HYDROPOWER SERVICES

- Inflow Monitoring for Short Term Scheduling
- High Hazard Dam Warning Systems
- Water Use Optimization
- Input to Real-Time Models
- Inflow/Outflow Monitoring Systems
- Compliance Monitoring
- Instream Flow Requirements
- Ramp Rates
- Water Rights Monitoring
- Water Quality Monitoring
- Gate Control
- Geotechnical Monitoring Systems

HYDROPOWER CUSTOMERS

PacifiCorp   Florida Power & Light
TVA    PG&E
Northeast Utilities   Southern California Edison
Millineum Power   Bureau of Reclamation H
Hatfield Hydro   Thunder Bay Power
So. New Hampshire Power   Consumer Power
US Army Corps of Engineers   American Power
Reliant Energy   Niagara Mohawk
Grant County, WA PUD   EWEB

PACIFICORP - CASE STUDY

NORTH UMPQUA HYDROELECTRIC PROJECT, FERC PROJECT NO. 1927

Compliance with Oregon Water Resources Department (OWRD) licensing regulations by monitoring flow in the network of canals withdrawing water from the North Umpqua River and its tributaries near Toketee Lake. As one of the lowest-cost hydropower producers in the U.S., PacifiCorp generates 8,000 megawatts of energy for nearly 1.5 million customers in the Pacific Northwest. On July 19th of 2000 PacifiCorp agreed to monitor flow in the network of canals withdrawing water from the North Umpqua River and its tributaries near Toketee Lake to assure water rights compliance.

Sutron received contracts for the fi rst two phases of the project. The contract for the fi rst phase, valued at $200,412, was completed in 2001.

The contract for the second phase of the project, valued at over $369,500, was awarded to Sutron in July 2002 (included with July 2002 bookings) to be completed by October 31, 2002. The contract for the third phase of the project, which will include real-time telemetry for all existing gauging stations, is expected in 2004.

In the fi rst phase a set of four stream gauging stations were established on the main canals supplying water for generation. In the second phase an additional 15 monitoring stations will be added on the natural stream reaches adjacent to the canals and on the penstocks that feed the project generators. Data from all the sites will be brought to PacifiCorp’s Toketee Control Center where it will be available to system operators.
The system will produce daily water usage reports and compare water usage to minimum and maximum allowable flows.

The turnkey system is designed, built, installed, supported and maintained by Sutron. Sutron also provides Pacifi Corp with the following:

- Hydrologic engineering services, stream gauging, installation of staff gauges, all data logging instrumentation and equipment, gauge houses
- Data reporting software and training of PacifiCorp employees for maintenance and operation.

REQUIREMENTS

In 2000, PacifiCorp met with Oregon Water Resources Department (OWRD) representatives at the Toketee Control Center to review PacifiCorp’s schedule for bringing the North Umpqua Project into compliance with operating licenses that specify maximum diversion from each natural stream as well as minimum flows to be maintained in bypass reaches (natural streams) below project diversions. The resulting agreement stipulated installation of a gaging system to account for all project diversions and bypass flows. Discharge data from the canal gaging system and penstock flowmeters was to be reported to the District 15 Watermaster’s Office in Roseburg, Oregon, on a daily basis. Flow information from bypass reaches will be reported daily beginning in 2002.

The resulting project has two phases. Phase I provides for monitoring flows in canals (by datalogger) and penstocks (by ultrasonic flowmeters). Reports will be generated by operators who acquire data from the logger network and the penstock flowmeters. Phase 2, completed by October 31st of 2002, will add monitoring of bypass reaches and bring all of the data to the Toketee Control Center by means of a radio network. A computer system will allow operators to monitor flows in real-time and will automate report generation for OWRD. OWRD requirements:

- Gages will meet applicable United States Geological Survey (USGS) standards.
- Rating tables for each gage will be developed from current meter measurements over the range of expected canal flows.
- Each rating will be verified annually to ensure accuracy
- Discharge data from the canal gaging system and penstock flowmeters will be reported to the District 15 Watermaster daily beginning in 2001.
- Flow information from bypass reach USGS gages will also be reported daily beginning in 2002.

THE PROBLEM

Because the area is mountainous with canal and river sites scattered over a 100 square miles, flow monitoring for North Umpqua presents challenges.
### THE SOLUTION – PHASE 1

Monitoring canal and river flows requires sophisticated expertise so PacifiCorp asked the U.S. Geological Survey to recommend a vendor. Sutron Corporation, a designer/manufacturer/installer of turnkey remote monitoring systems, was recommended. Sutron and PacifiCorp agreed to focus on canal sites in 2001 (Phase I) and completion of the entire system by October of 2002. ODWR Phase I requirements will be met by placing permanent gaging stations near the downstream ends of major canals, using data loggers (without telemetry) that read flow directly by determining the relationship between flow depth and discharge rate and that store flow data. Real-time flow data requires a communications network. PacifiCorp has in place a variety of hard-wire and fiber optic links and has conducted experiments with line-of-site radio. PacifiCorp’s access rights to an existing radio repeater site at Cinnamon Butte to the east of the project area will be an integral part of the solution. A complete radio path survey to facilitate design of the communications network for Phase 2 was completed in September, 2001.

<table>
<thead>
<tr>
<th>STATION</th>
<th>TIME</th>
<th>STAGE (ft)</th>
<th>FLOW (cfs)</th>
<th>WATER RIGHT (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemolo 1 Canal @ POV</td>
<td>08:02</td>
<td>3.66</td>
<td>143.5</td>
<td>565</td>
</tr>
<tr>
<td>Lemolo 1 Bypass</td>
<td>08:02</td>
<td>1.14</td>
<td>13.6</td>
<td>25 min</td>
</tr>
<tr>
<td>Lemolo 2 Canal @ Forebay</td>
<td>07:30</td>
<td>3.02</td>
<td>343.0</td>
<td>655</td>
</tr>
<tr>
<td>Lemolo 2 Bypass</td>
<td>08:00</td>
<td>1.65</td>
<td>23.9</td>
<td>25 min</td>
</tr>
<tr>
<td>Clearwater 1 Canal @ Forebay</td>
<td>08:05</td>
<td>4.15</td>
<td>228.6</td>
<td>200</td>
</tr>
<tr>
<td>Clearwater 1 Bypass</td>
<td>08:05</td>
<td>0.84</td>
<td>36.3</td>
<td>5 min</td>
</tr>
<tr>
<td>Clearwater 2 Canal @ Forebay</td>
<td>08:05</td>
<td>4.15</td>
<td>228.6</td>
<td>440</td>
</tr>
<tr>
<td>Clearwater 2 Bypass</td>
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<td>0.84</td>
<td>36.3</td>
<td>5 min</td>
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<td>6.39</td>
<td>147.9</td>
<td>1000</td>
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<tr>
<td>Slide Creek Bypass</td>
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<td>2.43</td>
<td>79.6</td>
<td>25 min</td>
</tr>
<tr>
<td>Fish Creek Canal @ Forebay</td>
<td>08:07</td>
<td>3.65</td>
<td>100.3</td>
<td>150</td>
</tr>
<tr>
<td>Fish Creek Bypass</td>
<td>08:08</td>
<td>1.14</td>
<td>36.3</td>
<td>20 Apr. 1 to Labor day, 10 Labor day through Mar. 31</td>
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<td>08:00</td>
<td>n.a.</td>
<td>32.0</td>
<td>n.a.</td>
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<tr>
<td>Tule Lake Penstock 2</td>
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<td>n.a.</td>
<td>63.4</td>
<td>n.a.</td>
</tr>
<tr>
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<td>08:00</td>
<td>n.a.</td>
<td>69.9</td>
<td>n.a.</td>
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<td>n.a.</td>
<td>235.3</td>
<td>1425</td>
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<td>0.84</td>
<td>166.45</td>
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<td>355.8</td>
<td>1800</td>
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<td>08:00</td>
<td>4.31</td>
<td>456.8</td>
<td>25/17 ODFW off-on</td>
</tr>
</tbody>
</table>
THE SOLUTION – PHASE 2

The Phase 1 monitoring system was in place by October 31, 2001 and the communications path survey to determine the exact combination of radios, repeaters, and other links needed to bring data back to the Control Center is finished. Next, the final communications system including data loggers and communications for the bypass reach sites will be implemented. The penstock flow meters will also be integrated into the telemetry network.

When the entire computer system and software have been incorporated, operators will access a computer that stores canal and stream gage ratings which are easily updated if changes are indicated by the stream gaging program. Ratings will be used in real-time to convert the telemetered stream and canal stages to flow. Values of the stage readings and the flows will be stored in a relational database that limits storage time for telemetered stage values and computed flows to 6 months.

There will also be a process that automatically generates OWRD flow reports containing tables showing site-specific stage and flow measurements at a mutually-agreed-upon time of day and that stores this data on the system hard drive. A graphical man-machine interface (MMI) will aid operators in station setup and interpreting data. Trained personnel will use the MMI to change station characteristics as well as add or remove stations.

The primary operator display will resemble a spreadsheet that contains a list of system gaging points and the current stage and flow. The display will update in real time.

The table will update every 15 minutes (interval set by agreement with OWRD). Stations whose report times are more than 20 minutes old will be marked by yellowed time panels. Stations whose report times are more than 1 hour and 10 minutes old will be marked by red time panels. Yellow and red marked time panels alert the operator to any problems with telemetry.

The table will also provide water right and low flow alerts. When flow exceeds the water right for the site, the flow value will be changed to blinking red and the amount of the alert will be presented in a separate “alert” window at the bottom of the table. Similarly, the system will warn if the flow drops below the specified minimum. The design will allow for multiple alerts (alerts at more than one site.)

SUMMARY AND CONCLUSIONS

PacifiCorp’s real-time flow monitoring network will allow project operators to view the flow in system canals, bypass reaches and penstocks in real time as well as alert them when any violation of minimum flow requirements or water rights takes place. The system will use line-of-sight radio, fiber optic, and hard-wire communications technologies, data loggers, streamgaging stations, and ultrasonic flowmeters. It will save about four person-hours per day and greatly shorten response time to any flow change situation.
USE OF GOES SATELLITE TRANSMISSIONS IN DAM MONITORING

By: Thomas N. Keefer
Vice President, Special Projects,
Sutron Corporation, Sterling, Virginia

Abstract

Information on piezometer levels and other geotechnical parameters has traditionally been collected by hand or by ground-based radio or hard-wire telemetry systems. Sutron Corporation has worked with the New England District, US Army Corps of Engineers (NAE) to develop alternative telemetry networks combining line-of-site radio, hard-wire, and GOES (Geostationary Operational Environmental Satellite) messaging.

NAE has responsibility for 31 flood control dams in Connecticut, Massachusetts, New Hampshire and Vermont. These dams control flood runoff in four major river basins in these states. All USACE dams are required to have a level of instrumentation that enables proper monitoring and evaluation of the structure under all operating conditions.

Geotechnical instrumentation at NAE dams consists of piezometers, seismic strong motion instruments, crest survey monuments, tilt plates, inclinometers, and other instruments as deemed necessary to adequately monitor embankment performance. Automated instrumentation systems are currently being installed at each dam to collect and transmit data from the piezometers, seepage measurement devices, pool level sensors and strong motion instruments to the NAE District office. These systems will improve the early warning of potentially critical embankment performance parameters. The GOES satellite system is a key part of the telemetry.

System installations consist of two types:

- Upgrades to existing hard-wired systems
- New, automated wireless systems.

The master data collection station at each site is a programmable data logger. Sutron developed custom software for the loggers to support the necessary multiplexing equipment.

Automated data is sent from the master stations at each site via network modems and/or GOES transmissions. Data is decoded and streamed into an Oracle database, with automated tabular, graphical, and visual Dam Safety output products posted on the web.

The upgrades to the hard-wired systems consist of data logger and telemetry upgrades using existing vibrating-wire piezometers. The upgrades have the advantage of requiring only a single data logger with a multiplexer and wiring to each piezometer. The disadvantage is a greater incidence of lightning damage to equipment, vs. having more data loggers to maintain at wireless field stations. The new automated wireless systems at NAE are field stations with solar power and battery backup. These systems employ pressure transducers utilizing 4-20 ma output.

BACKGROUND

New England District of the US Army Corps of Engineers (NAE) was a pioneer in adopting the Geostationary Operational Environmental Satellite (GOES) system for hydromet operations. NAE was one of the first districts to purchase a Direct-readout ground station for GOES in the late 1970s. The GOES system is a worldwide network of geostationary satellites parked in fixed positions over the equator. The satellites, primarily used for hurricane tracking and other weather-related activities, are also equipped with a data collection system (DCS) link. The DCS link allows licensed users to transmit environmental data through the GOES network to their own ground stations or to the central GOES ground station operated by the National Oceanic and Atmospheric Administration’s (NOAA’s) National Satellite Data Information Service (NESDIS) at Wallops Island, Virginia. The original GOES DCS link limited users to 100 bits per second (bps) data through assigned
one-minute windows every four hours. Additional emergency data could be sent through two dedicated “random” channels by any user with no assigned time windows. The system has been improved over the years so that users can now transmit 300 bps data through 10-second windows every hour. The availability of hourly data has greatly increased the utility of the system. Hourly data is adequate for daily operations on many larger river systems.

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PURPOSE AND SCOPE

The purpose of this paper is to describe the techniques used by NAE to transmit geotechnical data through the GOES system.

The paper covers:
- Hardware issues related to collecting data at the dams
- Software issues related to data collection and GOES message creation

COLLECTING DATA AT THE DAMS

PIEZOMETER NETWORKS AND GOES

A key element of earth-fill dam performance monitoring is an installed piezometer network. The purpose of the piezometer network is to allow the operating agency to monitor the piezometric surface within the toe embankment to ensure that the surface remains within the embankment and that piping does not occur.

The piezometer network is often installed during construction. Fifteen to thirty or more pressure transducers — typically based on vibrating wire technology — are buried in the embankment or suspended in small diameter bore holes within the embankment. The transducer cables can be terminated in individual locations at the borehole, or, in some instances all extended to a central location and terminated in a junction box. Piezometer levels are not expected to change rapidly. Rapid change is exactly what is NOT expected. Thus the reading of the piezometer levels has traditionally been done by manual methods. A “readout box” can be attached to an individual sensor, or the box can be attached to a switch in the central junction box. Readings are then taken manually and recorded so that piezometric surface plots can be created.

The nature of the piezometer networks presents the greatest challenge in using GOES as a telemetry method. Virtually all NAE dams are equipped with GOES telemetry. Typical dams transmit the pool elevation and outlet discharge. GOES is used at streamgaging stations to transmit river stage and compute inflow discharges. Many sites are equipped with rain gages and other weather instrumentation. The traditional instruments used to make these measurements provide zero to five-volt DC outputs, switch closure outputs, and other standard outputs that are compatible with the telemetry devices used for GOES. The GOES telemetry devices, called Data Collection Platforms (DCPs) can automatically take readings from any of the common hydrologic instruments used for pool elevation, stream stage, and weather. Most DCPs do NOT incorporate the technology required to take readings from vibrating wire piezometers. The manufacturers of vibrating wire equipment usually use proprietary techniques to make pressure measurements, and provide proprietary readout boxes for use in making manual measurements. In addition, most DCPs are not designed for large numbers of inputs of one type. The limited bandwidth of the GOES system (300 bps and 10 seconds of time per transmission) means that most DCPs are designed with limits such as 8 analog sensors or some other fairly low limit. Special hardware and software techniques are required to read a vibrating wire network and incorporate the information into GOES transmissions.

A secondary issue related to the use of GOES is costs. A single GOES DCP, along with the associated enclosure, antenna, solar panel or AC power supply, and battery can cost as much as $4,000. It is thus not practical to put individual DCPs at single transducers. Some type of network hardware is required.
SOLVING THE HARDWARE PROBLEM

Three types of hardware problems present themselves:

1. Bringing signals from a large number of individual piezometers to a central location where the DCP is located
2. Interfacing the large number of sensor signals to a typical DCP that is not designed for large numbers of one type of input
3. Interfacing vibrating wire sensors to a typical DCP

The first problem, that of bringing the piezometer levels to a central location, is a function of the age of the dam being monitored. Older dams are equipped with vibrating wire sensors that are already wired to central locations. These older sites offer mixed benefits.

The wiring problem is already solved, but the long wires are often buried in shallow trenches and make excellent lightning antennas. Nearby lightning strikes can generate surge voltages in the signal cables. The surges are easily capable of burning out individual signal channels, or in some instances burning up complete data loggers and associated equipment.

Sites with individual sensors terminated at the top of bore holes offer a different challenge. Extending wires to each site is not desirable because of the lightning problem.

Fiber optic links are feasible, but extending trenches over the toe embankment can be problematic. Depending on what type of surface material is present, the slope, and other factors. The method chosen by NAE is to make use of low-cost ($300 to $500), license-free, spread-spectrum radio modules. These modules can be placed in small housings atop individual bore holes and used to relay the piezometer signal to the central location, thus eliminating wires and most of the lightning-related problems.

The second problem has a dedicated hardware solution. The manufacturers of piezometer equipment offer hardware multiplexers that:

- Allows the user to wire large numbers (usually in increments of 16 – i.e. 16, 32, 48, etc.) of instruments to a single input/output (I/O) board
- Optionally contains the necessary hardware/software required to take readings from a vibrating wire sensor
- Provides the data from the sensor network as either a serial digital output, analog output, or four-to-twenty-milliamp output

The use of a multiplexer requires programming capability within the DCP or the data logger that drives the DCP. The necessary programming is described in the next section.

The third problem, that of reading the signal from vibrating wires, has two solutions. The first solution is to incorporate more dedicated hardware. Multiplexers are available with a module that can “ping” vibrating wires and return the pressure value. The second solution is to make use of pressure transducers that offer standard zero to five volt or four-to-twenty-milliamp outputs that can be read by the DCP.

Figures 1 and 2 illustrate typical solutions for the hardware problems associated with using piezometers with GOES DCPs. Figure 1 illustrates a typical multiplexer solution as used with an existing vibrating wire network connected to a central location. Figure 2 illustrates the general structure of a network that makes use of spread-spectrum radio links to bring the piezometer data to the central location.

Figure 1. – Reading a Network with a Multiplexer
Note in both figures that the device labeled Satlink is the GOES DCP. It is connected to an antenna that is pointed at the GOES satellite. The device labeled XPert is a data logger.

The data logger is required for data storage and to provide the necessary programmability to read the multiplexer and/or poll the individual piezometer sites using the spread-spectrum radios.

**DATA LOGGER, DCP, AND SOFTWARE ISSUES**

GOES DCPs are offered by a number of manufacturers. The type of DCP used must be considered carefully when deciding on which one is appropriate for use with a piezometer network. Two general types of DCPs are offered. The first type is a dedicated “OEM” transmitter. These DCPs typically offer no specific input/output capability. They are designed to be used as a general-purpose output device for any manufacturer’s data logger. These DCPs accept a serial data stream as input and handle the work associated with creating a GOES message and transmitting it on time. The second type is a combined data logger/transmitter. The combined units are capable of reading a variety of inputs—typically a number of analog voltages, a special serial interface called SDI-12, counters, and switches used for tipping bucket rain gauges. Most also offer some type of serial interface. These DCPs can be connected directly to hydrologic instruments. They collect data on a schedule, maintain a log of values, and handle the GOES transmissions. Some offer programming capability so that the user can write special data handling software such as interfaces to serial instruments or custom averaging routines.

The piezometer-monitoring network developed by NAE makes use of programmable data loggers and DCPs. The data loggers are programmable either in BASIC or C++. The programmability made it possible to incorporate the necessary software to schedule data collection on the multiplexer and also to poll data using the spread spectrum radios. The data logger is used to collect data and format the GOES messages. The DCP is used strictly for scheduling and sending the messages.

Two types of multiplexing hardware are used by NAE. One type combines the multiplexer with a module that is capable of reading vibrating wires. The other just uses the multiplexer to read analog or four-to-twenty-milliamp signals from a network of sensors. The multiplexer/vibrating wire combination provides data as serial values from the vibrating wire interface module. The multiplexer by itself provides a four-to-twenty milliamp or analog voltage output. In either case, programming is required. The multiplexer must be controlled by the data logger in both cases. A software module is required that sends “clocking” signals to the multiplexer to tell it which piezometer it is to read. The clocking signal consists of a timed series of zero-to-five volt pulses. Typically one pulse means “read channel one”, two pulses means “read channel two”, and so on.

If the multiplexer is being used alone, then its output will be tied to a single analog or four-to-twenty-milliamp input on the data logger. A software module must be created to tell the data logger which sensor is connected at a particular time, and when and where to log the data. The logger typically “knows” how to take data from the logged values and create a GOES message.

When the vibrating wire interface module is used along with the multiplexer the data enters the logger through a serial port. The same clocking software can be used to set the multiplexer to a data channel. Different software is required to open a serial port and read the data provided by the vibrating wire module. Logging the vibrating wire data and sending the GOES message are the same.
Recall from earlier discussions that the current GOES system supports hourly data transmissions through “windows” ten seconds wide at a data rate of 300 bits per second. The windows present strict limits on the amount of data that can be sent in individual transmissions.

NOAA-NESDIS, the operators of the system, dictate that the content of GOES messages must be formatted in printable ASCII characters. The user is free to chose how data are encoded within the ASCII character set. Some users chose to send readable message, encoding the number 3756.88 as the ASCII characters 2,7,5,6, “dot”, 8, and 8.

Thus this single number requires seven bytes (56 bits) to transmit. Other users make use of data encryption. Numbers are “scaled” and represented by one, two, or three bytes with the restriction that each byte only contain the numbers that correspond to printable ASCII characters. This encryption scheme, referred to as “pseudo-binary” can place many more numbers within a message. The downside is that the numbers are not readily interpreted by eye, and restricting the scaling to the printable ASCII range eliminates approximately one third of the range of numbers that could be sent by using full binary encoding. Pseudo-binary is still considerably more efficient than ASCII encoding.

It is not possible to make use of the entire 10-second window for data. Each message requires “overhead” consisting of a station ID and other required information. In addition, the software and the Wallops Island ground station cannot acquire DCP signals exactly as they begin. At least one, and in most instances two, of the 10 seconds are lost to signal handling issues. The remaining eight seconds provides space for 300 characters (8 seconds times 300 bits per second divided by 8 bits per character). Adequate resolution can usually be achieved by scaling data into two or three bytes. Thus a message can contain 100 to 150 data values, minus 25 to 50 characters of overhead.

A typical dam site might already be sending fifteen-minute data for the pool elevation, the tailwater elevation, and perhaps several gate and/or valve openings. Thus an existing site might already be using up five or six parameters worth of space. Typical 15-minute data would require 4 x 5(# of sensors) x 3 bytes = 60 characters of the available space. This still leaves more-than-adequate room to add 15 or 20 piezometer readings if the data are only collected hourly.
HYDROPOWER PRODUCERS NEED REAL-TIME DATA.
SUTRON DELIVERS.

Environmental concerns, water rights issues, safety requirements, decision support, optimization software…… All require real-time data to provide the greatest benefit to producers.

GETTING THE DATA WHEN YOU NEED IT

Sutron specializes in collecting and delivering remote data in your specified format because it’s not real-time if you have to wait to use it.

Sutron remotes include:
- Low current operation
- Multiple telemetry multi-tasking
- MODBUS, ALERT, SSP and other protocols
- Built in HTTP server
- Alarm and control capabilities

Sutron remotes are used to collect water flow and water quality data from stream, river and canal gauges; reservoir pool, precipitation, and met stations; as well as in flood control systems, piezometer based dam safety systems and much more.

GETTING THE DATA WHERE YOU NEED IT

Sutron manufactures, designs, installs and operates many types of telemetry systems including, Geostationary Satellite, Commercial Satellite, LOS Radio, Modem, and Ethernet Systems.

GETTING THE DATA THE WAY YOU NEED IT

Sutron’s XConnect Software is the solution to getting your data your way. XConnect is a fourth generation hydro-met data collection engine. XConnect and its predecessors are used to collect crucial operational data used to manage complete river systems such as the Colorado in the Western USA and the Mahanadie and Chambal River Basins in India; and individual hydropower projects in the USA and around the world.

XConnect provides data collection, real time calculations, viewing and web posting tools. Its open database architecture and flexible Export options make XConnect the perfect front-end data collection engine for your modeling software.

DATA HOSTING SERVICES - OUTSOURCED DATA COLLECTION

Not ready to implement a data collection network on your own? Sutron can collect, decode, archive and deliver your data to you or post to the web; or install and operate your data collection network.
ROMANIA - MARU DAM & HERCULANE DAM PROJECTS

DELIVERY, INSTALLATION, TRAINING & COMMISSIONING AT FULL FUNCTIONAL CAPACITY OF A WATER LEVEL MONITORING SYSTEM AT MARU DAM AND HERCULANE DAM IN ROMANIA

This project’s objective is the delivery, installation and finishing at full functional capacity of the equipment of measuring the water level at the Maru Dam and Herculane Dam in order to supply on-line water level data at the dam, both locally on the spot and to a distant center.

ETA Automatizari Industriale conducted an assessment at the location of both dams together with the GSM and satellite communications operators. The Geographic coordinates of the 2 locations have been measured in order to find the optimal data communications solutions. GSM signal level measurements have been conducted.

The existing facilities in which the new equipment was installed were assessed for their capabilities to offer cable connection for data transmission and utilities, data transmission to the Central Control Room and wireless transmission to SH Caransebes. The information received from the two points will be transmitted to the computer network in function at SH Caransebes and in a database.

The assembly of the system started at September 8th 2003 and the finishing at the dams was done in full on September 24th 2003. At the same date were done communications tests.

Lake Maru is located 25 miles from Caransebes. The equipment of measuring the water level at the Maru Dam is located on the right side of the dam, and the measuring is done through a metal pipe located inside the drawing-off well of the dam, up-stream connected.

The Lake Herculane is located at 50 miles from Caransebes. The water level measuring equipment at the Herculane Dam is located also on the rightside of the dam, and the measuring is done through a metal pipe located inside the dam.

This system was needed for the prompt evaluation of the water level, for an increased security in functioning and for the accuracy of the data collected and organized in a data base. Was foreseen the future possibility of prediction of the evolution of the water level, coordinated with the optimal working level and efficiency of the hydro-equipment.

In this project, ETA Automatizari Industriale has used sensors from the Swiss company Rittmeyer and dataloggers from the American Company SUTRON – a well known name in telemetry, especially in hydrology. SUTRON is world leader in this field, having built many major projects similar to this one around the world.

OWNER: S.C. Hidroelectrica S.A. 
Subsidiary Hidrocentrale Caransebes
Eng. Claudiu Mircea SUMA
Eng. Daniel FLOREA
Eng. Erich BLENERT
Eng. Alin GHERGHESCU
Silviu HREHORET

PURPOSE: Provide extensive Met System including 100 Automatic Weather Stations and Receive Site to replace existing monitoring and warning system

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Sensors

In the 2 cases with the measuring range of 72 m, and 27 m respectively, for the measuring level was required an accuracy of 1 centimeter. This level of accuracy was accomplished by using submersible pressure sensors with a domain of 20 meters water column (30 psi) and a preciseness of 0,05%. This represents in this domain to 1 cm.

The sensors have a digital communication standardized protocol: SDI-12. This protocol has a public status and it is used by many environmental sensors and dataloggers producers. On a fascicle of wires up to 10 sensors may be connected. The sensors are provided with high tension protection and an anti-humidifier device to prevent condensing on the pressure equalizer tube.

Datalogger

The controller used in this project is made by SUTRON: XLite 9210-0000. This controller is completely programmable, using the Windows CE computing system; has a display LCD, 3 interface serial RS-232 and one RS-485. For interconnecting with the submersible sensors, XLite has an interface SDI-12. On the serial interface 3 is connected the modem GSM MC35 Terminal. The Controller manages the pressure readings at programmed intervals and the data communication through GSM/CSD to the LAN of SH Caransebes. The readings are displayed on site as well on the LCD monitor of 2 x 20 characters.

The communication fascicle of cables SDI-12 allows the installation of the controller at remote distance from the submersible sensors. This distance might be according to the standards of over 70 meters (~ 200 feet). The whole controller has a small electricity (power) consumption, so may get power supply from electric batteries. In this case we used a system with storage buffer battery connected to the power network (220 V), with protection towards random fluctuations.
ROMANIA - MARU DAM & HERCULANE DAM PROJECTS

MARU DAM

HERCULANE DAM

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WIRELESS CONNECTION

In order to acquire the connection with the data loggers we used GSM industrial modems, type Siemens MC35 Terminal. In order to obtain a steadfast communication we used antennas type Sirio SPB-918-10, with good results.

APPLICATION IN LAN SH CARANSEBES

ETA Automatizari Industriala has delivered an application which was installed on the server existing at SH Caransebes head quarters and which makes available to the network the data regarding the water level. Added to that the information will be stored in a data base MS Access or in any other ODBC data base. This application may automatically access the data from dataloggers (in a possibly pre-established time frame).
SYSTEM RUNNING

The SUTRON Datalogger allows easy set-up of the sensors and the programming of the water level measuring intervals. It also offers an algorithm of displaying and transmission of water level, according with the measuring range of each sensor. The results of the measurements are saved in a .log file in the datalogger’s memory. The application from the SH Caransebes head quarter is collecting these data from the datalogger (in a pre-established time frame) and save them in a data base.

ETA Automatizari Industriale is active on Romanian IT market and has experience in designing, developing, and implementing SCADA systems for public utilities industry. More than 200 SCADA systems developed by our company are running the industrial thermal processes of the thermal energy suppliers in the following cities: Timisoara, Cluj-Napoca, Arad, Oradea, Deva, Alba-Iulia, Sannicolau Mare, Pitesti, Iasi (of an ~ total population of over 3,000,000).

Our SCADA solution (based on the OPC standard) have been chosen by S.C. Electrica S.A. FDFFE “Electrica Banat” S.A. for the remote control operation of the re-connectors from SDFFE Timisoara, SDFFE Arad, SDFFE Resita and SDFFE Deva. In this projects our company has used a technological mix in order to ensure the communication: GPRS and trunking radio stations.

ETA Automatizari Industriale has already a good history of cooperation S.C. Hidroelectrica S.A., developing till now two important projects. At the Subsidiary Hidrocentrale Targu Jiu, ETA Automatizari Industriale has supplied a SCADA solution, modern and standardized (using the OPC servers) for the monitoring of 7 hydro-electric power plants. In that project the data communication is done through wireless technology: 2.4 GHz and radio at 430 MHz.

At the Subsidiary Hidrocentrale Caransebes, ETA Automatizari Industriale has implemented the hereby mentioned system of measuring of the water levels at the Maru and Herculane Dams, integrating successfully high accuracy and fiability equipments: Rittmeyer (Switzerland) level sensors and SUTRON (SUA) controllers.

Starting 2002, ETA Automatizari Industriale is the exclusive representative in Romania of the German company EYEVIS GmbH – producer of the systems type video wall for control rooms – and has implemented other important projects in our country. ETA Automatizari Industriale has developed recently couple of important projects in the field of equipment installed at the control rooms at electric power control centers in the country.

Our company has installed video wall systems – data display on wide surfaces, with DLP cubes (Digital Light Processing) for the control rooms of S.C. Hidroelectrica S.A. Subsidiary Hidrocentrale Targu Jiu and S.C. Electrica S.A. F.D.F.E.E. “Electrica Banat” S.A.

Assessing the positive results of our company in the monitoring, tele-reading and remote control operation projects S.C. Hidroelectrica S.A. has granted us the status of agreed supplier. Starting the year 2003, ETA Automatizari Industriale is certified according to quality standard ISO 9001:2000.

Translated By Constantin Barba
In conjunction with the New England District, US Army Corps of Engineers, Sutron has developed two new software input blocks for the XPert Datalogger series. The blocks support several third-party vibrating wire interfaces and multiplexers. An XPert can now act as a stand-alone logger for a network of piezometers, or can act as a concentrator, relaying data to other system XPerts for telemetry back to a central location.

**INTERFACING TO VIBRATING WIRES**

Sutron now offers a family of solutions for connecting vibrating wires to our loggers. XPert blocks are available to support:

- **GEOKON MODEL 8020-51 vibrating wire to voltage converter** (single wire with or without thermistor)
- **CANARY SYSTEMS VW DSP serial vibrating wire interface** (two wires, with or without thermistors)
- **CANARY SYSTEMS MINIMUX** used in conjunction with the VW DSP or 8020-51 for up to 32 wires, or 16 wire/thermistor pairs. The MiniMux can also be used alone for non-vibrating wire sensors. The VW DSP supports multiple MiniMuxes, allowing the user to connect very large wire networks to an XPert.

**YES THEY DO!**
VIBRATING WIRE PIEZOMETERS

CONNECTING TO THE XPERT

The XPert user has a variety of ways to connect families of pressure sensors. The following are just some of the many options available.

SINGLE VIBRATING WIRE, SERIAL INTERFACE

TWO VIBRATING WIRES WITH THERMISTORS, SERIAL INTERFACE

FAMILY OF 16 WIRES, SERIAL INTERFACE
VIBRATING WIRE PIEZOMETERS

FAMILY OF 16 WIRES, ANALOG INTERFACE

FAMILY OF NON-VIBRATING WIRE SENSORS

Mokhtar Souss Dam
Sutron Project, Morocco
Communications Options

Data can be sent from any Xpert Datalogger configuration by any of the following options that Xpert supports:

- LOS Radio
- Dialup or Cellular telephone
- Hard-wire (including serial MODBUS)
- GOES satellite

Concentrators

One of the Xpert’s most powerful features is its ability to act as a cross-device repeater. This allows one Xpert to act as a sensor interface for a large number of sensors and then relay the data to another Xpert for telemetry. One of the many possibilities is illustrated here.