Monitoring Systems for Hydroelectric Performance Improvement

Accusonic Technologies specializes in the design, development, and manufacture of hydro-monitoring systems for performance measurement and control applications at hydroelectric facilities, including:

- **High-Accuracy On-Line Flow/Discharge Monitoring**
- **Turbine Efficiency Measurement and Monitoring**
- **Penstock Leak Detection and Failure Monitoring**
- **Multi-Unit Turbine Flow/Efficiency Monitoring**

High-Accuracy Flow Monitoring

Accusonic flowmeters use the multiple-path acoustic transit-time technique to measure average flow velocity at several elevations across a pipe or open-channel flow. The measured velocities are numerically integrated over the flow cross-section to determine flowrate. For open-channel flow, simultaneous water level data is used to determine the flow cross-section area.

By using multiple acoustic paths to resolve the flow velocity profile, flowrate measurement accuracy is maintained over a wide range of hydraulic operating conditions. Typical flowrate accuracy achievable using a 4-path flowmeter configuration is within ± 0.5% of actual flow. Open-channel flowrate accuracy with a 4-path configuration is within ± 2%.

Symmetrically crossed acoustic paths can be used to maintain flowrate accuracy under difficult flow measurement conditions caused by upstream bends or other non-ideal hydraulic conditions. Multiple crossed-path configurations have been effective for flow monitoring in the intakes of low-head hydroelectric units, providing flowrate accuracy within ± 2% of actual.

Significant advantages provided by Accusonic flowmeters for use at hydroelectric plants include:

- Superior flowrate measurement accuracy
- Continuous unit flowrate and totalized plant discharge
- No head loss
- No re-calibration requirements
- Multiple-unit flow monitoring

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Turbine Efficiency Monitoring

Accusonic's **Model 7530 Flow/Efficiency Monitoring System** is designed for direct, on-line monitoring of unit "water-to-wire" generating efficiency. This includes multiple-unit data acquisition, specialized software, and analog inputs for the auxiliary sensors required for measuring water-to-wire efficiency. Continuous unit monitoring with the Model 7530 establishes a historical on-line database that can be used for determining ***Historical Best***™ gate settings to improve total plant output. Unit flowrates and efficiencies can be output via analog channels or RS-232 serial digital interface.
The **Model 7432 Turbine Efficiency Monitoring System (TEMS)** is used in conjunction with separate unit flowmeters, including Accusonic flowmeter models for absolute flow-based turbine efficiency measurements, or with differential pressure sensors for Winter-Kennedy or other types of relative discharge monitors used for unit indexing. In addition to continuous multiple-unit monitoring, the TEMS can be used for periodic hydroturbine unit evaluation or acceptance tests.

Penstock Leak Detection and Failure Monitoring

Penstock leak detection is accomplished by continuous comparison of flowrates measured at opposite ends of the penstock. The upper and lower flowmeters are linked via serial digital communications, with one unit configured with specialized software to carry out flow difference comparison/leak detection functions and initiate programmable warning and alarm functions should a leak be detected. While the leak detection system must be sensitive enough to detect a leak, it must also be designed to minimize the possibility of false alarm trips that can arise from transient flow conditions due to operational load changes.

Leak detection software utilizes site-specific signal averaging for measured flowrates and flowrate differences and programmable warning and alarm threshold values. When the averaged flow difference exceeds the first programmed threshold, a warning relay is closed; surpassing the second threshold will result in alarm relay activation. In addition to flow differential-based warnings and alarms, Accusonic leak detection systems also provide warning and alarm conditions based on programmable over-velocity and over-flowrate thresholds. Extreme velocities and flowrates associated with a large magnitude penstock failure can be used to initiate an alarm even in cases where a rupture causes acoustic paths to cease operating and the flowmeter is unable to measure flowrate in one or more penstock sections.