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Vestas V90-3MW Wind Turbine gearbox health assessment using a vibration-based Condition Monitoring System

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Abstract

An advanced Condition Monitoring System (CMS) has been developed as part of the CMSWind FP7 Project for the assessment of wind turbine rotating parts. The validation of the system is presented in this poster. It was carried out during field trials at Bandirma Wind Energy Power Plant on a Vestas V90-3MW Wind Turbine.

Bandirma Wind Energy Power Plant (Turkey)

Vestas V90-3MW

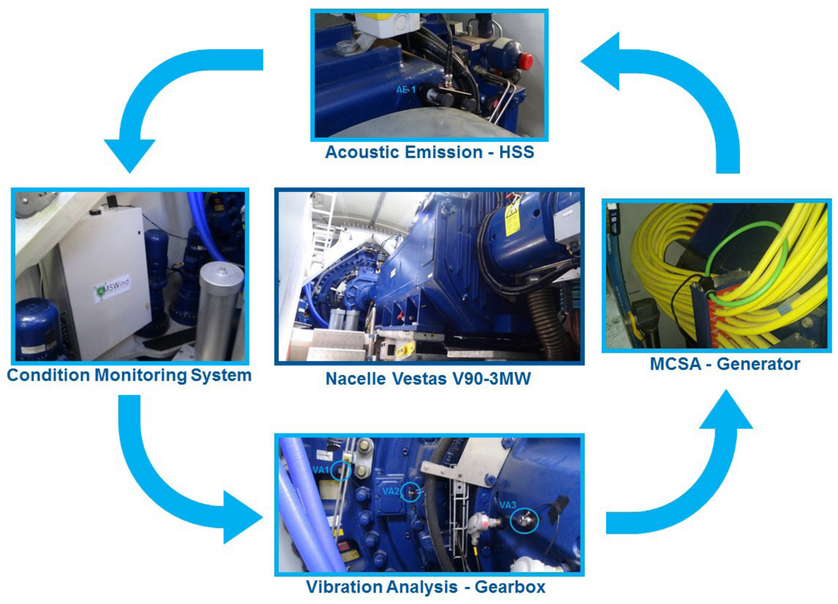
This integrated CMS, which utilizes three techniques specifically designed for wind turbines and their components (Acoustic Emission, Vibration Analysis and Motor Current Signature Analysis), will improve wind turbine machinery reliability. This estimation is made from the fact that unnecessary maintenance and out of service wind turbines are reduced or even eliminated, improving reliability and operation. The work described in this poster will show the application of the CMSWind System for enabling the prompt detection of changes in the gearbox health using Vibration Analysis. A new methodology based on the development of a baseline profile for the promptly detection of arising defects and their worsening with time is proposed. The results demonstrate that the proposed method is effective in the health identification of wind turbine rotating machinery.

Problem and solution proposed

In order to keep the huge amount of wind turbines running safely, continuously and profitably is challenging. The industry still experiences premature turbine component failures, which leads to increases in the operation and maintenance (O&M) costs and subsequently, the downtime of the turbine. O&M costs are attracting greater attention, as there is a need for the industry to reduce the turbine downtime, increasing its reliability and decreasing the cost of the energy (COE).

CM is defined as the process of periodically or continuously sense, measure and record selected physical parameters which are associated with the condition of the machinery such that a significant change is a sign for a developing failure. It is applied for the interim purpose of:

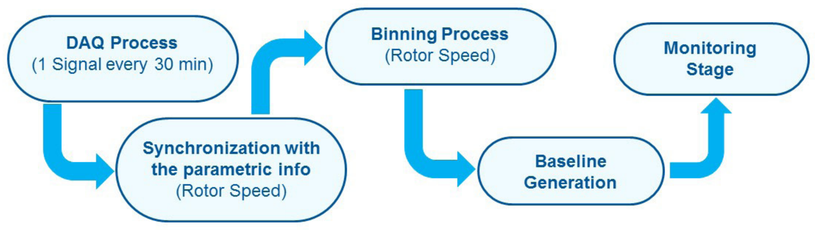
1) Detecting incipient failures early in advance so catastrophic failures are avoided;
2) Reducing, analysing , comparing and displaying the data and information to enable more cost-effective O&M (proactive instead of reactive maintenance);
3) Assessing component performances and helping to redesign them for longer life and reduce the costs.

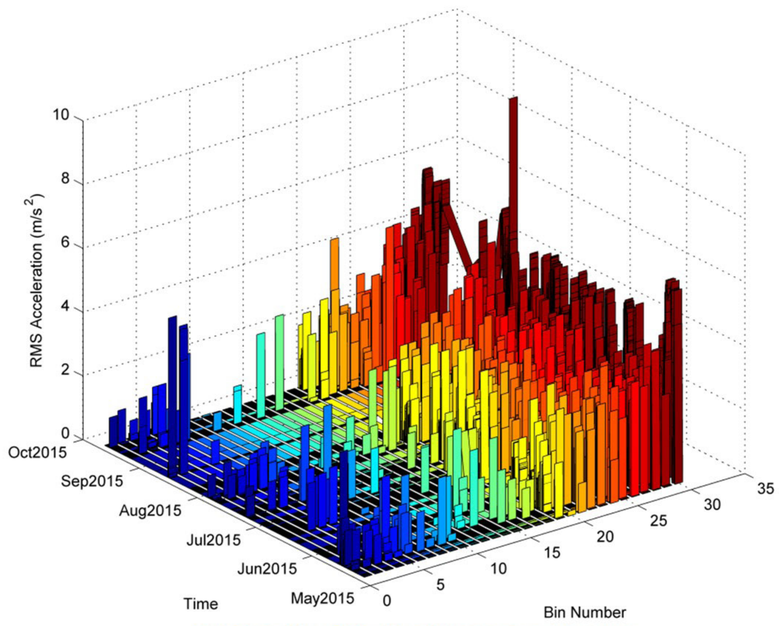


Solution proposed by the CMSWind Project

Wind turbine gearboxes tend to fail more prematurely than those in any other applications (2 to 11 years out of the desired 20 years). Although it is well documented on the literature that the failure rate of mechanical components is lower in comparison with the electrical subsystems, mechanical failures still creating unplanned maintenance, long turbine downtimes due to gearbox replacement and rebuild and increasing the warranty reserves. Based on the data compiled in the Wind Stats Newsletter which covers from 2003 to 2009, **gearboxes are the subsystem that causes the highest downtimes**. As reliability of gearboxes needs to be increased the Vestas V90 gearbox is the main targeted subsystem of this poster.

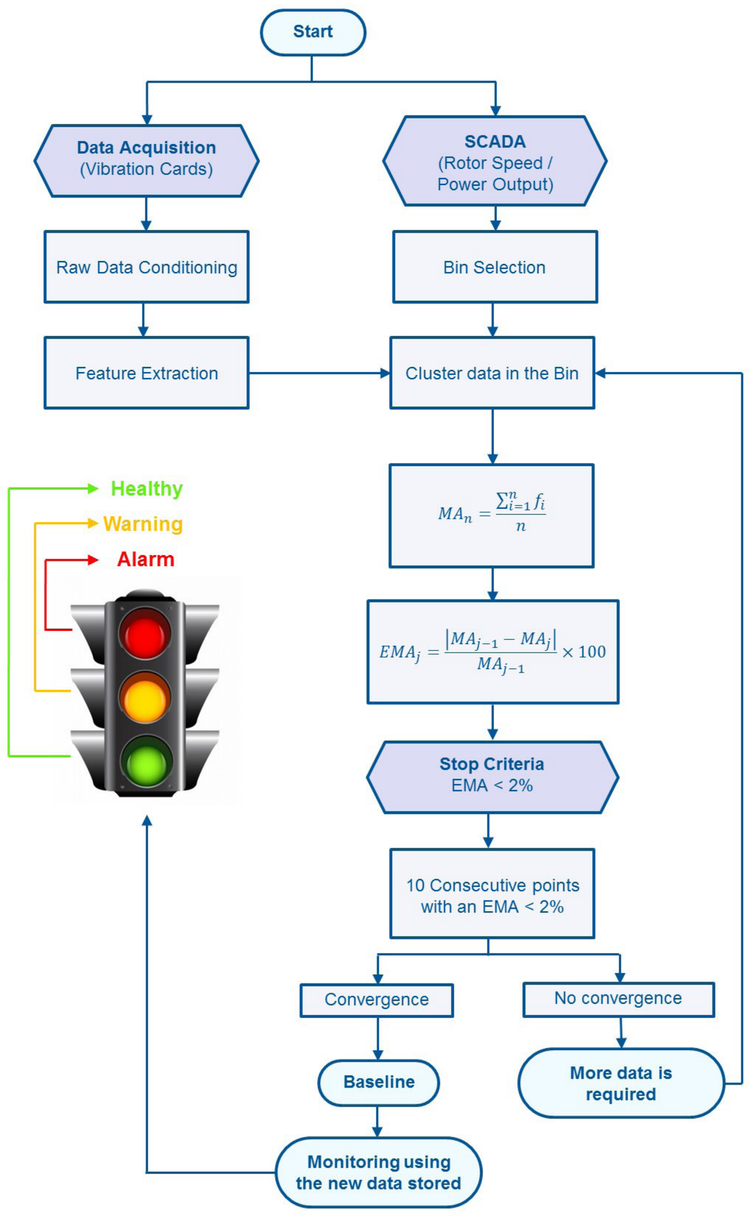
Monitoring strategy based on Vibration Analysis



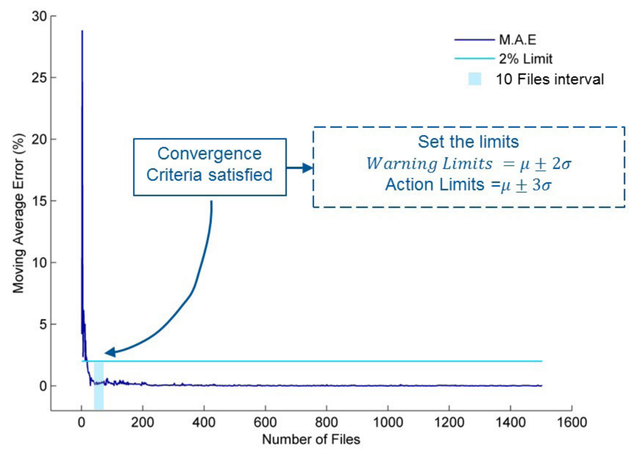


Variation of the RMS value of the acceleration per bin

Baseline Algorithm



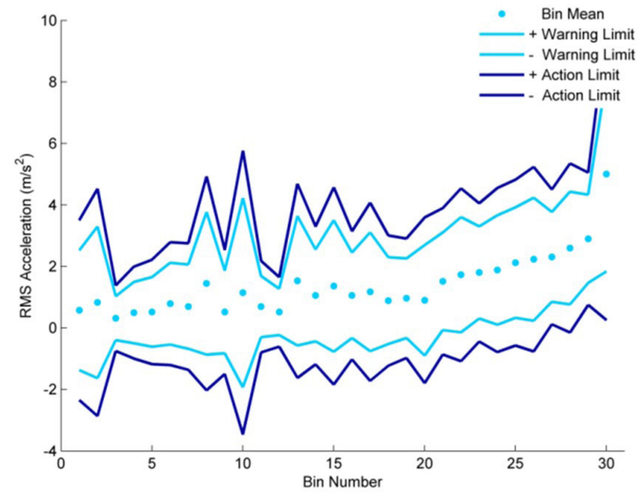
Baseline algorithm flow chart



Application of the convergence criteria to bin 30

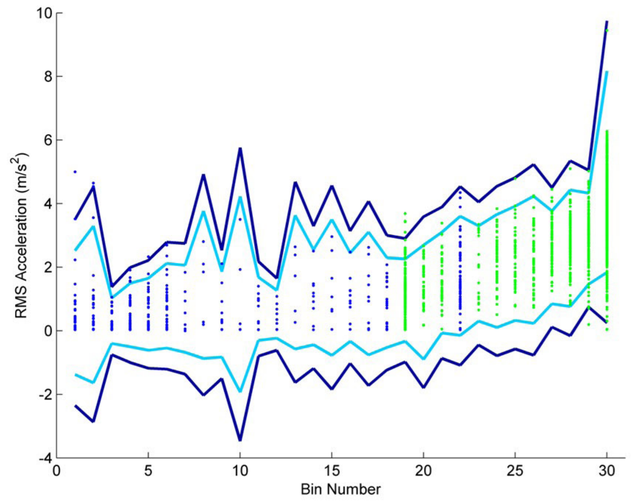
Results

Figure below depicts the baseline obtained after applying the algorithm previously described to the current data. It can be used as a **vibration level reference** for the identification of these deviations from the normal operation condition target. This baseline will monitored the machine whatever the defect may happen at low or high rotor speeds, covering the wind turbine through all its operational range. The number of files utilized for calculating de limits varies depending on the result obtained from the convergence criteria (see values in the table below).



Baseline based on the target mean per bin

The number of events recorded at low speed is very low as can be observed in the 3D plot. Is in these bins in particular, where there is not convergence of the method. It has been noticed that the number of data clustered in them is less than 70 files. It does not mean that provisional values cannot be given to the limits. It means that more data is required in order to average the current value more and set the limits in a more confident way.



Bin Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Convergence	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Points used for Baseline	41	31	41	45	45	37	7	5	12	5	10	9	5	9	7	10	9	19
Baseline Finished																		

Bin Number	19	20	21	22	23	24	25	26	27	28	29	30
Convergence	●	●	●	●	●	●	●	●	●	●	●	●
Points used for Baseline	98	143	47	69	55	56	39	35	31	39	27	30
Baseline Finished	June	July	June		July	June	June	June	June	June	May	May

Monitoring using a 3 months established baseline

Conclusions

- This poster presents the methodology and algorithms involved in the health monitoring baseline generation for a Vestas V90-3MW.
- According to the information provided by the wind farm operator , the status of the wind turbine was healthy during the whole field trials.
- The data gathered between May and October 2015 was examined in detail and no major variabilities were identified.
- The results does not show any symptoms of defect , corroborating the information provided by the operator.
- The baseline generated can be defined as an identification profile of that particular type of turbine.
- More data is required in order to average the current values stored at low speed in order to set the limits with more confidence.
- The algorithm is able to identify RMS deviations from the RMS target, allowing the operator to take preventive decisions concerning the wind turbine safety.

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