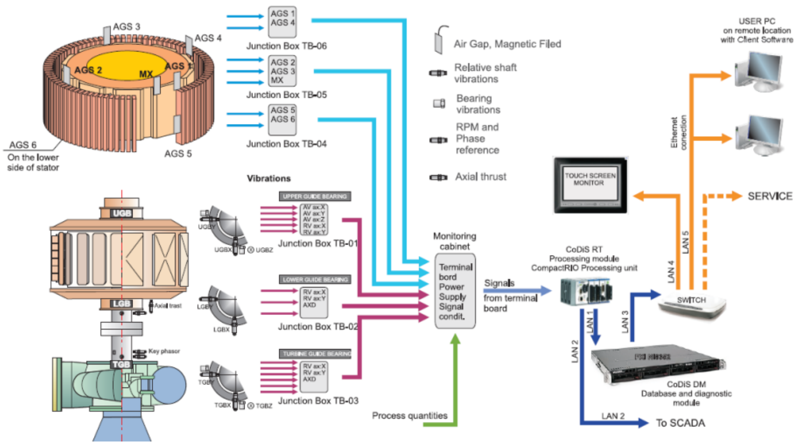
CASE STUDY – 03
Hydrogenerator stator and rotor eccentricity

Machine data:
Vertical hydro unit with 3 guide bearings (Combined Upper guide bearing, Lower Guide Bearing and turbine guide bearing) / Power: 25 MW; Stator Bore Diameter: ~ 4 m / Francis Turbine; Speed: 600 RPM

Monitoring Configuration:

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



Problem: Detected large stator and rotor eccentricity

This case study examines how the CoDiS on-line monitoring system helped identify a constant oil leak on the generator upper guide bearing. This condition was identified using data from the CoDiS monitor collected in various operating regimes during system commissioning. The system was installed in a major machine overhaul that included stator rewind and rotor pole inspection. This machine had a problem with the upper guide bearing seal crack and oil leak that couldn't be fixed. That was one of the reasons the power plant decided to install the machine condition monitoring system.

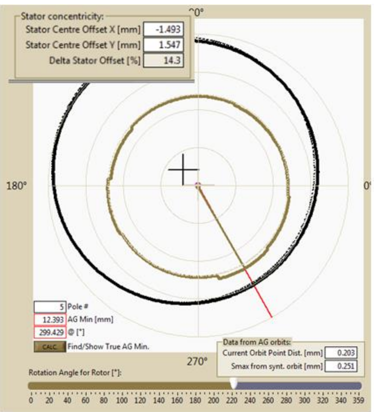
Data analysis and problem identification:

During commissioning of the system the data was recorded in all operating conditions from slow roll to full load and machine behaviour was analysed thoroughly to identify the source of the problem.
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 quantifies, air gap dynamic and static eccentricity and real time flux data analysis for shored turn detection on rotor poles.
CoDiS analysis tools help correlate the data recorded by various types of sensors simultaneously.
In this case a comparison between the air gap stator and rotor shape analysis and shaft vibrations (orbits) inside the bearing were crucial to help pinpoint the source of the cracked bearing seals.

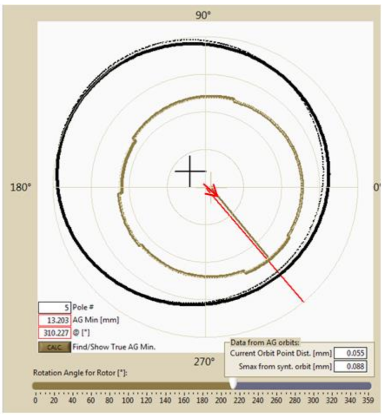
Air gap signal analysis

CoDiS stator and rotor shape analysis enables the identification of:

- Stator concentricity offset from ideal rotor and stator centre position
- Stator and rotor circularity offset from ideal circle
- Rotor dynamic centre movement represented as orbit and vibration of rotor body – enables rotor to rotate in any position from 0-360° and obtain the true air gap minimum position
- Rotor geometry changes (when eccentricity/vibration components of rotor body are extracted)
- Rotor concentricity offset from its ideal position



Before excitation

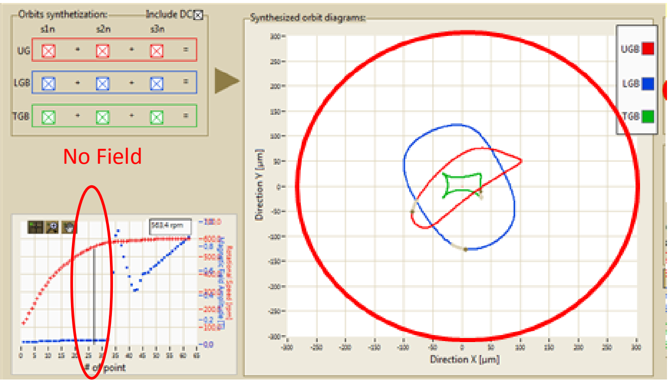


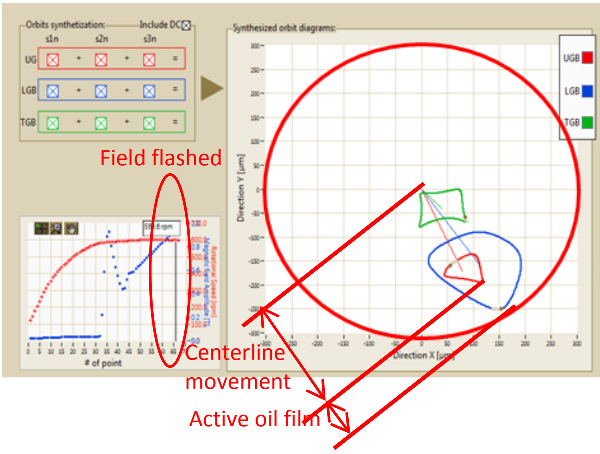
After excitation

Stator concentricity offset of 14% detected

Vibration signals

CoDiS vibration analysis tools enable the tracking of relevant parameters in all operating conditions.
On machine run up, the system automatically captures vibrations that can be correlated with flux in order to obtain insight into the machine condition. If there are problems such as eccentricity between the stator and rotor it would be visible in relative and absolute vibrations as well.
CoDiS 2D orbit analysis in transient operating conditions enables interactive sliding through the event. Orbit analysis shows dynamic movement of the shaft centre, but to be able to fully interpret the data, CoDIS includes the shaft static center movement on the same graph as well. This enables the user to track the oil film thickness and consistency.
As seen from the plots below, the data is taken just before and after excitation on full speed at 600 RPM.
Left diagram shows the position of the shaft at each bearing just before excitation and it is assumed that the rotor is spinning at the bearing's center. The right diagram shows the position of the shaft for each bearing after the excitation. The red circle represents the upper guide bearing clearance.
Orbit colours: upper guide bearing – red; lower guide bearing – blue; turbine guide bearing – green





Upper Guide Bearing clearance = 250 µm – red circle
Shaft centreline movement DC = 170 µm
Orbit Smax = 50 µm

Conclusion

The conclusion of the Veski experts was that vibration problems occur from the stator and rotor being eccentric which creates the static magnetic pull with field flashing. This was verified with CoDiS Air Gap monitoring module as shown on page 1. The pull is creating the load on that part of the bearing leaving the shaft no space to vibrate and making the oil film very stiff.
This is also visible in absolute bearing vibration measurements which increase from 0.75 mm/s to 4 mm/s with field flash whereas relative shaft vibrations decrease due to lack of space to move inside the bearing.
This load on the bearing was the reason for the cracked seal and oil leakage that was occurring repeatedly over the years.
The plant personnel needed to conduct serious refurbishment that would include stator shifting to minimize the eccentricity and reduce the magnetic pull force.