Hydroelectric Generator Maintenance
using the ZonicBook™

Energy

Application Note #58

It's hard to beat Mother Nature when it comes to maximizing efficiency in performing any task from creating soap bubbles to extraordinary plants that adapt and survive their environment under extreme, adverse conditions. The same idea of efficiency holds true for producing the electricity the North American continent consumes in sustaining manufacturing and a high quality of life. In spite of the effort expended to deploy nuclear power plants over the past 50 years, the Pacific Northwest still produces 90% of its needs with water-powered hydro generators. They were among the first machines to supply our nation's electrical requirements during the 1800s, and some, almost one hundred years later, are still operating. Today, they require special attention to continue running trouble-free.

Application Summary

BC Hydro, Bridge River Generation Area, British Columbia, Canada, for example, still maintains hydro generators that were installed as early as 1926. Excessive vibration, generated by any number of sources, is one of the most critical parameters that can bring a generator down, whether old or new. Vibrations must be detected in some way long before operators can hear them. By the time they are audible, the damage has been done.

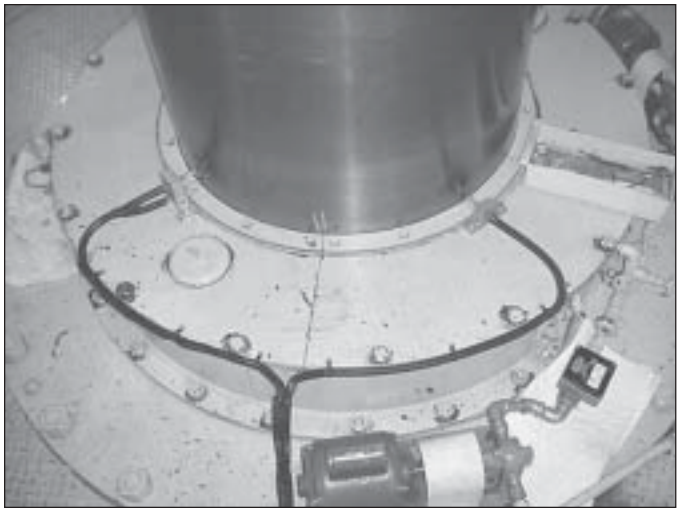
Excessive vibrations frequently come from worn bearings or instability in the bearings, cavitations in the turbine, and rough load zones. Detecting the noise from worn bearings is relatively easy for experts who can recognize anomalies in an acquired vibration wave shape. Displacement transducers mounted on the bearings provide clues in a signal signature that lets the maintenance engineers take action before a catastrophic failure.

Rough loads are caused by cavitations in the turbine, normally localized phenomena, and depend upon the shape and condition of the turbine blades as well as the intake and discharge head. Cavitations often start in the draft tube downstream of the turbine impeller, and the noise it creates can be heard, but it does not necessarily damage the impeller. As the load on the turbine changes, the cavitation zone may progress upstream until it does affect the turbine blades. This changes the vibration signature of the turbine shaft, but it is not the vibration that causes the damage, it's the cavitation itself.

Because the rough load zones change depending on the head and discharge pressures, they have to be re-evaluated fairly frequently. The head and discharge pressures depend on the reservoir elevation, and regulating the speed that it drops often relieves the hazard. But ultimate control still depends on the amount of water entering the system.

Possible Solutions

Several years ago, hydro-generator maintenance engineers at BC Hydro had installed large, computerized monitor panels to watch over the health of the systems, but the equipment has some serious shortcomings. They are not portable, and they lack a means of capturing wave shapes sufficient for analysis beyond a simple rms signal. Says Gary Jarl, Senior Maintenance Engineer, "We have several of the most widely used vibration monitoring panels available, but they strictly give us an overall vibration reading. They provide no spectrum, waveform, or anything else to analyze."



Many of BC Hydro's machines have permanent Eddy-current displacement probes installed to measure vibration. The displacement probes, with an output of 200 mV/mil, are used instead of accelerometers. The machines run around 300 rpm, speeds that are not very effective for accelerometers.

IOtech, Inc. ▲ 25971 Cannon Road ▲ Cleveland, Ohio 44146 ▲ (440) 439-4091 ▲ Fax (440) 439-4093

the smart approach to instrumentation™

IOtech's Solution

These drawbacks drove Jarl to evaluate alternative data acquisition systems based on cost and capability, and he selected the IOtech ZonicBook™ with eZ-TOMAS™ software. "I wanted something reliable, fairly easy to use, with a lot of flexibility. I have a lot of experience monitoring vibration with on-line systems, so it's a little hard to put into words exactly what I was looking for, but I knew what it was when I found it," says Jarl.

The ZonicBook is easy to set up and easy to use. For example, Jarl gave a young engineer a brief rundown on the ZonicBook, and within a couple of weeks she was extracting meaningful data and arrived at some excellent conclusions. "A lot of systems are available, but not like the IOtech. Many of the others require expert operators," says Jarl.

BC Hydro has had the one ZonicBook for about two years. Jarl uses it for continuously monitoring the generators and trouble shooting failures. He would like to have one hooked up all the time. That's why he recently bought a second one. One will be available as a trouble-shooting tool, and the other will be used for long term monitoring. Part of the reason he is evaluating the ZonicBook is to justify permanently instrumenting all 29 machines at some point. "Now," says Jarl, "I move the one ZonicBook around to various generators, where we suspect a problem, or where we made changes, just to get a baseline."

Conclusion

An IOtech ZonicBook is helping Senior Maintenance Engineer, Gary Jarl, maintain 29 hydro generators, ranging from 10 to 75 MW, that supply power to the Pacific Northwest, including British Columbia, California, and Alberta. He sets up preventive maintenance programs and uses a ZonicBook to troubleshoot problems and measure turbine shaft vibrations. Occasionally the ZonicBook is installed at one site for an extended time to log vibration data on a suspected turbine shaft, but more often, Jarl takes it from one site to another during his regular travel schedule.

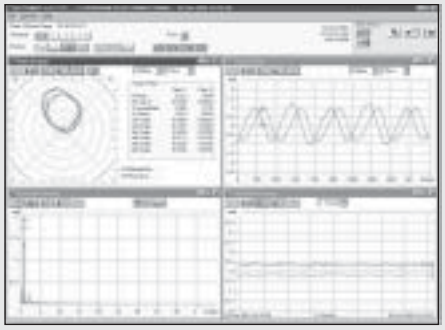
ZonicBook

The ZonicBook™ allows you to record, playback, analyze, and archive vibration or acoustic data in both time and frequency domain. ZonicBook provides real-time display of up to 16 channels, including real-time FFT displays. Other PC-based vibration analyzers record only frequency-domain information, making it impossible to play back time-domain waveforms and perform post-acquisition analysis.

Features

- Perform vibration measurements and real-time analysis with this portable, integrated hardware and software solution
- View real-time frequency-domain and/or time-domain data while streaming gapless data to your PC's memory and hard drive
- Replay acquired data for post-acquisition annotation, peak labeling, and easy generation of professional looking reports
- Export acquired data in a variety of report formats for further analysis and report generation
- Available in either 4-, 8-, or 16-channel configurations
- One 16-bit Sigma Delta A/D per channel provides low-noise, linear phase measurements
- 51.2 kHz max sampling per channel
- All input channels are sampled simultaneously for excellent phase matching
- Analysis frequency:
  4- & 8-channel, DC to 20 kHz
  16-channel, DC to 10 kHz
- 92 dB stop-band filter per channel
- Inputs are isolated from ground and PC to eliminate ground loops
- Includes high-speed PC-Card (PCMCIA) interface to notebook or desktop PC's
- DBK70 vehicle bus option (J1850 VPW, J1850 PWM, J1939, ISO-9141, CAN) enables simultaneous measurement of vehicle bus parameters along with vibration measurements
- Powerable from AC line or 12 VDC for in-vehicle applications
- Optional battery module for portable applications
- Operates under Windows®

Optional eZ-TOMAS™ Software



- Continuously monitor up to 16 channels of inputs
- Attach accelerometers, tachometers, proximity probes, and other sensors directly to the ZonicBook™
- Use with notebook PCs for portable applications
- Designate up to three channels as tachometer inputs
- Define up to 10 spectral bands per channel, per tachometer reference
- Automatically set limits and define alarm conditions based on historical spectral levels
- Store statistically significant data based on transient or alarm conditions
- View vibration data from anywhere using your networked computers
- Save and recall your specific vibration reports

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