fractures develop very quickly
- Tooth fracture in planet stage causes significant secondary damage (ring gear rupture!)
- These events always require inspection before restart
- Automatic turbine shutdown on some systems



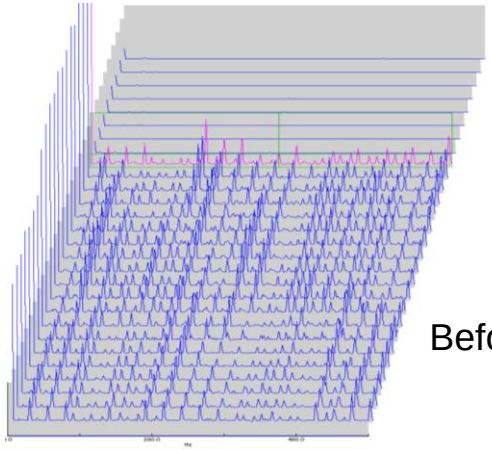
Waterfall Plot of FFT



Trend Over Time of Enveloped FFT

Example 2: High Speed Bearing Damage

- Bearing damages typically develop over long time period (6 months or more)
- Bearing measurements typically once per day
- Planet bearings typically more difficult to detect damage (indirect transmission path)



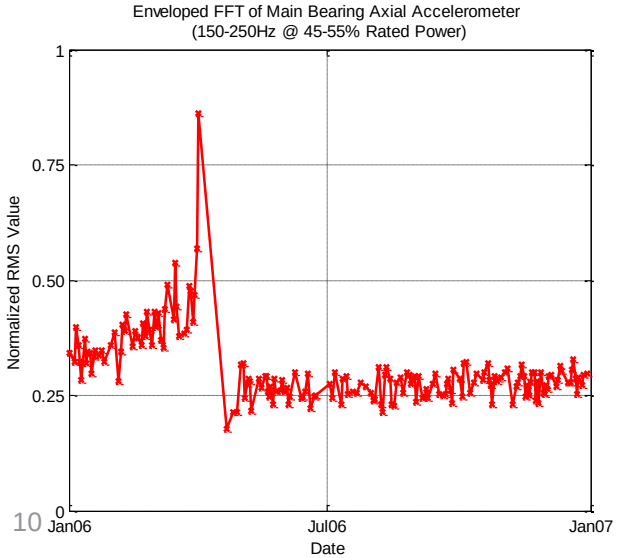
After Replacement

Before Replacement

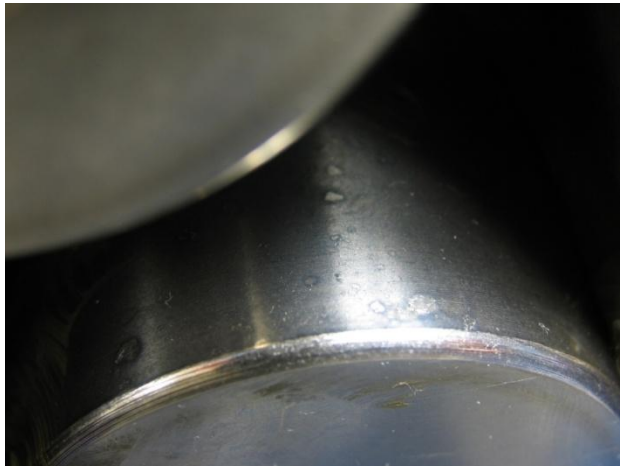
Waterfall Plot of FFT

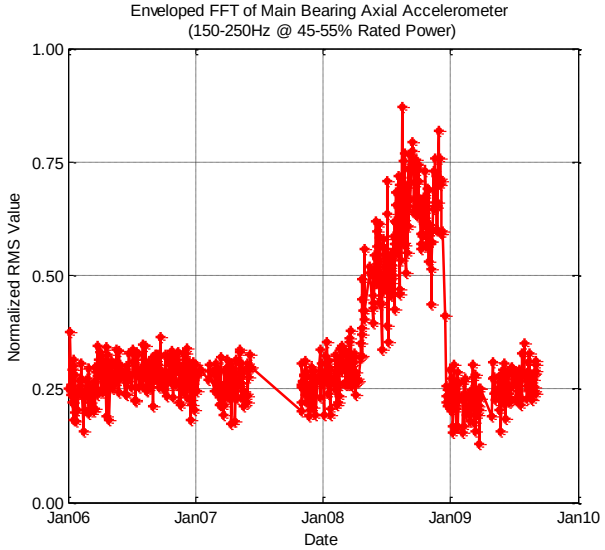
Example 3: Main Bearing Damage
1st Case

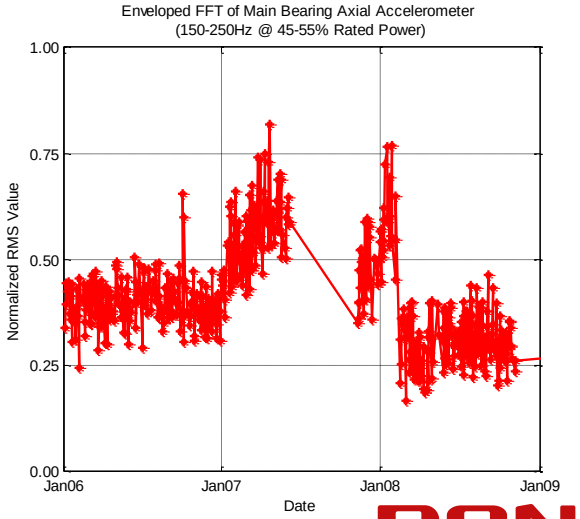
- Analysis method developed in-house
- Axial accelerometer on the main bearing housing
- Trigger levels derived from 6 years of historic CMS data over large number of turbines
- Simple trigger level crossing
- Enveloped FTT analysis at 45-55% rated power
- Detects damage 6 months before required replacement



Example 3: Main Bearing Damage Detection
Follow on Cases







Conclusion

- DONG Energy has excellent experience with vibration based CM
- Required on all new projects
- CM adds significant value to our projects
  - Significantly reduces the chance of secondary damage
  - Facilitates planning for repair and/or exchange of components (critical offshore!)
- Access to historic data enables development of analysis tools

Thank You