Brüel & Kjær Vibro

Application Note

Case study – VC-6000 Compact Monitor used for monitoring small hydroelectric generating units

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ABSTRACT

The VIBROCONTROL 6000® Compact monitor is delivered to Andritz Hydro as an OEM product for monitoring their smaller hydro generating units. This vibration monitor proved to be well suited to this application since it has a lot of the functionality that is normally found on the more expensive rack-based systems.

Figure 1. Andritz Hydro workshop in Schio, Italy. (The spiral case and distributor shown in the photo is actually part of several older units that are being reconditioned to be installed in rural South American towns through a non-profit organization. Retired Andritz Hydro factory workers are being asked to come back part time to do the reconditioning and commissioning.)

Company

Andritz Hydro Srl. (formerly called VA-Tech Escher Wyss) is the Italian company affiliate of the multi-national concern Andritz Hydro (formally VA-Tech Hydro Andritz). The Andritz Hydro facilities in Schio (Vicenza), Italy, take care of mechanical and electrical engineering for procurement and workshop assembly of large and compact hydroelectric generating units and

Figure 2. Typical Andritz Hydro compact hydrogenerating unit (horizontal Francis turbine, 9.2 MW).

Service & Rehabilitation of old hydroelectric power plants, including site erection and commissioning. The Schio plant, with 110 employees, assembles and works on most hydro generating unit components, including turbines, pump-turbines, governors, plant automation, protection, excitation, SCADA, remote controls and low and medium voltage cubicles. The main customers include the Italian electric utilities ENEL, EDISON and EDIPOWER and the Spanish utility ENDESA.

Brüel & Kjær Vibro has delivered a full range of monitoring systems to Andritz Hydro over the years, which include the VIBRO-CONTROL 6000® Compact monitor and the VIBROCONTROL 4000 monitoring system. These systems have been used on hydro generating units ranging from 4MW units to units over 150MW.

OEM monitoring requirements

The Italian workshop of Andritz Hydro has very special needs for a machine condition monitoring system for their smaller hydro generating units. Several of their clients have small hydroelectric generating units, sometimes less than 10MW, where there is only a single hydroelectric generating unit in the power station. A typical example of this is shown in Figure 2. These power stations collectively play an important role in the local energy distribution, despite their small size, so uptime is vital for these machines. But as a result of the hydro generating unit size and small numbers in the power station, it can be difficult to find a cost-effective monitoring solution for these critical machines.

A typical rack-based safety and condition monitoring system has all the necessary functionality and

remote monitoring capability for these types of applications, but such a system would be too expensive for monitoring a single hydro generating unit. There would be many empty slots in a rack-based system that is normally designed to monitor several machines.

There are many inexpensive vibration monitors in the market, but these do not have sufficient measurements for effective condition monitoring of hydro units. These types of vibration monitors are primarily designed for monitoring pump and fan motor trains. Moreover, these types of monitors often do not have a remote monitoring interface that can be accessed by a SCADA system.

Compact monitor as an OEM product

The Brüel & Kjær Vibro VIBRO-CONTROL 6000® Compact monitor provided an optimal solution to this dilemma. This vibration monitor has wide-ranging condition monitoring measurement capacity, and can be interfaced via OPC to a DCS/SCADA system for remote process visualization, acknowledging alarms, resetting relays and changing setup parameters.

The Compact monitor is factory-configured at Brüel & Kjær Vibro for the specific monitoring requirements at Andritz Hydro, such as for the sensor inputs and specialized measurements. This pre-configured product is then delivered as a standardized OEM product platform to Andritz Hydro, which can be used for many different types and sizes of hydroelectric generating units. When the compact monitor is installed on-site at an end-user's power station, the measurement parameters are "fine-tuned" to the particular characteristics of the generating unit, such as rotational speed, number of turbine blades, etc. The relay configuration and vibration data to be exported to the DCS are set up on-site according to the requirements of that power station. An OPC interface is also set up on-site for exporting data to the SCADA system, if needed.

Typical monitoring configuration for the compact monitor

For Andritz Hydro, the compact monitor is typically used to monitor small hydroelectric generating units, many of which are under 10MW. Figure 3 shows a typical configuration for the compact monitor for safety and condition monitoring a typical hydroelectric generating unit. In this example, four compact monitors are used for monitoring the upper and lower generator guide bearings and the turbine guide bearing, and for monitoring the axial vibration.

Installation

X-Y displacement sensors are installed on the three guide bearings as shown in Figure 3. In smaller hydro units such as in this example, access may be difficult for placing the displacement sensors directly at the bearing. This is the case for the lower generator guide bearing as shown in Figure 4 (right), where the radial X-Y sensors are placed as close as possible to the lower generator bearing housing. This is also the case for the thrust bearing, where a velocity sensor is used for monitoring the axial vibrations in place of the axial displacement sensor. The velocity sensor is located on top of the

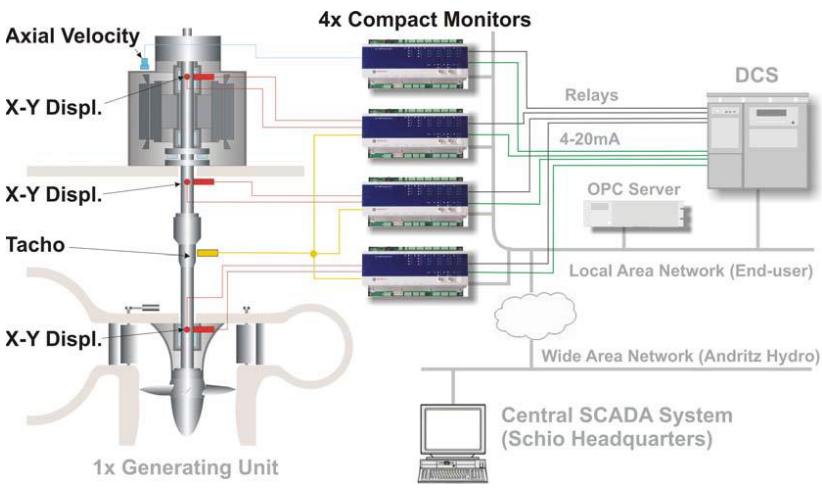

Figure 2. Typical Andritz Hydro compact hydro-generating unit (horizontal Francis turbine, 9.2 MW).

Figure 4. Examples showing sensor installation on the hydro generating units. On the far left is the velocity sensor on the generator top cover for monitoring axial vibrations. The two photos in the middle show the X-Y radial displacement sensors mounted just over the turbine guide bearing. On the far right are the X-Y radial displacement sensors mounted below the lower generator guide bearing.

Figure 5. Typical cabinet installation for the compact monitors.

generator cover housing, as shown in Figure 4.

The four compact monitors are typically installed in a cabinet in the instrument room of the power station, as shown in Figure 5. The tacho signal is wired to the three monitors at the bearings. This allows triggered vector measurements to be made for all the guide bearings for early fault detection and diagnosis by using a single tacho sensor.

Relay signals are wired to the emergency shutdown system for tripping the machine if the vibrations indicate an impending catastrophic failure. A trip multiplier function in the compact monitor prevents the normal high vibrations due to start-up/synchronization will not trip the machine.

Measurements and signal conditioning

As shown in Figure 3, each compact monitor is set up for a specific monitoring task. Figure 6 shows the signal flow diagram for the compact monitors used to monitor the generator and the turbine guide bearings.

The compact monitor has measurements that are used for safety monitoring and machine condition monitoring, as summarized in Table 1.

Remote monitoring

In addition to the relay outputs, the compact also has data outputs. The DC outputs are used for exporting 4-20mA signals that are proportional to the vibration signals to the process control system at the power station. Operators use this information to keep an eye on the vibration levels of the generating unit. Using the setup software program that comes with the compact monitor, the Operators can also acknowledge incoming alarms, reset relays and change setups.

Vibration data is also exported from various power stations to the SCADA system at the Andritz Hydro Italian headquarters in Schio via an OPC interface. Here the factory is not authorized to change the setups, but they can

Sensor (meas. point)	Measurements		Faults that can be detected and diagnosed
	Safety Monitoring	Condition Monitoring	
Relative radial vibration **(all bearings)**	○ **Overall** (ISO:1Hz/10Hz - 1kHz) ○ **DC** (shaft position)	○ **2x magnitude** ○ **2x phase**	Bearing damage, lack of lubrication, overload, wear, misalignment, unbalance
Tacho	-	○ **Speed, phase**	Phase and triggering used in other measurements
Absolute axial vibration **(stator casing)**	○ **Overall** (ISO:1Hz/10Hz - 1kHz)	-	Axial stator movement, thrust bearing problems

Table 1. Measurements provided by the four compact monitors at a typical end-user hydro power station.

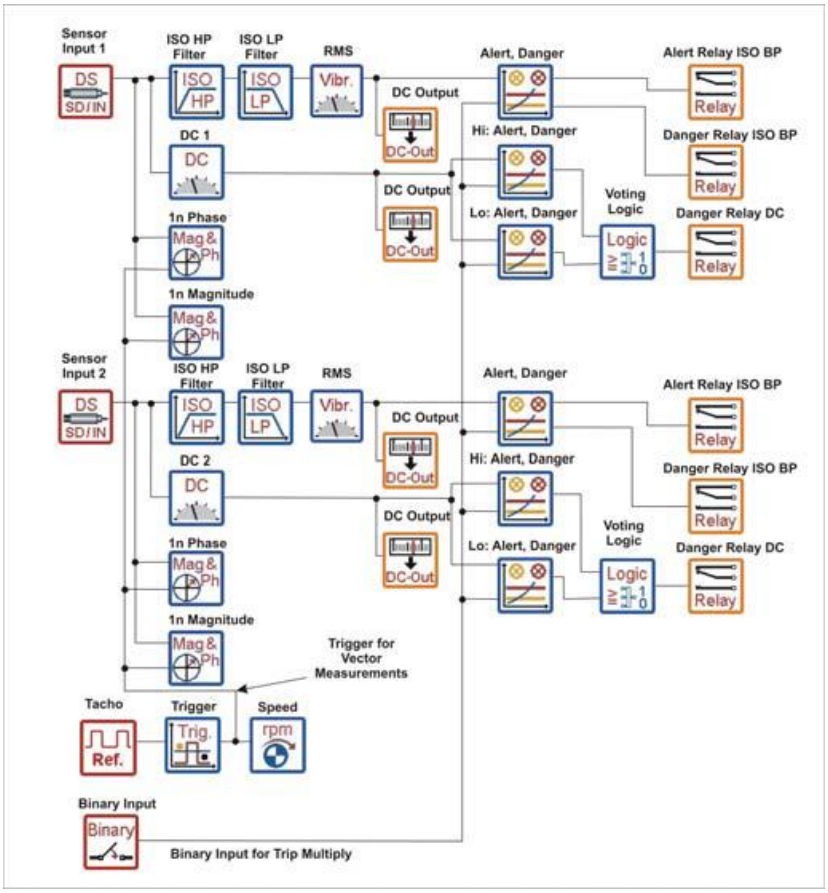

Figure 6. Signal flow diagram for the compact monitor for monitoring the generator and turbine guide bearings.

keep an eye on the performance of their machine during the warranty period. This makes it both easier and faster to react to machine problems should they arise. An example of a SCADA screen display is shown in Figure 7.

Conclusion

The compact monitor plays an important role in filling the gap between inexpensive vibration monitors and the expensive rack-based monitoring systems. This is important for monitoring critical hydroelectric generating units that are relatively small, and where there are only one or two units in the power station. The functionality that is important in this case is:

- Condition monitoring measurements such as vectors
- Remote monitoring capability

As an OEM product, it is also important that the compact monitor be limited to one or two standard configurations, that can be later fine-tuned on-site.

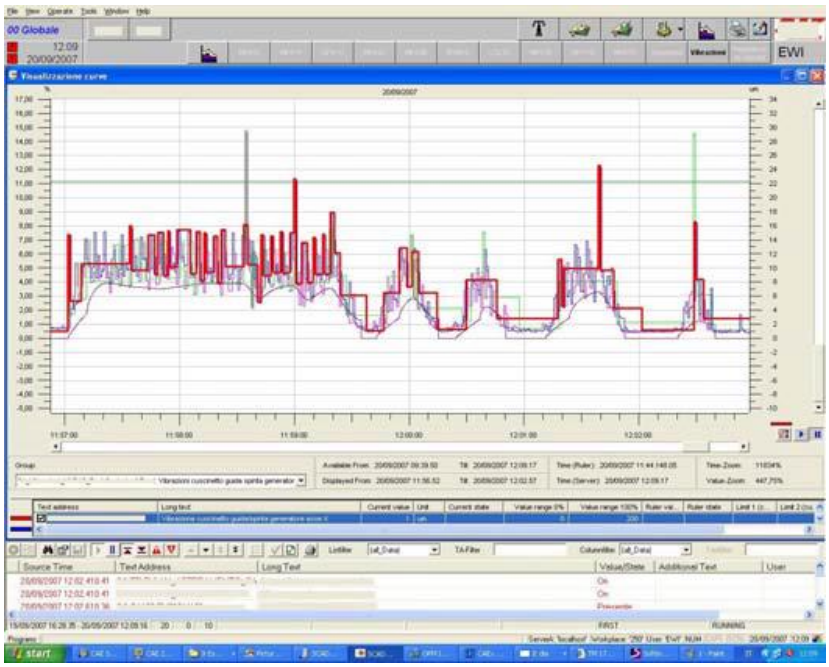

Figure 7. Example of the vibration data exported to the SCADA system via OPC interface. The screen picture above shows vibration data plotted against process parameters such as speed and active power. The Compact monitor has its own remote monitoring software and database (xms), but this is not needed for this application, as this is done by the SCADA system.

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