Brüel & Kjær Vibro

Application Note

Case study – Monitoring case vibration with an accelerometer on low-speed hydro turbines

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ABSTRACT

It is an ongoing discussion whether it is possible to monitor case vibration with accelerometer sensors on low speed hydro turbines. In this case story a hydro power station customer has both accelerometers and displacement sensors installed on the 65 RPM turbine bearing, so the measurements can be compared. The results show that accelerometers can indeed be used to monitor low-speed vibrations as well as displacement sensors and the more expensive velocity, but there are limitations.

Application Description

The Compass monitoring system is installed at the **Freudenau Hydropower** plant near Vienna. The six bulb type horizontal machines have a 7m diameter, so they are among the largest in Europe. Several monitoring techniques are used on the machines, including vibration monitoring. Relative shaft vibration is measured with non-contact displacement sensors while the absolute vibration is monitored with accelerometers. As the turbines are rotating at 65.2 rpm, it is the necessary to monitor at least the 1Hz frequency component in the monitoring spectrum in order to detect and diagnose 1x faults such as unbalance.

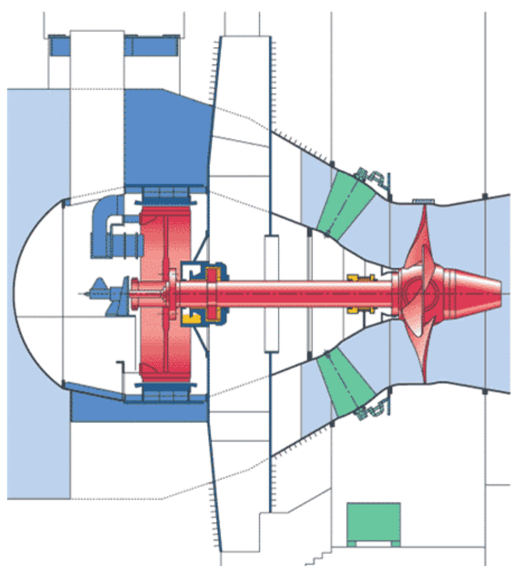

Figure 1. Cutaway schematic of the horizontal bulb-type turbine.

Sensor Location

The turbine has two guide bearings, where one accelerometer is located on each bearing housing in the horizontal direction for monitoring absolute, radial vibration. The relative shaft vibration is monitored with a pair of X-Y probes on each bearing. An accelerometer was installed for measuring the case vibration. This sensor has a 3dB frequency range between 1Hz and 10 kHz with a sensitivity of $10 mV/ms^{-2}$.

Measurement Setup

As the signal coming from the accelerometer is extremely low around 1Hz, proper wiring and shielding is important. To improve the signal-to-noise ratio of the whole measurement chain

including the electronics it is important to use a high signal gain of around 40dB. In addition to this signal enhancement is used to reduce frequency components that are not synchronous to the rotor. The number of averages was set to four.
Several full spectra were made up to 10Hz with 400 lines for both the displacement sensors and accelerometers. This gives a frequency resolution of 0.025Hz.

Measurement Results

For comparison purposes, measurements were taken from two machines (units 2 and 5).
As expected the quality of the spectrum plot gets better as the base vibration gets higher. This applies to both the accelerometer and displacement sensors. With an overall case vibration of around 0.5mm/s and 20µm for the relative shaft vibration the results for the spectra are decent.

The following plots show the results for the generator bearing and for the turbine bearing for the two machines. As the spectrum has a line at 1.075 and one at 1.100Hz, the harmonic cursor was used in the plots to determine the exact frequency of the first harmonic. This was 1.086Hz.

Figure 2. Freudenau hydroelectric power station.

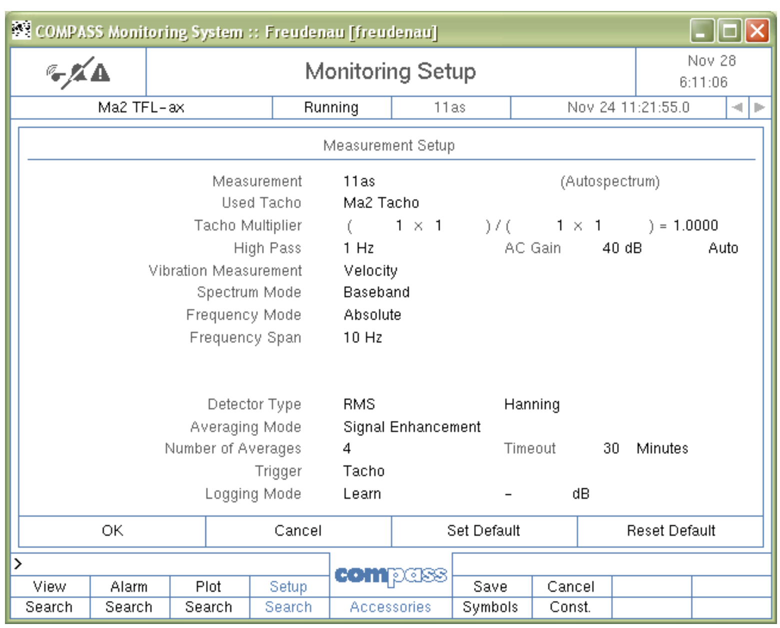

Figure 3. Measurement setup of the FFT spectrum measurement.

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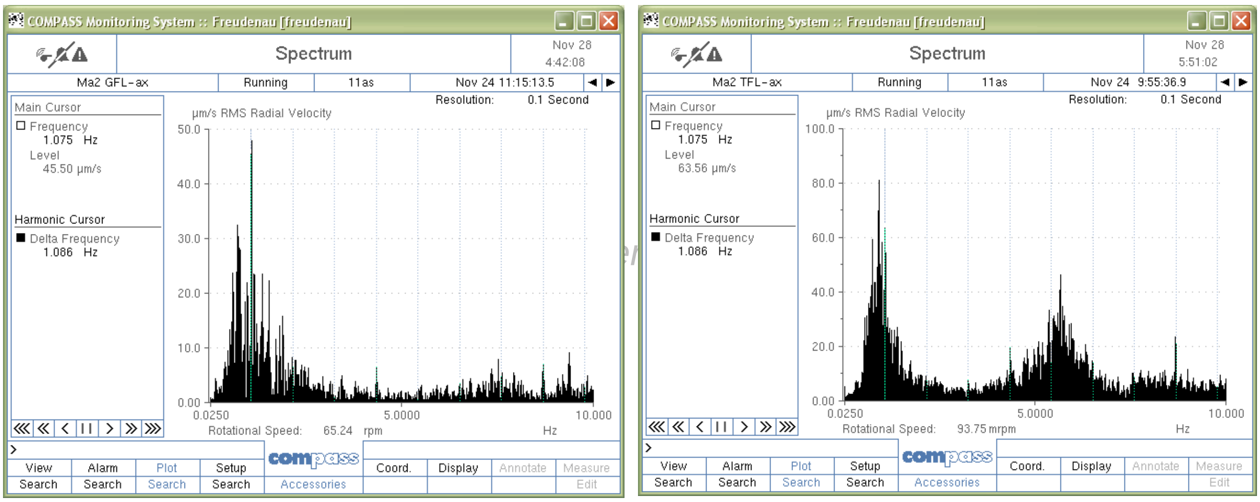

Figure 4. LEFT: Absolute vibration at generator bearing, unit 2. RIGHT Absolute vibration at turbine bearing, unit 5.

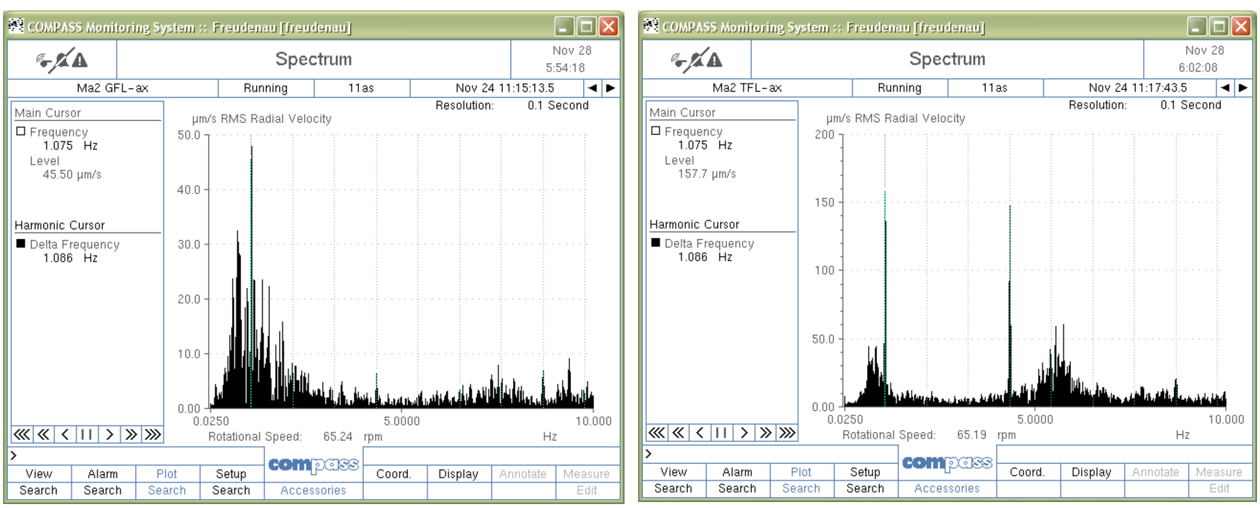

Figure 5. LEFT: Absolute vibration at turbine bearing, unit 2.
RIGHT Absolute vibration at generator bearing, unit 5.

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