Brüel & Kjær Vibro

CASE STUDY

Detection and Diagnosis of a Slip Ring Fault of a Wind Turbine DFIG

Over 60% of all wind turbines are currently using the doubly fed induction generators (DFIGs). At the time of their introduction they offered higher efficiency (synchronized to grid with variable wind turbine speed), better power factor control (import/export of reactive power) and reduced converter cost (only 25-30% of power passes through the convertor) compared to the previous generation of generators. This is made possible by connecting the rotor windings to the grid via a multi-phase slip ring unit and a voltage converter. The slip ring unit consists of a set of spring-loaded brushes that ride on slip rings mounted on the rotor, for each phase.

A number of generator faults can be detected by accelerometers mounted in the load zone of the generator bearings, including faults with the slip ring assembly. This case study shows how early detection of slip ring defects could result in a fast, inexpensive repair. If, on the other hand the slip ring fault is not corrected at an early stage of development, this could lead to a catastrophic failure where the generator is destroyed.

MACHINE/INDUSTRY/PROCESS

A multi-MW wind turbine in a wind park was operating at full production when the Brüel & Kjær Vibro condition monitoring system was temporarily disconnected for approximately two months. Shortly after the condition monitoring system went back online, the customer notified the Brüel & Kjær Vibro Surveillance and Diagnostics Service Centre and requested the initial data to be analyzed.

OBSERVATION/DIAGNOSIS

The Brüel & Kjær Diagnostics Group analyzed the data using a detailed time waveform and frequency spectrum, as shown in Figures 1-2. Increased vibration indicated a potential problem with generator slip ring unit.

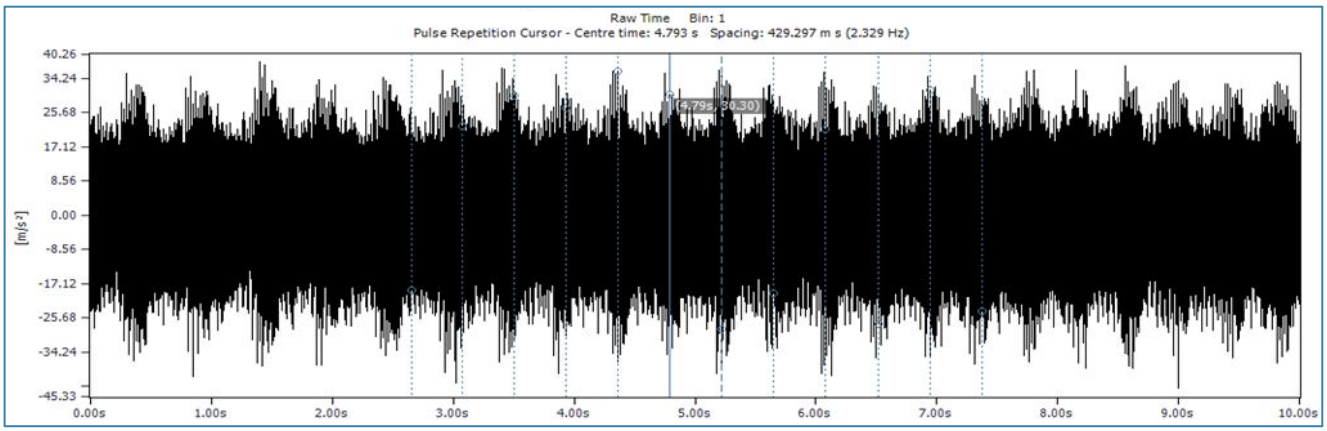

Figure 1: The time waveform showing amplitude modulation of a little less than 2.5 Hz.

OBSERVATION/DIAGNOSIS (Cont.)

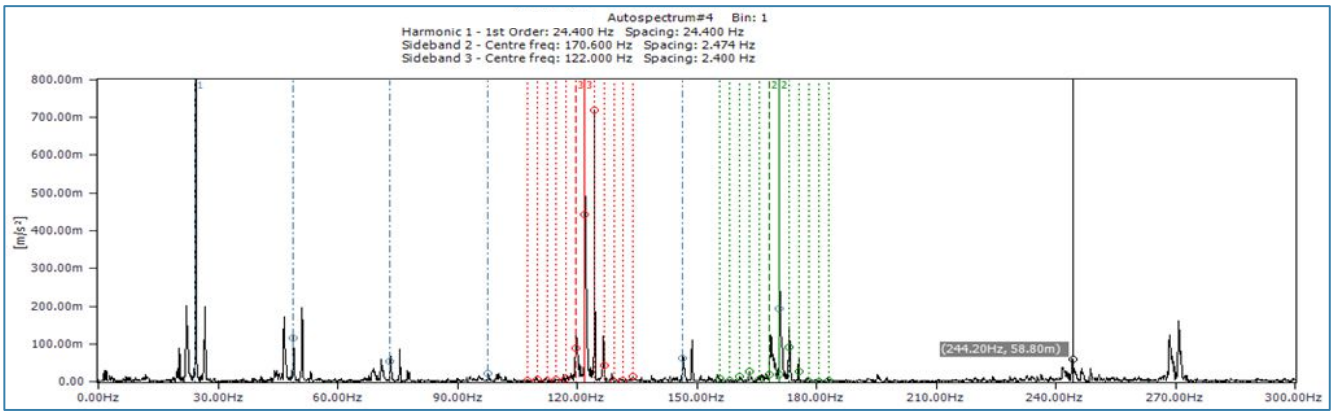

Figure 2: Increased vibration amplitude for several harmonics as measured by the accelerometer located on the non-driven end generator bearing.

An alarm report was immediately issued followed by phone conversation with the customer explaining the problem. Below is an extract from the recommendation section of the report:

- Generator inspection is recommended within 1-2 weeks.
- It is recommended to perform an up-tower generator test run with particular focus on the slip ring unit. Check the height of the slip ring brushes to be within the acceptable limits, inspect the condition of the cooling groves, insulation ring and the current clamps.
- Provide feedback to bkvcm@bkvibro.com after the maintenance work has been carried out.

RESULTS/FEEDBACK

A site inspection was done one day after the report was issued.

Figure 3: Slip ring shown with worn out cooling groves (left), and worn out brushes (right).

RESULTS/FEEDBACK (Cont.)

After the slip ring unit and brushes were replaced, the wind turbine returned to production with lower vibrations measured on the generator bearings.

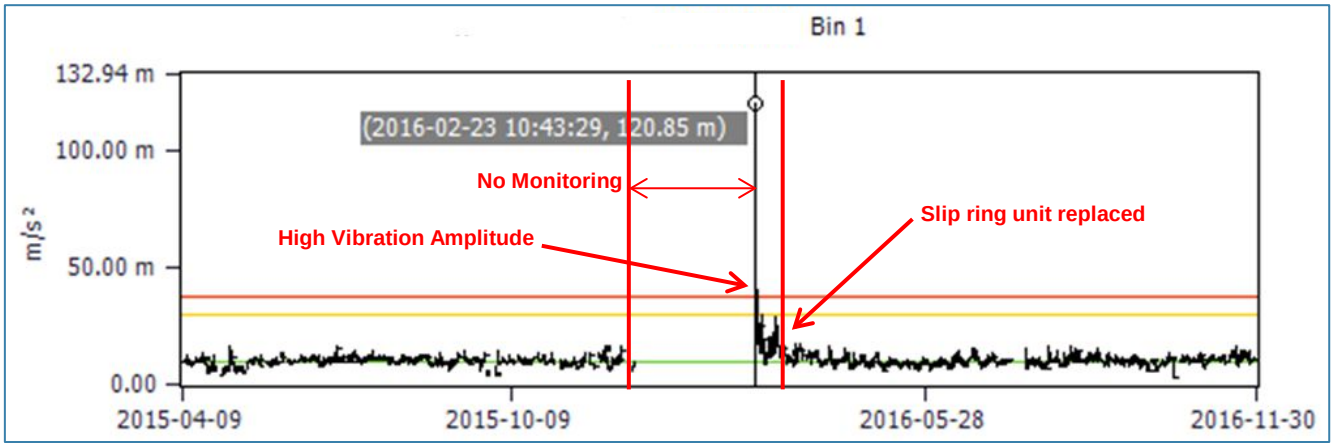

Figure 4: Vibration amplitudes returned to normal (6x harmonic shown), as measured by the accelerometer located on the non-driven end generator bearing.

BENEFITS/COST SAVINGS ESTIMATION

There are clear benefits in detecting a slip ring fault early. The cost and downtime in replacing the slip ring unit is small in relation to the maintenance and downtime associated with a catastrophic failure of the generator.

- **Slip ring unit replacement**: Approx. 4000 € plus a few hours downtime (500-1000 €)
- **Generator replacement:** Approx. 100 000 € (includes crane) plus downtime (four weeks at 2000 € per day), with a total of 156 000 €

This gives a savings of 151 000 €, which does not include labor.

CONTACT

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