HYDROPOWER APPLICATIONS
FAQ

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Q1 – Is it easier to just measure the rough load zone pressure fluctuations with a pressure sensor mounted on the draft tube cone of a Francis turbine ?

Yes and no. At partial load, the action of the draft tube's elbow on the swirling flow field induces axial/longitudinal pressure and flow fluctuations which are easily transmitted throughout the complete hydraulic installation. Whenever they occur at a resonance frequency, high pressure & flow rate fluctuations, mechanical vibrations or torque fluctuations may develop. Pressure fluctuations measured on the draft tube cone measure the superposition of the rotating pressure field and the longitudinal pressure fluctuations. One might measure relatively high-pressure fluctuations due to the rotating pressure field, but these are not necessarily problematic, contrary to the longitudinal fluctuations. It is possible to install multiple sensors symmetrically around the draft tube and separate the rotational and longitudinal fields by vector decomposition. The longitudinal fluctuations can be more easily measured at the high-pressure side of the turbine.

Q2 – Does VibroSmart and VibroSight do centreline plots?

Both VibroSmart/VSV30x and VM600/XMV16 data acquisition modules have the capability to measure relative shaft vibrations, including the DC component. Based on the DC component of 2 proximity probes positioned at 90°, the VibroSight software can calculate the shaft centerline position and visualize it in a dedicated plot.

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Q3 – What magnetic flux front end solution we have? Runner clearance and rough load zone which front ends can be used?

Meggitt does not have magnetic flux sensors in its product catalog. Currently, VibroSight is able to process either magnetic flux density signals (Tesla) or its derivative (Tesla/s). The processing is supported for signals measured by both VM600/XMV16 modules and VibroSmart/VSV modules. Any magnetic flux sensor on the market, outputting either an appropriate voltage or current signal, can therefore be used. Note that due to the capability to use the magnetic flux density derivative as an input signal, a simple wire loop (with an appropriate surface) glued on the stator wall, could be used as a cheap alternative to a sensor.

For runner clearance, Meggitt's TQ-423 proximity probe is the recommended sensor. It has a large measurement range (12 mm) in terms of distance and sports a pressure proof tip.

The rough load zone (RLZ) fluctuations are often measured indirectly. This can be achieved through an accelerometer or velocimeter installed on the turbine's head cover (VSE210, SE120, CE620) which is able to measure the low RLZ frequencies. RLZ vibrations are also measurable via the relative shaft vibration using proximity probes, which can inherently measure a large frequency range down to DC. Finally, it is also possible to use pressure sensors (see also previous question).

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Q4 – There was a mention of stator expansion measurement, which type of probe is used for this? & how is this measured?

The stator expansion can be measured using a number (8-12) of proximity probes installed (symmetrically) around the stator. The sensors are fixed to the building floor and measure the radial distance to the stator housing. When the machine is starting up, one can clearly see the radial stator expansion and deformation using VibroSight's spider plot.

Q5 – What is the difference between net head and working head ?

The height difference between the water reservoir and the tail race in a hydroelectric facility is called the gross head and it determines the maximum amount of power that can be produced.

However, energy losses occur whenever water flows through pipes due to friction and this reduces the actual rate of power production. These losses reduce the overall head and result in a number known as the effective head or net head.

Q6 – What is the relative discharge?

Very often the operating condition parameters are expressed using non-dimensional numbers. In this case, it refers to the actual discharge (flow rate) value divided by the design discharge for the turbine. The design point of a hydraulic machine is at or near the best efficiency point (BEP).

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Q7 – Percentage of opening the guide vanes , do you capture it using the guide vane servomotor position transducer or using a rotary transducers installed on the wicket gates?

Both measurement methods are used in the field. Typically, the vibration monitoring system does not measure the guide vane opening directly, but imports these values via an interface (Modbus, OPC,…) from the DCS or SCADA system. Meggitt Energy does not have rotary transducers in its product catalog.

Q8 – Is it possible to capture the cavitation percentage using pressure fluctuation sensors?

This is a difficult question to answer, because the term "cavitation percentage" is not entirely clear to me. Cavitation is a complex phenomenon and a large subject on its own. Cavitation can indeed be measured using dynamic pressure sensors, amongst other sensor types. However, the problem is to interpret the measurement data correctly, for example how is it linked to blade erosion (not all cavitation has the same erosive power). Also, cavitation measurements are indirect, meaning that you measure some effect of cavitation (noise level, mechanical vibration, acoustic emission levels, …). Interpretation of absolute values is challenging, however the evolution of measured parameters over time might provide some interesting information.

Q9 – How do you select the number of air gap sensors based on the rotor diameter?

There is a general guideline indicating that the circumferential distance between two successive sensors should not exceed 4 to 5 meters. Given the rotor diameter, this allows to determine the typical number of sensors to be used.
In practice, the number of sensors depends very much on the user preferences and the type of analysis they want to perform. A minimum of 4 sensors is needed, but 8 or 12 sensors are common numbers as well.

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Q10 – What are the advantages/disadvantages of using a velocity sensor over an accelerometer assuming that both cover the same bandwidth?

This depends on the application, the vibration frequencies at play and the frequency range of interest. Both solutions give good results.

Velocimeters directly measure velocity which relates to the machine's vibration energy. Accelerometers measure vibration forces acting on the machine, which are proportional to the vibration frequency. This implies that velocimeters are better in measuring low frequency vibrations and accelerometers are better for higher frequency vibrations in terms of signal output level or signal to noise ratio.

In general, accelerometers can cover a larger frequency range compared to velocimeters.

Velocimeters are often a bit larger in size and have some moving parts inside. Accelerometers on the other side are very compact and have no moving parts.

Velocimeters do not need an external power supply contrary to accelerometers.

Q11 – Is there any benefit of acquiring the new speed module (SpeedSys300) if you already have an MPC4 ?

The SpeedSys300 is an overspeed protection system. Because of the criticality of an overspeed condition, standards such as API670 require that overspeed systems are fully separated from any other protection system. The two systems serve different requirements related to international standards.

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Q12 – What is the risk of not measuring the magnetic flux?

Airgap and magnetic flux measurements are mainly used in large hydro generators. The large diameters of these machines imply a certain mechanical flexibility, and their shape and radial position are influenced by operating forces. Off-center or out-of-round conditions can reduce operating efficiency, give rise to unbalanced electromagnetic forces, vibrations and, in more severe cases, can lead to damage from magnetically induced heating or result in a rotor-to-stator rub. These measurements can also detect problems related to individual poles. Magnetic flux measurements can also detect faults related to pole windings.

Not measuring the magnetic flux increases the risk of undetected faults going unnoticed, and consequently their eventual impact on the operation and availability of these assets.