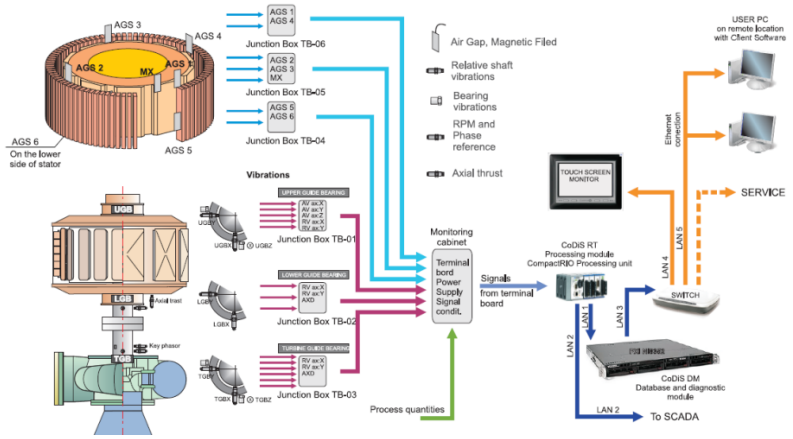
CASE STUDY – 02
Hydrogenerator loose stator core

Machine data:
Vertical hydro unit with 3 guide bearings (Combined Upper guide bearing, Lower Guide Bearing and turbine guide bearing) / Power: 55 MW; Stator Bore Diameter: 4,6m / Francis Turbine; Speed: 428,5 RPM

Monitoring Configuration:

- 6 relative shaft vibration
- 6 absolute bearing vibration
- Axial displacement
- 1 Magnetic Flux probe
- 4 Air Gap probes @ 90°
- Phase reference (and RPM measurement)
- Process quantities



Problem: Detected Loose Stator core

This case study examines how CoDiS on-line monitoring system helped in identifying a problem related to loose stator core that occured after refurbishment work that included stator rewind on one of the units in the power plant. This problem was identified using data from the CoDiS database collected in various operating regimes during the 6 months of machine operation. This machine is very important to the electro system as it is an emergency plant that needs to be fully operational in less than 5 minutes from the dispatcher request. The machine can also operate in condenser mode compensating the reactive power from the grid. The problem was detected by plant personnel as increased bearing vibrations on the upper generator bearing in the X direction were identified under certain machine operating conditons.

During system (and machine) commissioning, data was recorded under all operating regimes and the vibrations were in Zone A according to ISO 7919-5 and ISO 10816-5 standards.

After 6 months of operation strange behaviour was detected with *increased bearing vibrations* in only one direction *in the upper guide bearing plane*. First the plant personnel suspected there is a problem with the bearing or the sensor had malfunctioned but after further testing they turned to Veski remote assistance and data interpretation.

Data analysis and problem identification:

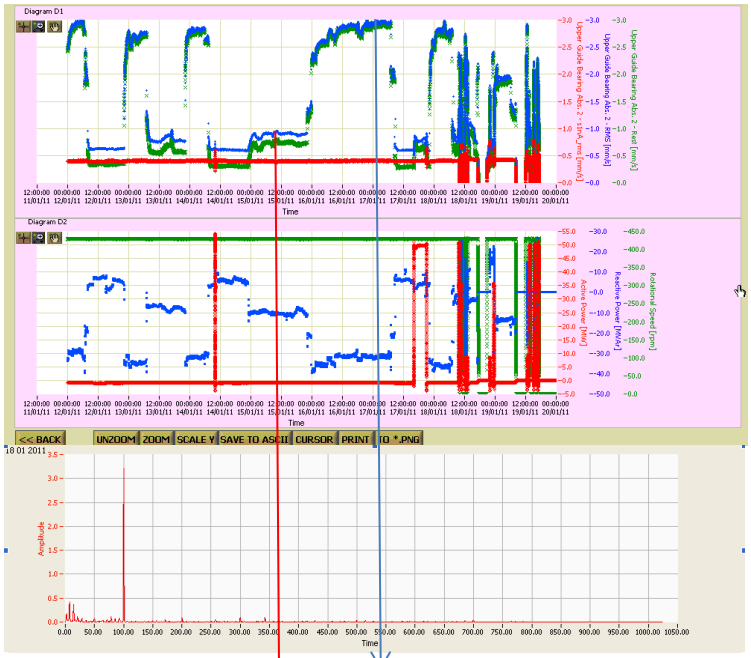
Remote access to the CoDiS system in the power plant enabled all the diagnostics to be performed on-line without the need for Veski specialists to travel to the power plant.

The CoDiS system is suited for real time analysis and trending of all important signal components such as:

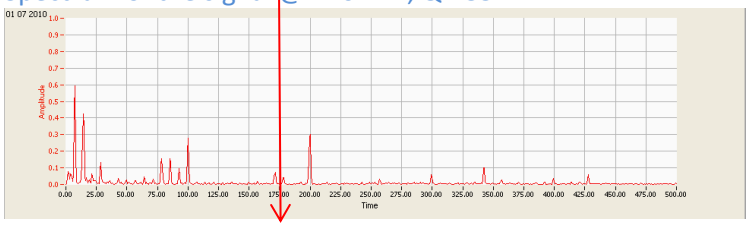
1x, 2x, 3x (Amplitude and Phase), Rest (non Harmonic), process quantities, air gap and flux data.

Everything is recorded in the history database so off-line analysis and data comparison is simple to perform. For this analysis, data was compared in two periods; right after system and machine commissioning and 6 months later. Two weeks of data during each period was analysed for comparison.

Data recorded in January 2011 revealed the problem with high vibration at the mentioned sensor position. Historical trends were analysed as shown in figure 1. The vibration data was analysed alongside operating parameters such as RPM, P (Active Power) and Q (Reactive Power). Comparison of data in different operating conditions is crucial in understanding machine behaviour. It was clear that vibrations on that bearing were changing significantly with operating conditions, most significantly with reactive power.



Spectrum of the signal @ P=0MW, Q=-35MVAr



Spectrum of the signal @ P=0MW, Q=-10MVAr

Trend results of 10 days on **UGB** 18.01.2011, **RMS** (overall) = **3 mm/s/ Rest** value = **2.8 mm/s** /

1st has not changed
Rest = RMS – 1st, 2nd and 3rd harmonic
Upper diagram: RMS value (blue curve), S1n value (red curve),

Rest value (green curve)

Lower diagram: Red curve – Active Power; Blue Curve – reactive power

Green curve – RPM

Conclusion

From 100 Hz component in the spectrum on UGB, the conclusion of Veski experts was that vibration problems occurred due to the fact that the *stator core was loose* and that *the problem was not in the bearing itself*. This was seen from the absolute vibration sensor located at the upper guide bearing and is very visible when the machine operates in capacitive load with more than -20 Mvar.

When the core stiffness decreases the natural frequency of the core decreases into the 100 Hz zone and this resonance causes the vibration amplitudes to increase. The driving force also changes with the operating conditions and as it increases it causes the core to vibrate at higher amplitudes at 100 Hz frequency. The core vibrations are transferred to bearing housing causing the bearing vibrations at 100 Hz but lower in amplitudes than on the core.

At the beginning of operation it was not visible as they didn't operate the machine under such conditions.

After a period of 6 months the core loosened and the vibration amplitudes started to increase up to the alarm limits on the generator bearing.

Since there were no stator core or frame measurements connected to CoDiS the end user conducted separate measurements on the core with a portable instrument with the results being more than 15 mm/s (RMS).

After thorough inspection, loose stator core joints were detected that occurred after the rewind work.

The machine was stopped and the core problem was repaired in the shortest possible timeframe putting this important machine at full availability.