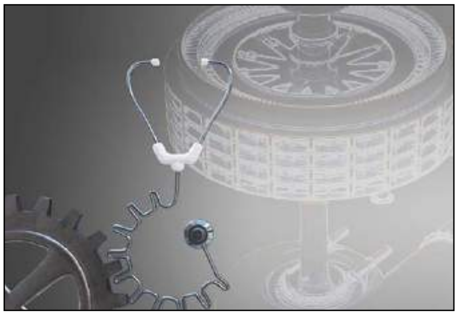


ZOOM® System for Hydroelectric Generators

VibroSystM's ZOOM system is an indispensable tool when monitoring phenomena in hydroelectric generators.

Consisting of the ZOOM software suite, acquisition units, sensors and measuring chains, the system provides you with the information you require to adequately reduce unplanned outages and plan out your maintenance schedule.

THE ZOOM SYSTEM INCLUDES:

- **ZOOM Software Suite**

Installed on a server-type or desktop computer, the ZOOM software suite incorporates a variety of software applications and services that allow for manual, automatic, and conditional measurements of multiple parameters related to the condition of a hydroelectric unit.

This user-friendly software helps manage different parameters, set alarm thresholds, and communicate data bidirectionally with different control systems (SCADA/PLC) through Modbus® or OPC® protocols.

- **Acquisition Units**

Installed inside a ZOOM monitoring cabinet or wall mounted enclosure, acquisition units are designed to be configured within a network environment that includes a server. These units ensure around the clock online monitoring, analysis and protection for hydroelectric generators.

That being said, VibroSystM's acquisition units are designed to keep protecting your unit even if the network connection with the ZOOM software is lost.

- **Sensors and Measuring Chains**

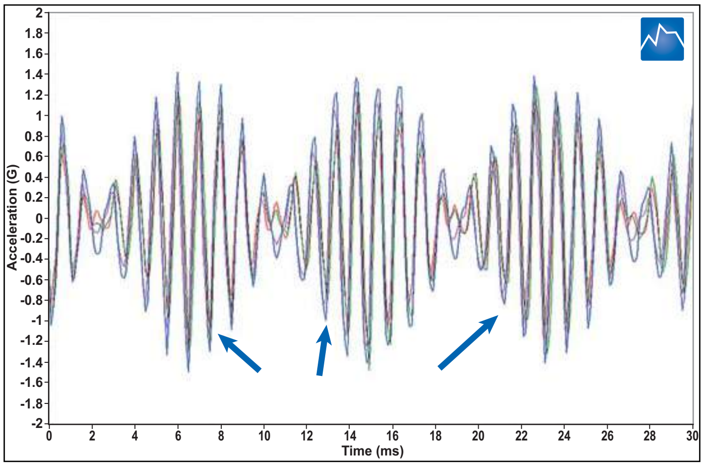
From the patented VM™ capacitive air gap measuring chain to the cutting edge FOA™ fiber optic accelerometer, VibroSystM's vast array of high precision sensors are built and rigorously tested in-house to guarantee reliable parameter measurements in a variety of harsh environments.

PHENOMENA AFFECTING HYDROELECTRIC GENERATORS

Drawing on its 30-year experience in unit condition monitoring, VibroSystM has compiled a list of phenomena that have a direct impact on hydroelectric generators. Thanks to the ZOOM software suite, VibroSystM's results interpretation specialists are able to observe and diagnose a particular phenomenon and provide you with detailed reports that will help you better understand your power generating assets.

LEGEND: Graphs Videos

Click on the buttons to see ZOOM software graphs and videos.

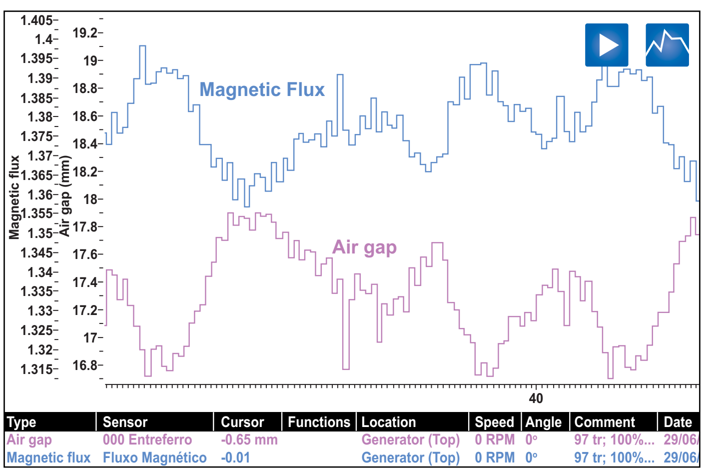


High frequency stator core oscillation is clearly noticeable. The results at 0 Mvars are somewhat lower than at 16 Mvars.

VSM797S sensor

- **Detecting Early Stages of Stator Core and Frame Component Loosening**

Measuring absolute vibration by installing the VSM797S™ piezoelectric accelerometer on the stator core allows us to identify important vibration sources that can loosen stator core laminations and eventually lead to overheating and failure of the stator core itself.



Magnetic flux intensity is inversely proportional to air gap. Therefore, a small air gap produces higher magnetic flux results and vice-versa.

MFP sensor

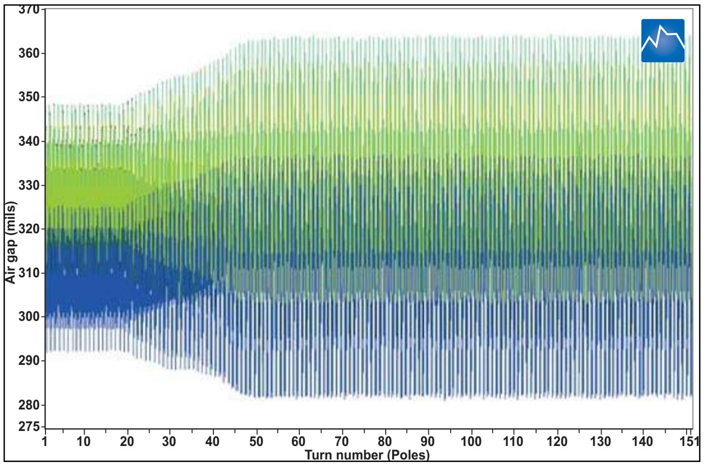
VM air gap sensor

PCS sensor

- **Detecting Abnormal Rotor Rim Expansion, Stator Movement and Distortion**

Although rotor rim expansion is common during unit operation, an uneven expansion can have severe consequences on both the rotor and stator. A deformed rotor adds a cyclic, magnetic unbalance that puts additional stress on the stator and weakens various stator frame components.

To further understand abnormal expansion, movement and distortion, the ZOOM software allows for the correlation of air gap data collected by the VM air gap sensor, the magnetic flux generated by the unit through the MFP™ sensor, and shaft displacement data collected by the PCS™ capacitive proximity sensor.

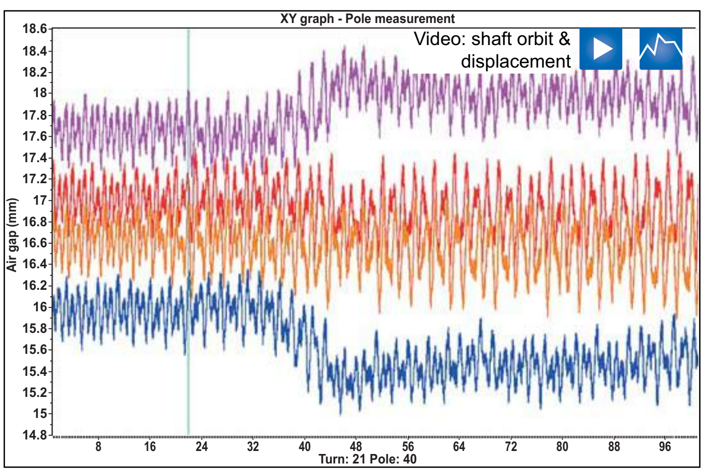


Significant distortion of the rotor as the Unit is being synchronized to the grid. The rotor expands in some areas while it contracts in other areas.

VM air gap sensor

- **Evaluating Rotor/Stator Stiffness**

Combining data collected by the VM air gap sensor with periodic analyses of rotor/stator stiffness and circularity, in all dynamic modes, allows us to detect air gap anomalies and vibration values that exceed specified acceptable tolerances. This data can also be used to help identify loose rotor poles. Early detection of worn-out, loose or overshrunk components helps extend unit life and adequately plan maintenance outages.



Classic case of a magnetic center which differs from the mechanical center.

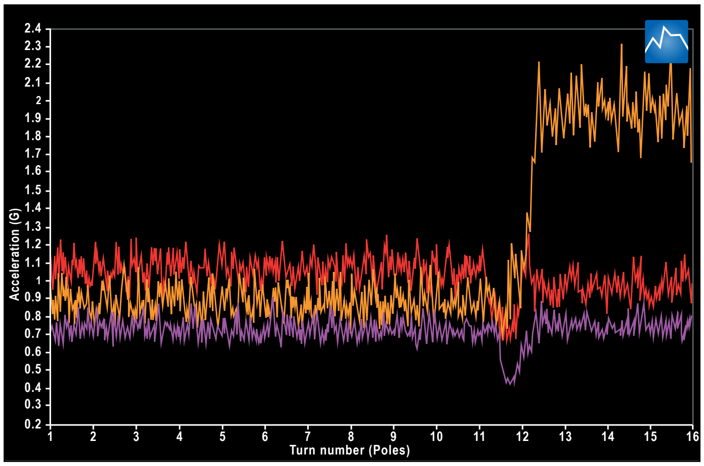
VM air gap sensor

PCS sensor

- **Evaluating Generator Misalignment Problems**

Disruptions in shaft alignment and rotor eccentricity often lead to overheating stators, excessive vibration, loose stator cores, stator bar vibration and premature bearing deterioration.

In order to observe this phenomenon, the ZOOM software correlates data collected by the PCS capacitive proximity sensor and the VM air gap sensor in order to identify mechanical and magnetic center discrepancies and problems related to rotor eccentricity.



End-winding vibration during load increase. The acceleration recorded by 1 fiber optic accelerometer increased significantly as the load is increased, as opposed to the other 2 accelerometers.

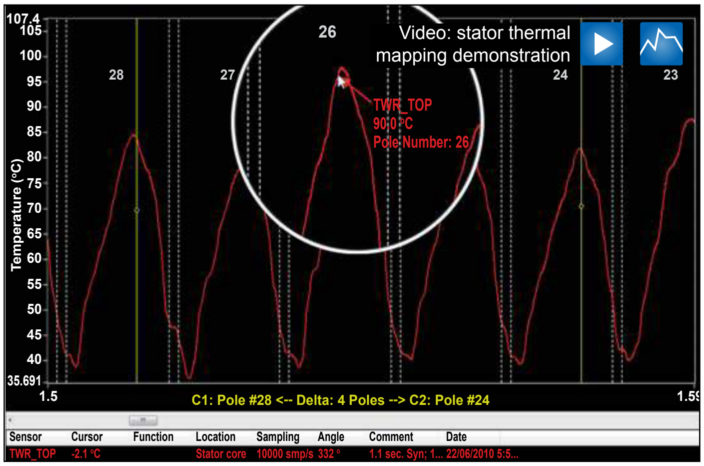
FOA sensor

SBV sensor

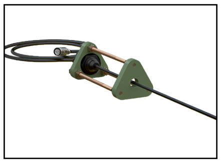
PDA acquisition unit

- **Detecting Loose or Defective Wedging, End-Winding Support Systems and Stator Winding Insulation Problems**

Inserting the SBV™-202P capacitive proximity sensor inside a stator wedge, facing the stator bars, has been proven to be the best way of measuring in-slot bar position variations and relative vibration. If not monitored, this phenomenon can lead to insulation damage and defective wedging or end-winding support systems. Furthermore, the FOA single or dual axis fiber optic accelerometers can be installed to measure absolute vibration found in end-windings and support systems that are subjected to mechanical and electrodynamic stress.



Online rotor pole & interpole temperature measurements.



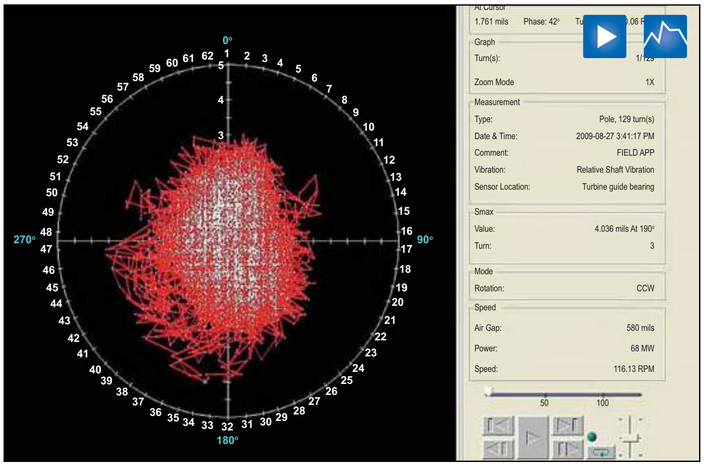
TWR sensor

TWS sensor

- **Detecting Stator Core Delamination and Overheating Rotor Poles**

In order to detect stator core delamination, stator core and/or winding temperature must be monitored. This is achieved by installing a TWS™-200 temperature sensing measuring chain around the stator core. The data collected by the TWS-200 will allow the ZOOM software to create a thermal mapping display of the stator, which in turn will allow for the detection of significant heat signatures on its surface. Observing stator core temperature is the first step in detecting cooling system deterioration and stator core delamination.

To measure rotor pole temperature, the TWR™-200 temperature sensor is used. This sensor is capable of detecting the maximum temperature of each pole at the nominal rotational speed. To collect the data, the TWR-200 is inserted through one of the generator's ventilation holes and detects heat signatures emitted by rotor poles. Monitoring rotor pole temperature helps detect damper bar defects or protruding poles that lead to overheating.

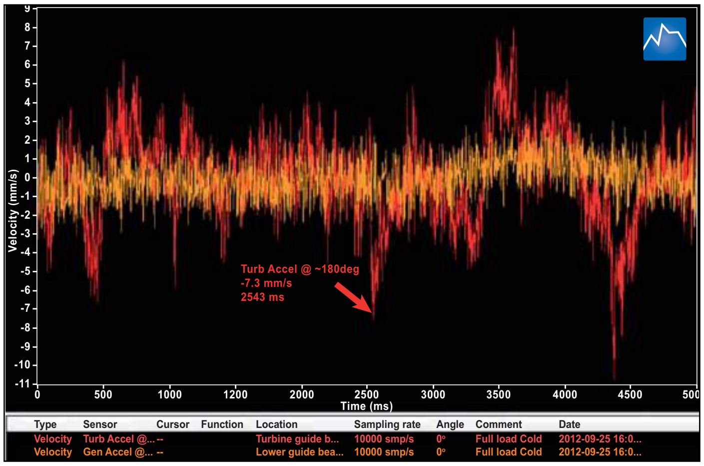


Orbit of the turbine guide bearing during field flash. The energization of the rotor has little or no impact on the shaft movement at the turbine guide bearing.

PCS sensor

- **Measuring Axial Shaft Movement**

Axial shaft movement, or axial displacement, caused by the turbine's hydraulic thrust or vertical misalignment of the unit, is a common phenomenon that occurs during normal unit operation. Nevertheless, it remains important to monitor axial displacement in order to prevent excessive rotor movement and ensure bearing integrity. Installing the PCS™ capacitive proximity sensors around the unit is an effective and proven method of observation for this movement.



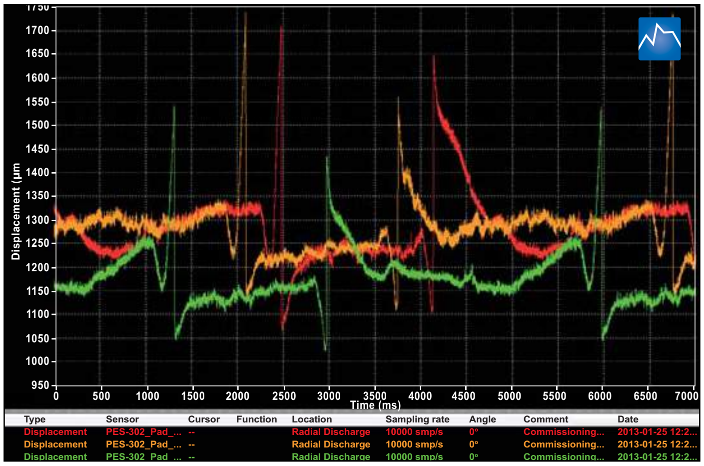
Example of absolute guide bearing vibration at full load – cold.

VSM797S sensor

PCS sensor

- **Prevent Bearing Anomalies and Deterioration**

By installing the PCS sensor, along with the VSM797S accelerometer throughout the unit, especially at bearing levels, we can properly identify important vibration signatures that have a direct effect on guide bearings. Furthermore, these sensors have the ability to observe both relative and absolute vibration.

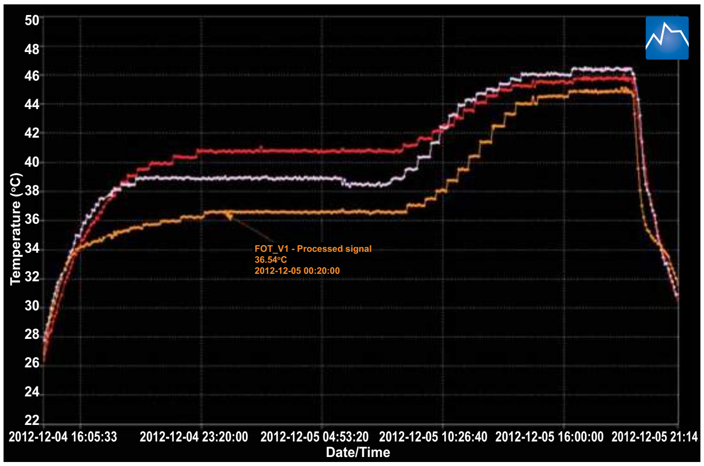


Example of oil film thickness results.

PES sensor

- **Monitoring Thrust Pads**

Since thrust pads are submerged in oil, the sealed, PES eddy current proximity sensor is the best tool for measuring oil film thickness. Adequate lubricant film thickness is essential in preventing rubbing that can cause overheating which in turn can eventually lead to premature pad wear and thrust bearing deterioration.



Example of coil temperature in trending format during a short period of time.

FOT sensor

- **Detecting Anomalies in Switchgears and Brushes**

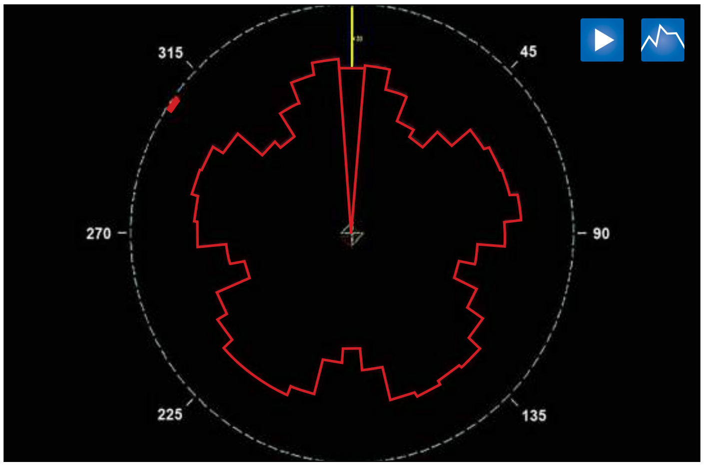
Gradual contact deterioration in switchgears and brush assemblies translates into a temperature increase over time. Even when inspection and maintenance are carried out at regular intervals, online temperature monitoring provides trend information that helps keep electrical switchgear and brush assemblies in good operating condition.

The installation of the FOT-100™ fiber optic temperature sensor will allow the ZOOM software to trigger alarms when abnormally high temperature levels are detected.

Detecting Steel Throat Liner Deformations and Abnormal Turbine Unbalance

Variations in runner band clearance and high levels of turbine guide bearing vibration are indicators of throat ring and runner band deformation or unbalance. This is particularly true after a runner has been repaired. Problems resulting from throat ring deformations range from decreased unit efficiency to runner blade throat ring contact. This can be prevented by correlating measurements taken by the VSM797S accelerometer (radial and axial vibration) and the SPES™ underwater eddy current proximity sensor in the ZOOM software.

Furthermore, unit movement can significantly affect blade tip and runner band clearance, causing blade rubbing against the throat ring, leading to abnormal turbine unbalance and, in some cases, cause an entire unit to seize up. To observe such phenomena, the SPES sensor is installed in the throat ring to measure the distance to the blade tip.



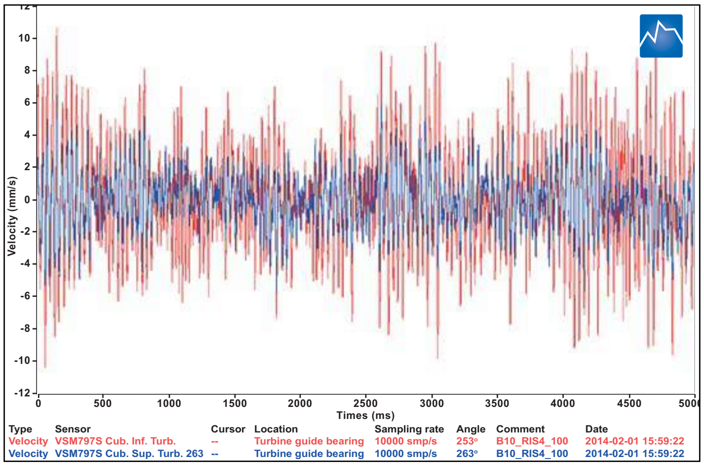
Representation of blade orientation variation of a kaplan turbine.

SPES sensor

VSM797S sensor

Identifying Water Flow Anomalies

Pressure surges and water flow turbulence can lead to increased vibration on the turbine head cover and support bracket, severely affecting wicket gate operation. This phenomenon affects turbine behavior and eventually causes turbine guide bearing deterioration. This excessive vibration is also transferred to the draft tube which can seriously affect its integrity. To measure this vibration, the VSM797S piezoelectric accelerometer is installed on the head cover, spiral case, and draft tube.



Velocity results (in the time domain) from 2 piezoelectric accelerometers installed on the head cover.

VSM797S sensor

Publication: 2016-06-08