Hydroelectric Turbine Supervisory Instrumentation

The unique monitoring requirements of hydroelectric turbine generators are satisfied with Hydroelectric Turbine Supervisory Instrumentation (HTSI) monitors. Properly installed HTSI systems can provide early detection of mechanical unbalance, electrical unbalance, misalignment, guide and thrust bearing failures, wicket gate and shear pin problems.

HTSI monitoring points

Selection and proper placement of HTSI transducers are critical to an effective monitoring program. **Figs. 1** and **2** represent the basic styles of hydro turbines, but there can be many variations. The most common measurement locations are for radial vibration (usually two per bearing) and axial thrust position transducers for Francis and Kaplan type turbines. Other HTSI transducers include bearing temperature and multiple event/revolution tachometer (used for speed and zero speed indication).

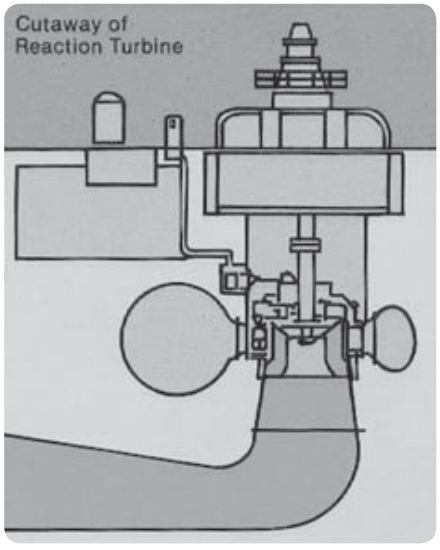

Fig. 1. Reaction turbine.

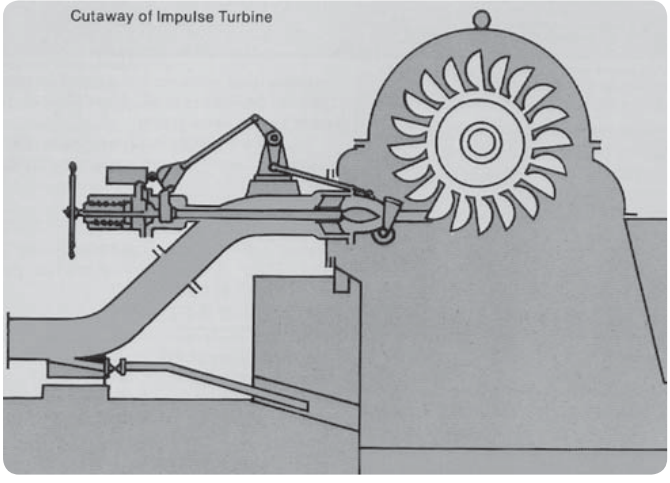

Fig. 2. Impulse turbine.

M800A HTSI modules

Vibration, thrust and speed

These three measurements are critical to an effective HTSI system. Radial vibration can be detected at the hydroelectric turbine guide bearing(s). Typical running speeds of hydroelectric turbines are from 60 to 600 r/min depending on turbine size and mounting position (horizontal or vertical). The CMMA 864-DSP is a four channel vibration module that is used with the M800A Programmable Machinery Monitoring and Protection System for measuring radial vibration on hydroelectric turbines. The CMMA 864-DSP low frequency module uses eddy probes for its inputs, which are well suited for monitoring hydroelectric turbine shaft motion and position.

Measuring a hydroelectric turbine's exact axial thrust position (relative position of the thrust runner to the thrust bearing) protects the rotor's critical axial clearances. The CMMA 864-DSP is a four channel thrust position module that is used with the M800A Programmable Machinery Monitoring and Protection System for measuring axial thrust position on hydroelectric turbines.

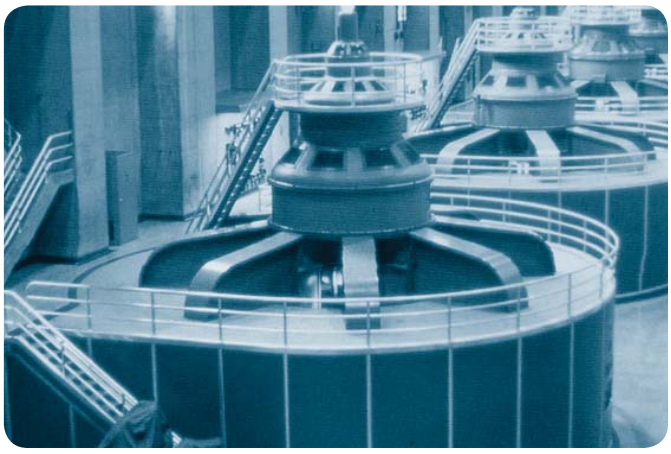

Fig. 3. Turbine generators.

Other related process parameters such as wicket gate position, turbine flow, water flow and load should be monitored to give additional correlation to vibration and position measurements. The CMMA 864-DSP is also a module that accepts process variables in the form of 0 to 10 V or 4 to 20 mA DC signals.

An eddy probe transducer can be installed to observe a keyway or notch to provide a once per revolution event from the hydroelectric turbine shaft. This event can be used to indicate turbine speed or provide a reference mark for phase angle and frequency measurements that are vital for performing diagnostics.

Hydroelectric turbine start-up or coast down rates are dependent on turbine metal temperatures, wicket gate position, etc. Maintaining the turbine at the maximum permissible start-up or coast down rates while providing a smooth transition from various wicket gate positions and load changes provides optimum compromise between machine safety and operating costs.

The Rate of Change of Speed Monitor indicates start-up or coast-down rates in r/min and will alarm if the maximum permissible rate is exceeded. This measurement requires no additional transducers.

- CMMA 881-00-10-01 Speed Monitor Module, r/min, rate of change, zero speed or peak hold

Temperature

This measurement is recommended for hydroelectric generator bearing metal temperatures and lube oil temperatures.

- CMMA 871-00-10 Temperature Module

MIM (Monitor Interface Module) and PRISM⁴ on-line software

Critical hydroelectric turbine monitoring

To extend the benefits of proactive maintenance to critical machinery, the Monitor Interface Module (MIM) can be used in conjunction with the M800A to acquire valuable single and dual channel buffered data. With PRISM⁴ on-line, viewing orbits (filtered and unfiltered), shaft centerline, Smax plots and more make diagnosing hydroelectric turbine problems clearer and easier.

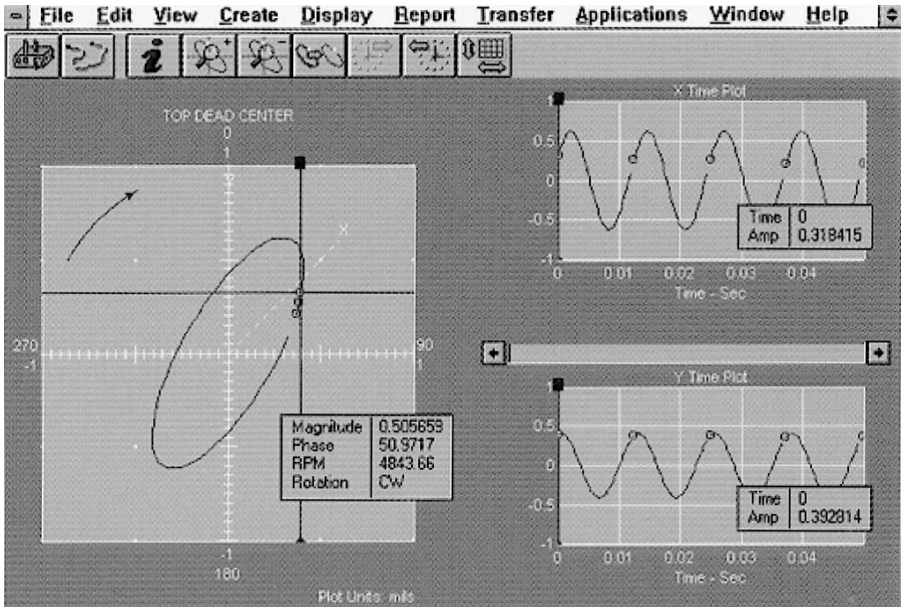

Fig. 4. Orbit plot.

SKF diagnostic hardware/software offerings

- **CMMA 162:** Monitor Interface Module (MIM)
- **CMSS 104-03:** Cable harness assemble, 3 m *(9.8 ft.)*
- **CMS 100:** PRISM⁴ for Windows Software
- **CMS 150:** PRISM⁴ for Windows/on-line software
- **CMMA 30058B:** LAN card

Training and support

SKF offers a comprehensive range of customer support courses to assist you in implementing and realizing full benefit from your predictive maintenance program.

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