CASE STUDY – 01

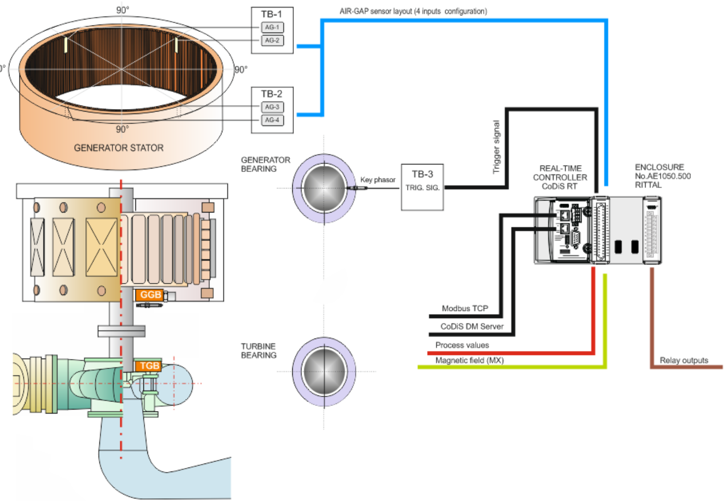
Hydro generator loose rim detection

Machine data:

Umbrella type (Generator guide and turbine guide bearing) / Power: 205MVA; Stator Bore Diameter: 13.8m / Francis Turbine; Speed: 100 RPM

Monitoring Configuration:

- 4 Air Gap probes @ 90°
- 1 Magnetic Flux probe
- Phase reference (and RPM measurement)
- Process quantities



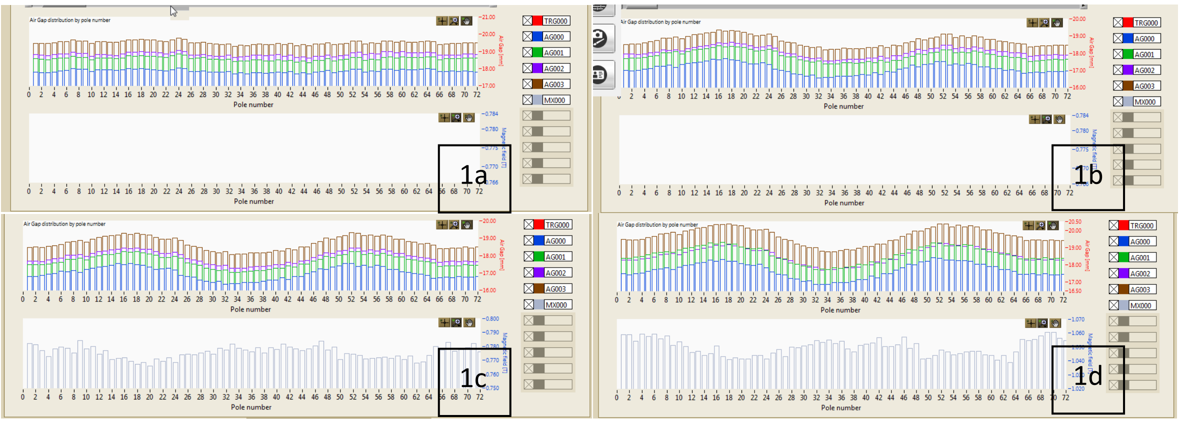
Problem: Detected loose Rim

This case study examines how CoDiS on line air gap monitoring system helped indentify a loose rim problem that occured after refurbishment work including changing the rotor poles, as well as rewinding the stator of one unit in the power plant. This condition was identified using data from CoDiS air gap and flux monitoring collected in various modes of operation during commissioning of the machine. Analysis of the system database revealed that the generator often goes to over speed (up to 150% of rated RPM) putting the rotor under a lot of stress that could lead to more severe rim loosening or even cracking in rim segments. Therefore CoDiS on-line continuous monitoring and data analysis is very important to ensure machine safety and contributes to efficient machine repairs and maintenance.

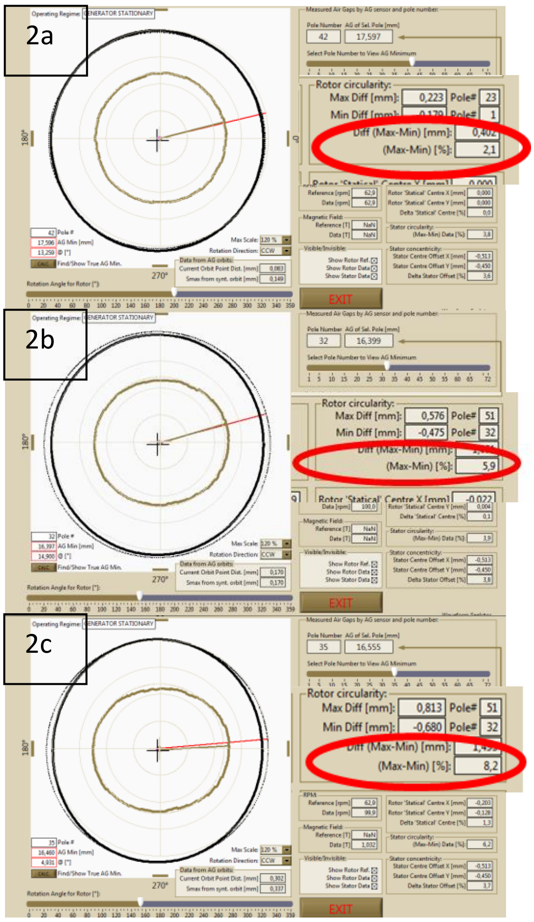
During commissioning of the system (and machine) air gap data was recorded from slow roll to maximum load. For this case study, data was taken in the following operating regimes to determine the significance of the loose rim problem identified during preliminary analysis:

- 60% RPM free / run figure 1a; figure 2a
- 100% RPM free run / figure 1b; figure 2b
- Field flash (field increase up to 100%) / figure 1c
- Full load / figure 1d; figure 2c

The upper half of figure 1 (1a to 1d) shows the air gap pole profiles at the operating regimes listed above. The lower half shows the magnetic flux pole profile. Note that when the generator is at free run (figure 1a and 1b) it is unexcited and there is no field, thus the magnetic flux pole profile is empty..



The stator and rotor shape comparison is shown on figure 2



Figures 2a to 2c shows that the rotor stiffness and shape are not consistent at the various operating regimes

Rotor circularity offset was changing as follows:

2.1% @ 60% RPM/no excitation – no high centrifugal and no electrical forces

5.9 % @ 100 RPM / no excitation - the centrifugal forces started to stretch the rim. The rim distortion due to stretch is more apparent in one direction than the other. The major axis of the ellipse was in the direction of poles 32 to 68 and the small axis was in the direction of poles 15 to 51.

8.2% @ full load - both centrifugal and magnetic forces are present. Additional distortion was visible in the same direction (poles 32 to 68) at full load and the rim stiffness continued to decrease in that direction.

Following industry guidelines [1] adapted for dynamic meausrements the tolerances for rotor circularity should not exceed 6%. This Unit at full load steady state was 8.2%, and outside of this guideline

The end user organized the rim to be inspected by the OEM and the conclusion was for the rotor to be re-shrunk in order to achieve adequate rotor rim stiffness and ensure stable and safe operation of the unit.

[1] "Hydroelectric Turbine Generator Units - Guide for Erection Tolerances and Shaft System Alignment, Part V", Canadian Electrical Association (CEA), 1989, rev. 1998