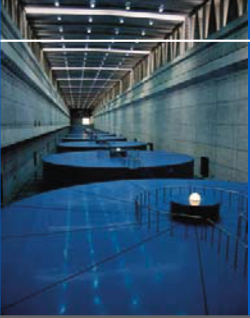

ZOOM MC/TM

VibroSystM

CS016

Detecting and Diagnosing a Rotor Design Weakness on New Hydrogenerators

Machine Data

Commissioning:	1999	Nominal Air Gap:	11 mm/0.433 in.	Turbine Type:	Bulb / Kaplan	Bearing Layout:	Generator Guide
Power:	42 MW	Stator Bore Dia.:	6.45 m/253.94 in.	Nbr Blades:	4		Turbine Guide
Speed:	112.5 rpm						

This case demonstrates the usefulness of monitoring new machines during commissioning using VibroSystM air gap technology to detect generator anomaly. At this new 5-bulb unit hydroelectric project, the utility insisted the generators be fully equipped with a ZOOM system.

Within months of its commissioning, the first generator experienced a rotor-stator contact resulting from rotor rim failure. At that time, the monitoring system was not operational due to project constraints. The utility insisted the monitoring system be implemented as soon as possible for both the unit return to service and the commissioning of the remaining bulb units.

While at site to complete installation and commissioning of the ZOOM system, VibroSystM technician and the plant supervising engineer reviewed data acquired by the system on the other machines. They found an irregularity in the air gap results of one unit. At Full Load, the air gap sensors were measuring different rotor shapes (Figure 1). Sensor at 225° angle (bottom) was providing the most dramatic result. Comparison of each sensor at different operating conditions, ranging from Speed No Load (SNL) to Full Load (FL) demonstrated a transient bump between poles #29 and #52 resulting from a loose section of the rotor rim (Figure 2).

With gravity helping, the loose rim section protruded into the air gap when rotating towards the bottom, then returned to its position when passing at the top (Figure 3). This cyclic flexing was imposing stress on the rotor rim components. The maximum bump amplitude (most critical air gap) occurred when rotor pole #39 passed in front of the sensor at 225° angle. Comparing these results with data recorded at Full Load nine days before clearly showed that the situation was deteriorating very quickly and that a failure could potentially occur at any time.

(continued on overleaf)

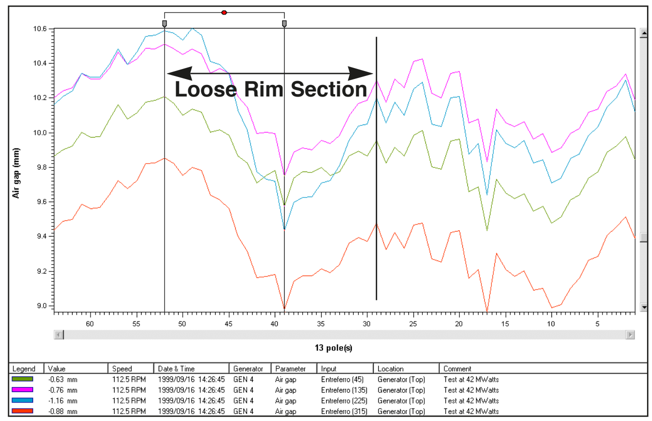

Figure 1: Signature graph of generator at Full Load showing a significant variation for the sensor at 225° (blue curve) between poles #29 and #52.

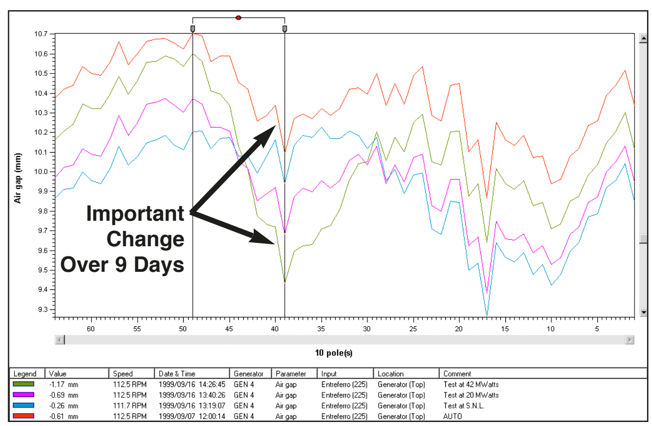

Figure 2: Signature graph of rotor profile at various operating conditions facing sensor at 225° and comparison with result 9 days earlier.

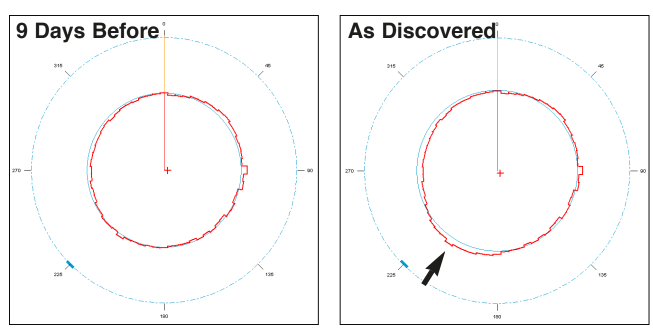

Figure 3: Polar graphs of rotor profile 9 days apart measured by sensor at 225° (right) angle. Note the bump protrusion in the area between poles #29 and #52.

Notes on back of page

Meanwhile, the vibration monitoring instrumentation did not reflect these changes (see *Case Study CS017*).

The plant supervising engineer realized the similarity with the previous incident and immediately alerted Head Office. Using the remote access capability of the ZOOM system, Head Office engineers reviewed data, agreed that another rotor-stator contact was imminent and ordered the machine stopped. They urgently contacted the generator manufacturer and faxed them plotted results. The utility requested the manufacturer inspect the rotor rim. Two days later, engineers from the manufacturer and the utility were on site to investigate.

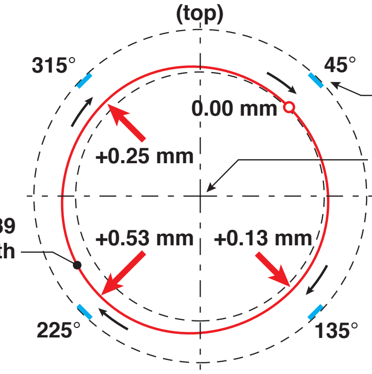

Figure 4: Illustration of pole #39 (most critical of the loose section) path over one rotation relative to its position facing sensor at 45°.

The engineers found the rotor rim and rotor-to-spider attachments in much worse condition than the unit that sustained the first incident. Several bolts broke during percussion tests. The cyclic imbalance overstressed the bolts, thus further loosening the rim.

A detailed generator design review was performed and modifications were implemented on all five machines. The compression bolts were replaced by ones with higher elasticity and the rotor rim-to-spider interface strengthened. Rotor performance is now systematically monitored and air gap alarms have been fine-tuned to effectively warn of air gap loss. No abnormal changes have been detected since and the machines behave within set guidelines.

This case clearly demonstrates that air gap monitoring is capable of predicting an imminent air gap failure so that preventive action can be taken. It also shows that critical air gap change can occur within a matter of weeks for which periodic off-line testing is insufficient.

Air gap data was instrumental in analyzing and diagnosing the problem, and monitoring it afterward. The system was beneficial to both the utility and the manufacturer. In addition to getting a return on its investment before all units were even commissioned, the utility experienced the powerful capabilities of the ZOOM system. It was provided with valuable information to enforce warranty terms. Meanwhile, the manufacturer was able to quickly identify the design weakness and find a solution, then implement corrective actions on all units to ensure no other units would fail, and therefore avoid paying additional penalty due to forced outages.

For more information, contact VibroSystM at:
2727 East Jacques-Cartier Blvd
Longueuil (Quebec) J4N 1L7 CANADA
Tel.: +1 450 646-2157 • +1 800 663-8379 (US only)
Fax: +1 450 646-2164
Email: sales@vibrosystm.com
www.vibrosystm.com

[1] *1 mm ≈ 39.4 mils / 1 mil ≈ 0.0254 mm or 25.4 µm*