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in this issue

EDITORIAL
6 AFTER ALL THOSE CARROTS, HERE COMES THE STICK

RELAYS
8 ADAPTIVE RELAY SCHEME NETS SAVINGS OF 25 SAIDI IMPACT MINUTES

INNOVATION
14 STUDENTS INVENT DEVICE TO PROTECT WORKERS FROM ARCING DANGER

RENEWABLES
16 REAPING THE WIND: AERISYN EXPANDS TOWER PRODUCTION

DISTRIBUTION
18 DISTRIBUTION AUTOMATION AND DEMAND RESPONSE

DEMAND RESPONSE
24 SMART THERMOSTATS: AVOIDING SURPRISES IN THE COST OF INSTALLATION

UTILITY SPOTLIGHT
26 EPB BUILDING SETS EXAMPLE FOR BETTER ENERGY BEHAVIOR

SUBSTATIONS
30 DIGITAL CONTROL SYSTEMS FOR HIGH-VOLTAGE SUBSTATIONS-PART II

CONFERENCE
36 HISTORIC MEETING SPEARHEADS BATTLE AGAINST COUNTERFEIT GOODS

38 PRODUCTS AND SERVICES SHOWCASE

38 ADVERTISERS INDEX

editorial board

BRUCE CAMPBELL

CHARLIE MACALUSO

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SCOTT ROUSE

DAVID W. MONCUR

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AFTER ALL THOSE CARROTS, HERE COMES THE STICK

By Don Horne

The August blackout of 2003 affected utilities and customers in many ways.

For customers, the power they had taken for granted for decades was suddenly a commodity that could be taken away in the wink of an eye – and a commodity whose value would rise dramatically in the months and years to follow.

For the utilities, it meant deregulation (and in some cases re-regulation), the launching of massive infrastructure and generation projects, and – for good or bad – a much higher profile than ever before.

Suddenly the word "nuclear" was being said again, and today there are dozens of reactors being planned from sea to shining sea.

Federal tax breaks and funding sprang up like wildflowers, encouraging the creation of solar, wind and various related renewable generation technologies.

Designated transmission corridors were quickly approved to bring new conduits of much-needed electricity to the northeast, brushing aside local NIMBYism for the greater good of power-hungry urban centers.

Many carrots appeared to avoid another such blackout. But more recently, a stick in the form of a nationwide order demanding that trees be trimmed is drawing the attention of all utilities.

Now for the first time ever, a utility can be formally sanctioned and penalized for allowing trees to grow into power lines.

And we're not talking a slap on the wrist here.

The first two fines handed out by NERC in June totaled $225,000.

Those fines can go as high as $1 million per day.

The bill requiring tree trimming was passed by Congress in 2005, but it was not until 2007 that it was enforced – providing utilities with a grace period to comply.

Those fines in June were levied for the offending utilities not being "aggressive enough" in their trimming.

It was FirstEnergy in Ohio who was primarily fingered with the blame for the 2003 blackout when transmission lines came into contact with tree limbs (although human and computer error did play a part), spurring the shutdown of 21 power plants in three minutes across the eastern United States and Ontario.

NERC estimates that 90 percent of weather-related outages are caused by trees coming into contact with power lines.

For NERC, the health or aesthetic beauty of the trees near power lines comes in a distant second to maintaining a proper clearance around transmission line conductors.

Historically, crews have never had a shortage of trees and vegetation to trim to maintain hundreds of thousands of miles of power lines. But you can bet that with NERC promising fines of $1 million a day, the trimming has taken on a greater urgency.

And in many cases, resulted in trees being cut down altogether.

FirstEnergy admits that trees that had been trimmed in the past are now removed to ensure reliability of the system.

The fines do not apply to distribution lines, so the hue and cry over a denuding of the landscape hasn't been raised. But there are several homeowners who have cried foul when the local utility began cutting trees to preserve the integrity of transmission lines.

To comply with NERC's directives, Duke Energy's policy included cutting trees that can potentially grow within 20 feet of a transmission line.

In one township outside of Cincinnati, Ohio, the outcry from residents and elected officials forced Duke to temporarily halt the cutting of trees on private property back in June.

The operative word here is "temporarily".

For FirstEnergy, having the stigma of the 2003 blackout hanging over its head, the utility cannot allow another disruption of power because a tree limb has come into contact with a transmission line. That million-dollar-a-day stick carried by NERC will certainly be waved like a magic wand should and when the time comes to remove those trees that were granted a stay of execution.

In a perfect world, we would all have a private gardener to maintain the lawn and shrubbery around our homes – but we simply cannot afford it.

The same applies to utilities like FirstEnergy, who cannot reconcile shelling out thousands and millions annually to trim back trees that could be removed in one fell swoop, and one single payment.

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ADAPTIVE RELAY SCHEME NETS SAVINGS OF 25 SAIDI IMPACT MINUTES

By Richard R. King P.E., Jersey Central Power & Light

Jersey Central Power & Light (JCP&L), a subsidiary of Akron, Ohio-based FirstEnergy Corp., recently initiated a project to identify protection system improvements that could be made to proactively combat wind and lightning related weather events that create sustained power outages. JCP&L determined that these improvements had the potential to improve the System Average Interruption Duration Index (SAIDI) reliability metric by as much as 45 minutes annually.

Like many utilities, JCP&L operates a large installed base of electromechanical (EM) and microprocessor-based protection relays in its substations complemented by line reclosers on its distribution system. JCP&L's 3200-square-mile territory, with 1100 circuits, services 1.1 million customers.

Customer research indicated that reducing the number of momentary outages on blue-sky days drove higher levels of customer satisfaction, while momentary outages during storms generated minimal customer dissatisfaction. With that information, JCP&L set out to devise a protection scheme that limited the number of sustained outages resulting from temporary faults during storms.

One of the first obstacles encountered was the inflexibility of the current system, specifically the limitations of the EM relays installed in JCP&L substations. It was recognized that while each was equipped with two timing curves, delay and instantaneous, these timing options were only selectable locally through dedicated cut off switches wired to the units.

Figure 1. Jersey Central Power & Light's Red Bank Distribution Substation.

NEW SYSTEM CONCEPT

Based on the satisfaction data and recognition of the significant investment of installed EM relays, JCP&L's challenge was to develop a system able to change relay timing settings proactively in response to real-time weather information. A solution was prototyped in early 2006 utilizing a series of relays and intri-

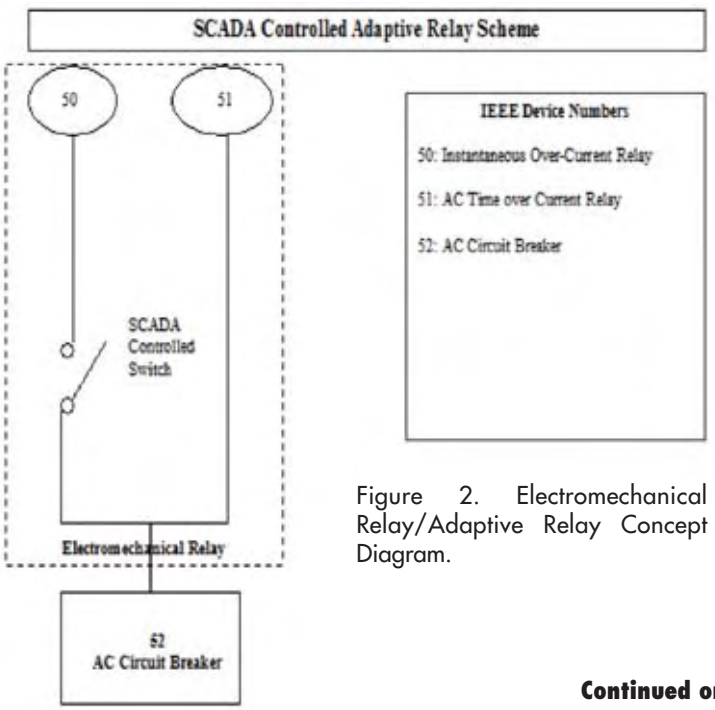

Figure 2. Electromechanical Relay/Adaptive Relay Concept Diagram.

Continued on Page 10

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Continued from Page 8

cate wiring tied into the Supervisory Control And Data Acquisition (SCADA) system. From a schematic perspective the solution was simple and the concept proved to be viable with a projected reduction in SAIDI of 25.1 minutes annually, if deployed system-wide.

The next phase of the project involved finding a commercially available product supported with engineering expertise that met the application requirements. The relay product needs were summarized to include field-tested reliability, SCADA compatibility and feedback capability to confirm operation, a local target display, models available for operation at 48 or 125 volts direct current (DC) and the ability to expand to control more than one breaker installation. Finally, there was the desire for a model that could not only interface to the electromechanical relays, but also to the several different manufacturers' microprocessor-based relays in use on the system in a cost-effective manner. Electroswitch, of Weymouth, Massachusetts, was contacted. After an initial concept meeting, they provided a solution — a variation of a two-position Series 31 Tagging Relay (TR).

Figure 3. The customized Electroswitch Series 31 Tagging Relay chosen by Jersey Central Power & Light.

HOW THE SYSTEM WORKS

JCP&L's Northern and Central Regions, each with its own Regional Dispatch Office (RDO), operate 13 independent districts. Each district has one substation outfitted with SCADA-interfaced wind speed and lightning detection equipment. These systems report to the RDO by exception when measured wind speeds cross a 25 mile per hour threshold or the presence of lighting is detected. Based on these inputs, each region's RDO has the ability to set the protection-timing scheme of each substation individually or by group. The simple actuation of the Electroswitch Series 31 TR via SCADA closes in the instantaneous relay changing their relay-timing scheme to a fuse saving mode.

Fuse saving mode is a protection scheme where a feeder circuit breaker is set to operate in its instantaneous mode, allowing it to operate first and faster than the lateral tap fuses. Data supports that approximately 70 percent of faults are temporary. Having the ability to open the circuit first on a breaker's instantaneous setting and then close it back on a slower time

Figure 4. The mode of the Electroswitch Series 31 Tagging Relay is obvious from a glance at the faceplate.

delayed setting allows most of these types of faults to clear themselves. If the fault is still present after the breaker closes back in on its time delayed setting, the fuse on the effected lateral will blow, requiring a line-crew to replace it. Because most faults are temporary, this fuse-savings scheme prevents a large number of unnecessary fuse operations. When a system is operated in a fuse sacrifice mode, the instantaneous relay trip is disabled and the fuse is always allowed to operate first.

When an RDO operator makes the decision to change relay protection timing in response to inclement weather, a SCADA signal is sent and each selected TR reports back confirming the operation. Locally at the substation, each Electroswitch TR latches in its red mode target to signal that the protection scheme is in storm fuse savings mode. Additionally, the RDO sends a system-wide page to the appropriate managers and operations personnel, alerting them of the system timing change.

Figure 5. Open 3-phase breaker cabinet. The Electroswitch tagging relay at the upper right controls storm settings for the three overcurrent relays to the left.

Once the weather alert has subsided, the RDO sends another SCADA command to the selected TRs to command each

Continued on Page 12

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Continued from Page 10

back to its normal operating mode. An acknowledgment of operation is received, the TR's local mode tag changes from red (storm fuse savings mode) to green (normal time delay mode), and the RDO reissues a system-wide page alerting all that the protection timing is back to its normal, blue-sky, fuse sacrifice mode.

IMPLEMENTATION

JCP&L started the system-wide project implementation in July 2007. It was completed and fully functional in December 2007. Installations were completed at 275 locations which are able to control all 1100 circuits in JCP&L's 13 districts. The installations included the Electroswitch Series 31 TRs, wiring, testing, upgrading of the RDO SCADA software, commissioning and training of management and operations personnel on the Adaptive Relay solution.

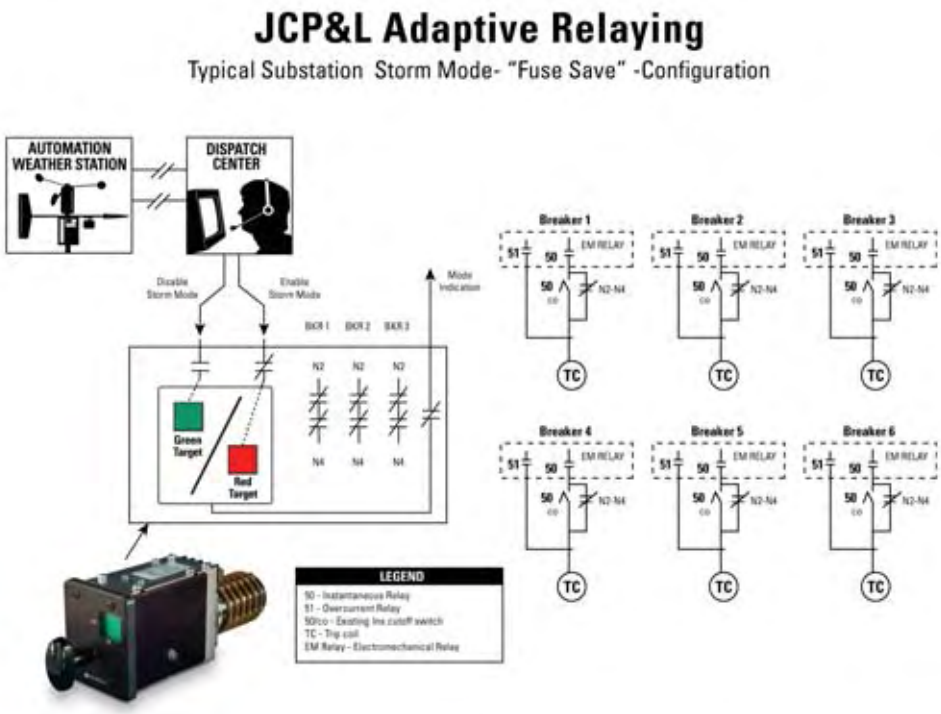

Figure 6. The Electroswitch Tagging Relay provides a local mode tag that is red in storm mode ("fuse save") and green in normal mode ("fuse sacrifice"). The Tagging Relay also provides an acknowledgement to SCADA confirming each operation.

RESULTS TO DATE

Over the first 46 days of operation from December 16, 2007 to January 30, 2008, there were five wind-related instances where the system was operated proactively switching to prepare for inclement weather. During these five storm-mode periods, 100 percent of the 275 Adaptive Relay sites confirmed proper operation, 64 breaker operations were recorded and an estimated 7,546 customers were saved from sustained outages.

The conservatively calculated savings during the period were 2.695 SAIDI minutes — an annualized run rate of 21.4 SAIDI minutes. Results through March 2008 also exceeded the annual SAIDI savings forecast of 25.1 minutes.

JCP&L anticipates additional benefits from this protection timing strategy. Operating in instantaneous mode during storm periods will limit the system's exposure to extended fault current improving the life of station transformers, in-line equipment and distribution lines reducing exposure to conductor burn down.

SUMMARY

With one SAIDI minute saved per $30,000 invested, the six-month project is recognized by JCP&L as a most cost effective SAIDI improvement project.

Richard R. King, P.E., is supervisor of engineering for Jersey Central Power and Light. Responsible for system reliability in the utility's central region, he is a licensed professional engineer in New Jersey, New York, and Pennsylvania.

Figure 7. Jersey Central Power & Light has successfully reduced the number of outages caused by wind and lightning.

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STUDENTS INVENT DEVICE TO PROTECT WORKERS FROM ARCING DANGER

Engineering students at Johns Hopkins have invented a tool that would allow utility workers to disconnect power lines from residential transformers at a safe distance, beyond the range of dangerous electrical arcs.

Their prototype, built at the request of Baltimore Gas & Electric Co., consists of a lightweight aluminum frame that uses rope and a lever-and-pulley system to enable the worker to detach a transformer's power connector, known as a load break elbow. This operation sometimes triggers an explosive arc that can cause serious skin burns and eye injuries. Such arcs can travel as far as 8 feet from the transformer, but the students' device would enable workers to disconnect the line from 10 to 12 feet away.

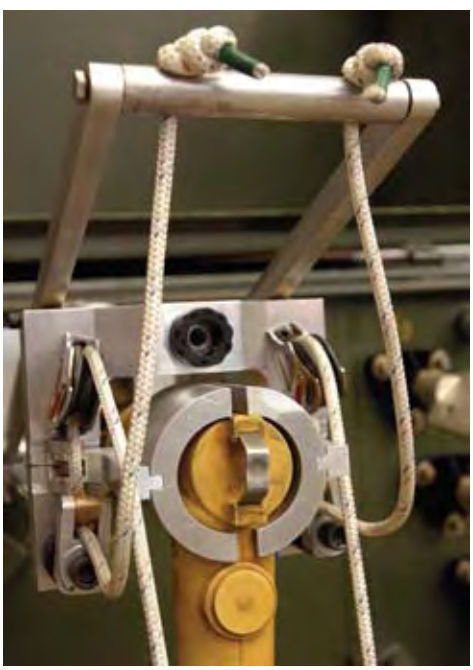
"We're very pleased with the outcome of this project," said Bruce R. Hirsch, a Baltimore Gas & Electric Co. representative who worked with the students. "What they've given us is a good start. It's a very simple design, and they've suggested some further refinements. This device was made to enhance the safety of our people, and that's BGE's top priority."

To acquire the new safety tool, the utility last year turned to Johns Hopkins undergraduates enrolled in the two-semester Engineering Design Project course, offered by the Department of Mechanical Engineering. BGE's project was aimed at protecting technicians who work in the above-ground, pad-mounted transformer boxes commonly found in residential neighborhoods.

Currently, because of the risk of an electrical arc, such workers must wear safety goggles, flame retardant clothing, protective gloves and a hard hat, and must use an 8-foot-long "hot stick" to disconnect lines that typically carry 7,600 volts. BGE asked the students to devise a system that would allow the workers to remove such lines from 10 to 12 feet away, beyond the reach of an explosive arc.

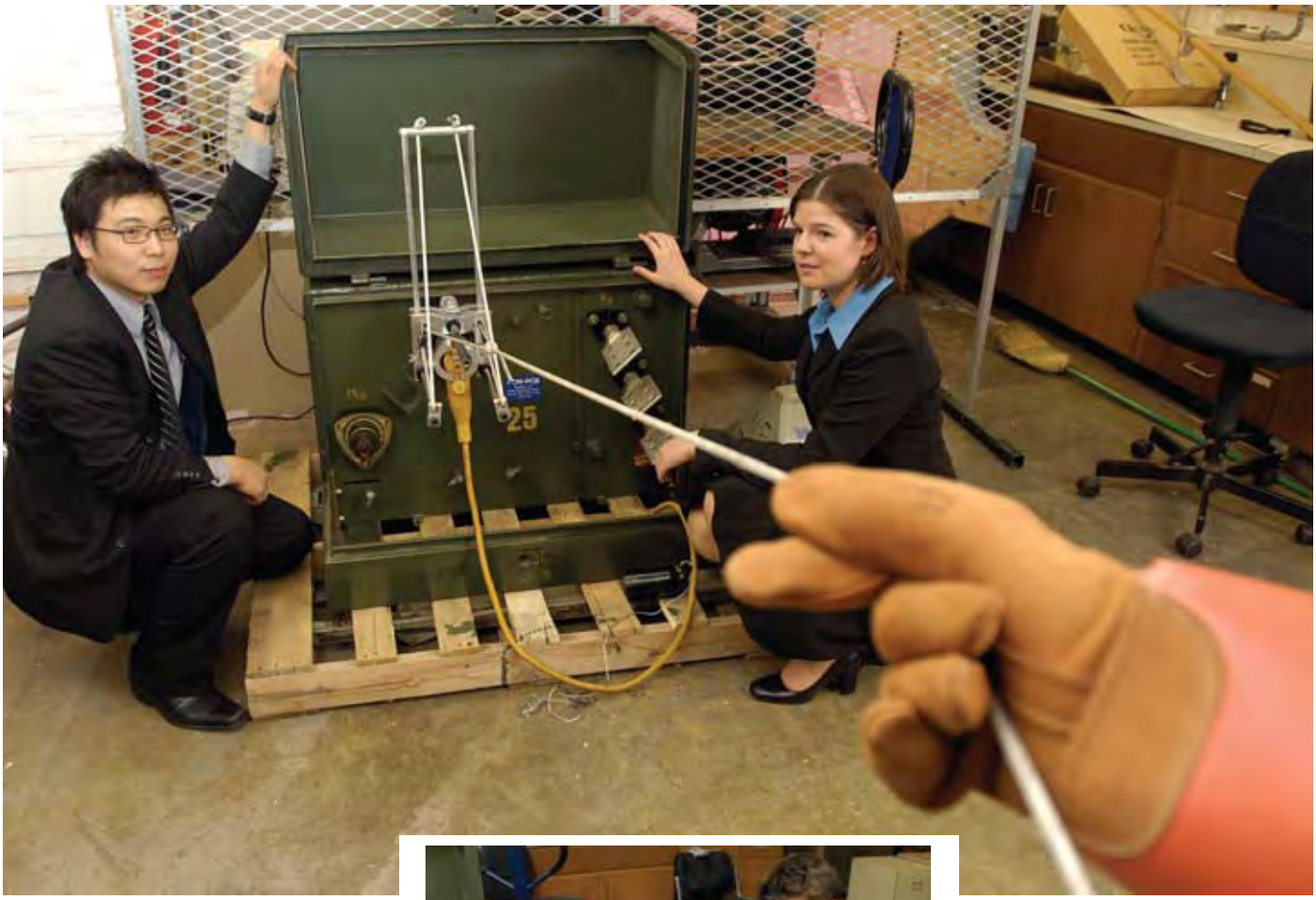
The utility's challenge was assigned to a team consisting of seniors Kyle Azevedo of Bridgewater, Conn.; Julie Blumreiter of Muskego, Wis.; and Doo Hyun Lee of Seoul, Korea. BGE provided an unpowered out-of-service residential transformer box for the team members to use in developing their tool.

The students initially consid-



While enrolled in the two-semester Engineering Design Project course, seniors Kyle Azevedo, Julie Blumreiter and Doo Hyun Lee invented, assembled and tested this tool to help protect electric utility workers.

Photos by Will Kirk/John Hopkins University



ered complex designs that would employ hydraulic or pneumatic power. "We finally decided on an all-mechanical design that would require no batteries or motors," said Azevedo. "One of our primary goals for this tool was simplicity."

The finished prototype features three guide rails that surround the transformer's elbow connection. A sliding component of the device houses a clamp that grabs onto the connector. The utility technician can then use the lever and pulley system to detach the power line from a safe distance. Compared to the current hot stick procedure, their device requires the worker to exert only a third as much force, the students said.

When the frame is clamped on to the power line connector, a utility worker can pull on the rope from a safe distance to disconnect it. The student engineers tested the device on an unpowered out-of-service transformer box provided by the project's sponsor, Baltimore Gas & Electric Co.

The students' tool should also be simple to transport and utilize during repair assignments. "We wanted to make this device as small and as light as possible so that one worker could easily operate it alone," said Lee.

The undergraduates spent about $9,600 to make the prototype but estimated that it could be mass-produced for far less. The prototype has been turned over to BGE, which will conduct further tests and consider refinements in the device before deciding whether to deploy it in the field.

The student inventors, who recently received their diplomas, viewed the engineering design course an important part of their education. "It gave us the chance to apply a lot of the knowledge we'd been gathering over the previous three years from lectures and textbooks," Blumreiter said.

"In working through this project, we got real-life experience in the design, manufacturing and assembly processes."

Blumreiter and Azevedo are planning to enter graduate engineering programs at Stanford University and Georgia Tech, respectively. Lee plans to begin working soon as a structural analysis engineer in New Jersey.

The utility worker's device was one of nine Johns Hopkins projects completed this year by undergraduates in the engineering design course, taught by Mike Johnson and other faculty members in the Department of Mechanical Engineering. Each team of three or four students, usually working within budgets of up to $12,000, had to design a device, purchase or fabricate the parts and assemble the final product. Corporations, government agencies and nonprofit groups provide the assignments and collaborate with the students. The course is traditionally a well-received, hands-on engineering experience for Johns Hopkins undergraduates.

REAPING THE WIND: AERISYN EXPANDS TOWER PRODUCTION

By Don Horne

The explosion of wind generation sweeping the United States has generated a boom in Tennessee – and Aerisyn LLC is helping to drive that boom.

Aerisyn has a lease on 155,000 square feet in what was the Alstom facility in Chattanooga and is expanding their production to 250,000 square feet.

Aerisyn currently manufactures more than 200 towers a year. The wind towers that support the rotor and generator of the wind turbine are 200 feet to 300 feet tall and up to 15 feet in diameter at the base.

"Finding a facility that can handle a 300-foot tower is rare," says Tom Kale Jr., CCIM, of NAI Charter Real Estate Corporation, the company that negotiated the lease contract with Alstom. "Alstom is located in the former Combustion Engineering plant where they processed nuclear reactors. It has 1,000-foot long bays and an 800-ton crane. It also offers easy access to the river with a port that can handle the heaviest tonnage north of New Orleans."

Today's wind turbines are much more efficient than their cousins of a decade ago. Taller towers reach higher to take advantage of stronger air currents, so one new turbine today can produce the same amount of energy as up to 20 of the first-generation towers. An average wind turbine today produces between anywhere from1.5 to 2.8 megawatts.

Building these towers does present several unique challenges.

The few existing U.S. wind tower manufacturers cannot meet current demand in North America, so U.S. energy companies have been forced to purchase towers from abroad. Although Aerisyn has expanded, it still is swamped by domestic demand – which led to the development of their unique automated production assembly line at their Chattanooga plant. The automated line not only speeds up the construction of the tower sections (which are on average 14 feet in diameter, 50 to 100 ft. long, and weigh up to 50 tons), but helps to make Aerisyn competitive against those same Asian competitors.

Aerisyn developed – in conjunction with ESAB – a sophisticated, consistent joining process for assembling wind towers, which are constructed by welding together a series of massive cylinders.

And to say "welding" is not to completely convey the technology needed to fabricate the towers.

The fabricating process begins on one of two ESAB Avenger gantry cutting

machines. One machine has a 32-ft. by 109-ft. cutting table with twin heads that allow Aerisyn to cut two 10-ft. by 10-ft. high-tensile-steel plates at the same time, while two more plates are loaded onto the table. This machine is equipped with oxyfuel cutting and beveling heads and is used to cut heavier 2.5-in. plate. A second machine has a 14-ft.-wide by 109-ft.-long table and is equipped with plasma cutting and beveling heads to cut plate up to 1 in. thick.

This mammoth task is completed over and over again, with the smallest of tolerances to ensure a seamless connect throughout the tower.

The current facility in Chattanooga had been used to build nuclear reactors, and the space is exactly what Aerisyn needs. Located near railways and waterways, it solves a key problem tower manufacturers face: transportation.

"Aerisyn is a substantial addition to Chattanooga's existing high-tech manufacturers that support the community's efforts to assume a leadership role in energy conservation enterprises," said Trevor Hamilton, Vice President of Economic Development for the Chattanooga Area Chamber of Commerce. "Additionally, it is great to see a former manufacturing space be brought back to life for this unique and exciting industry."

Aerisyn concludes that wind-generated electricity is cheaper to produce per kilowatt than new-installation, electric generation facilities utilizing either coal or nuclear fuel. Additionally, the time to project completion for wind generation is faster than other conventional generation sources. Wind is now economically competitive with other power generation sources due to advances in turbine design and manufacturing efficiencies.

Currently, there are four or five other manufacturers in the U.S. who supply towers for the wind industry, Aerisyn officials said. These entities are booked to capacity, thus opening up the opportunity for Aerisyn to join in supplying the industry. With Aerisyn's automated tower manufacturing line, it is possible to be competitive in the world market by reducing the labor costs of manufacture while maintaining a high level of quality control.

Wind turbines, which provide a clean and renewable source of electric power, constitute the world's fastest growing energy source, Aerisyn President Marlin Laidlaw says.

"Wind energy allows us to meet the increase in power consumption requirements in the U.S. and, at the same time, increase our reliance on green power.

"California already has a significant portion of their energy generated as green power, with some proponents seeking up to a 25% reliance on green power within a few short years. Many other states are following the lead of California and Texas, with 16 states currently having a Renewable Portfolio Standard in place, whereby a portion of all energy consumption is green power."

Aerisyn has already begun exploring additional partnerships in Tennessee with the Oak Ridge National Laboratories, the UT Sim Center at Chattanooga, and eSpin, a nano-technology company.

TVA operates several wind turbines in support of its Green Power Switch alternative energy program. Green Power Switch is a renewable energy initiative that allows consumers in the Tennessee Valley to buy green power – electricity that's generated by cleaner, renewable resources such as solar, wind and methane gas.

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DISTRIBUTION AUTOMATION AND DEMAND RESPONSE - PART I

By Nokhum Markushevich and Alex Berman, Utility Consulting International

The load models for Distribution Automation Applications are typically based on representative load shapes for different load categories and times. At the present time, in the most detailed DA applications, the loads are aggregated in the load centers of the equivalent secondary circuits of each distribution transformer.

The aggregated load may represent a load of a single customer, or loads of several customers, which can be of different load categories. Some of these customers may have implemented demand response (DR) means. When the demand response is enabled, the load shapes for these customers change. It seems that for a group of customers, there are at least two typical load shapes: one without the demand response enabled and another with the implemented demand response.

Actually, customers of the same category, which have the same typical load shape without demand response, may have different kinds and degrees of demand response, i.e., the same load category may have many "typical" load shapes with DR. The load shapes with DR are also different because they depend on the value of the incentives to activate demand response, on the time when the DR is activated, and on the duration of the applied DR.

It is more likely that the demand response is required during system peak-load times, but it also can be needed at other times. Figure 1 presents an example of Locational Marginal Prices (LMP) during

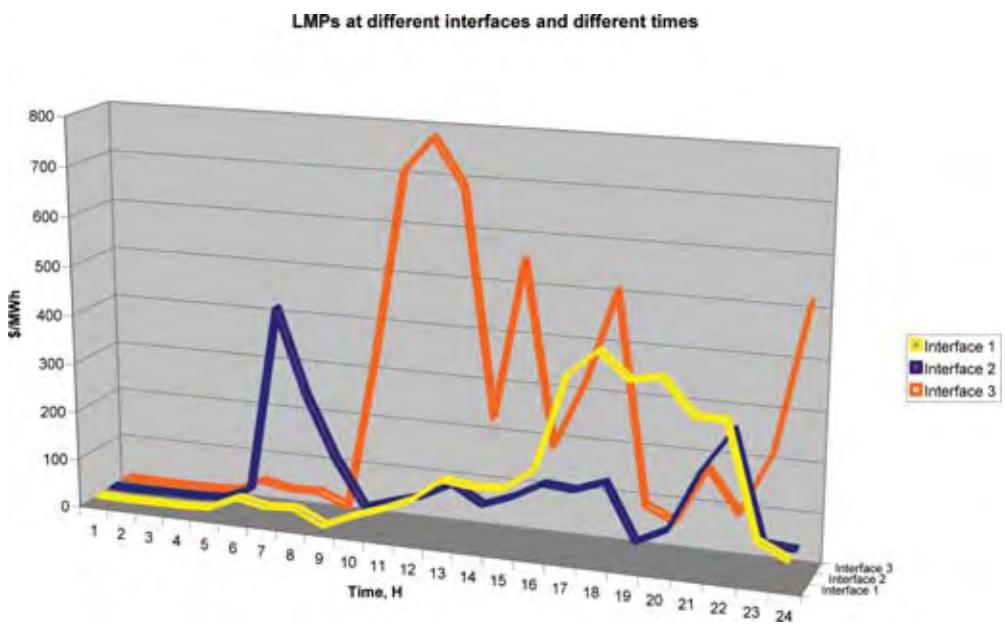

Figure 1. Example of daily LMPs at different interfaces of the same ISO

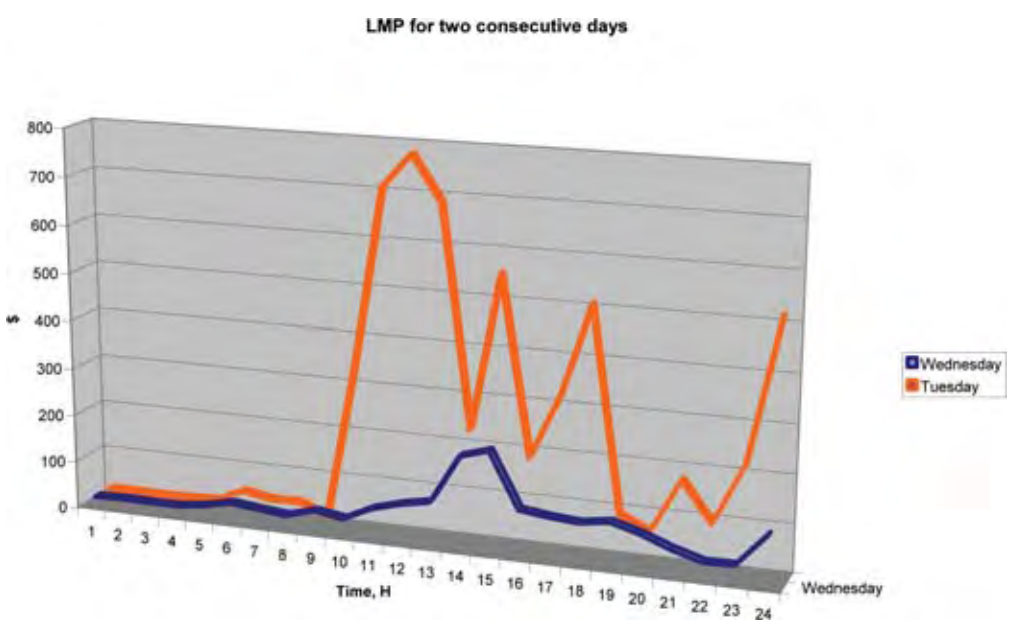

Figure 2. LMPs for different days at the same interface

a day at different interfaces of the same ISO. As seen in the figure, if the LMPs exceeding definite values can be considered as a price signal for DR, the signal would come not only at the time of the peak load, but also at other times of the day, and they are not the same in different days (Figure 2).

The performance of the DR is also different for different means. For instance, the thermostatic loads available for control triggered by a DR signal is different dependent on the initial intensity of cooling or heating, which, in turn, is different at different times and for different ambient temperatures. The usage of energy storage for DR depends on the amount of previously stored energy and on the amount of the energy discharge. The amount of the stored energy depends on the availability of feasible energy supply for storage.

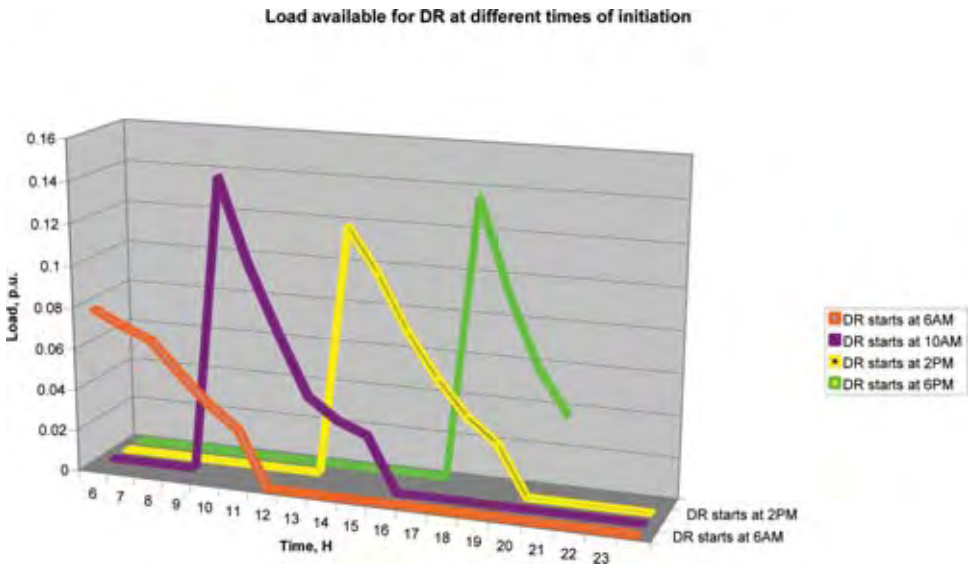

Figure 3. Load available for DR at different times of DR initiation

Figure 3 illustrates the difference of load available for DR for different times if initiation of DR.

Figure 4 illustrates the different load shapes if DR is initiated at different time, and Figure 5 illustrates the difference in load shapes with DR of different duration.

The Distributed Energy Resources (DER) used for demand response have another set of characteristics [1], which may be different at different times and locations, e.g., the cost of production by a DER device may depend on the current price of fuel or on the current operational state of the device. In general, if the DR initiation is based on a price signal, the response to this signal depends on the comparison of this price signal with the cost of providing the demand response. The price signal and the cost may vary in time. This means that the load shapes with DR will be different dependent on the value of the price signal, time, and duration of implementation of the demand response.

As it is well known, the DA applications are critically dependent on the load models for distribution transformers used for the near-real-time simulations.

With the practically unlimited variety of the load shapes with DR, it is unrealistic to prepare in advance the sufficient set of "typical" load shapes and to know when and which of them should be used.

There are two components of information needed for integration of demand response behavior with DA applications: a) the near real-time load with demand response activated and b) the load with demand response expected in the near future for the look-ahead or study DA applications.

With the implementation of the Advanced Metering Infrastructure, the near real-time component of information may become a reality, especially for large customers with significant demand response.

The information about the expected behavior of demand response in the near

future should rely on predictive modeling. The modeling could be based on such input data for individual loads or groups of similar loads as follows:

- Initiation signal for triggering the demand response
- Time of the initiation signal
- Time delay for implementation of demand response
- Real-time load measured or modeled
- Typical time-dependent or load-dependent (or both) function of demand response for the particular time of initiation. For example, such a function could be presented as an exponential function in time with a demand response portion factor, such as:

DR (kW) = Current Load (kW) x DR portion factor x e –(t-t[initiation]/[Tconstant])

The DR portion factor can also be a function of the time or load.

- Conditions for energy storage
- Contractual constraints on utilization of DR

These characteristics could be pre-determined and stored in the CIS databases and corrected based on historic data collected via AMI; or they could be submitted to the DA simulation models through near-real time information exchange with the object models of significant DER and customer EMS.

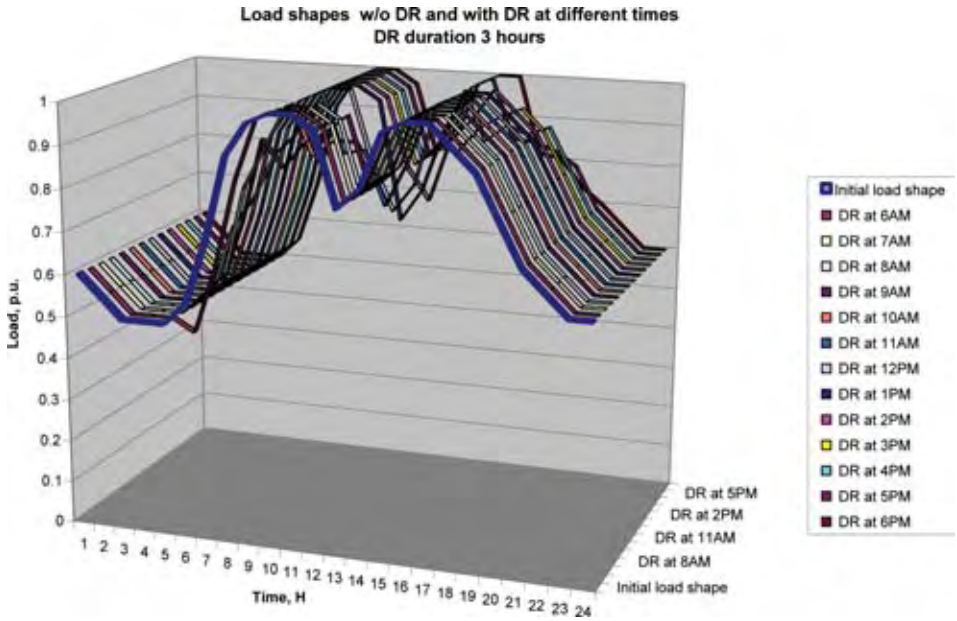

Figure 4. Different load shapes for different times of DR initiation

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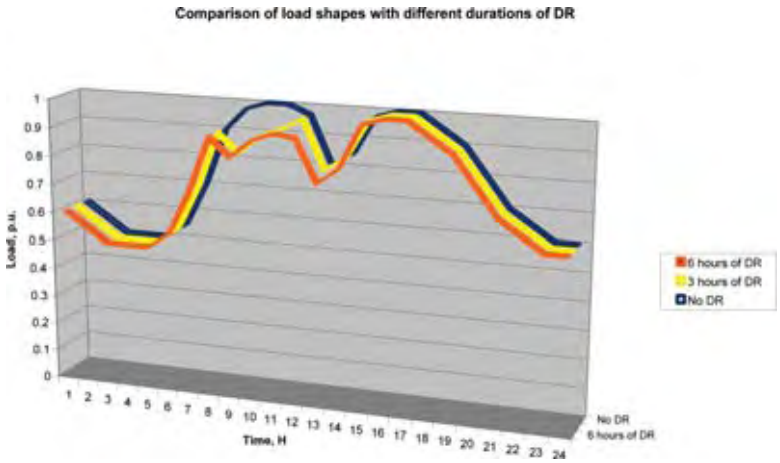

Figure 5. Different load shapes for different durations of DR

With such information support, the DA applications would adjust the corresponding load models to the expected conditions of demand response.

On the other hand, the DA applications would be able to generate a price signal necessary to achieve needed amount and location of the demand response to resolve critical operating conditions.

Consider some examples of integration of DA applications with Demand Response models.

When the Demand Response changes the load of participating customers, it also changes the power flow, the power losses, and the voltages along the passage of the load from the generations to the point of consumption. These changes depend on the allocation of the Demand Response, on the real-time connectivity and electric parameters of the distribution and transmission systems, and on the reaction of controlling devices to the changes of the operating conditions.

The end-result of Demand Response applied to a participating load includes all of the following components:

• Load reduction of the participating customers

• Loss reduction in the distribution and transmission systems due load reduced by DR

• Change of loads and losses due to change of voltages caused by the change in power flow

• Change of load due to change of voltages caused by the reaction of controlling devices to the change of power flow

• Change of available generation capacity due to changes of reactive loads and losses

• Change of power flow margins in distribution and transmission.

If these changes are taken into account by the near real-time DA applications optimizing the operating condition [2], the composite effect of local Demand Response can be significantly increased.

Consider an illustration of the impact of DR on the results of coordinated Voltage and Var Optimization in distribution. In the two-feeder distribution system (Figure 6) fed from one transformer with automatic voltage control, the Demand Response can be applied to three locations along Feeder 1:

• Close to the bus (Cl);

• In the middle of the feeder (Mid);

• Close to the end of the feeder (Rem).

The total nominal amount of load reduction via the Demand Response is 3.3% of the total load connected to feeder #1. In this example, it is 0.3 MW. It is assumed here that the load is connected to the secondary buses of the distribution transformers. When the Demand Response is applied to any place, the power flow through the corresponding distribution transformers and through the upstream portion of feeder 1 changes because of the change of load. The voltages change because of the changes of voltage drops in the distribution and transmission lines and transformers, as well as because of the reaction of the voltage controller at the substation transformer due to line-drop compensation. The loads in both feeders change because of the change in voltage, and the power losses change due to change in the power flow and voltages.

The end results of all these changes depend on the size and location of the demand response, on the load power factor, on the connectivity and parameters of the distribution and transmission circuits, on the voltage controller settings, on the total load connected to the bus with the common LTC, and on the load-to-voltage dependencies [3-4]. In the examples below, we will consider in different combinations the following operating and business conditions for applying the demand response:

- The voltage in the distribution system before implementation of the DR is kept at the low standard voltage limit in the critical point of the secondaries.
- DR is applied to the customers close to the substation bus.
- DR is applied in the middle of feeder #1.
- DR is applied close to the end of feeder #1.
- Only feeder 1 is connected to the substation bus.
- Two feeders (#1 and #2) are connected to substation bus.
- No transmission operations are taken into account.
- Transmission operations are taken into account.
- Instead of demand response applied to the customers in

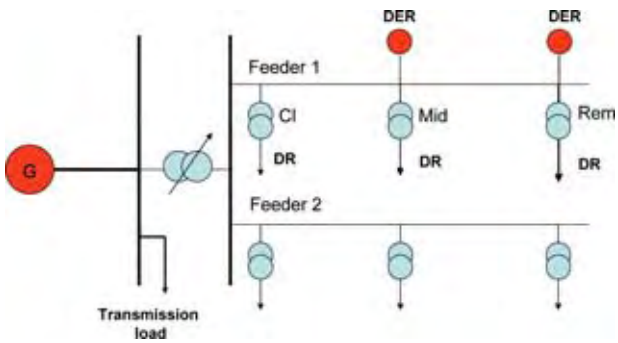

Figure 6. Distribution system for illustrating the impact of coordination DA applications with DR

the secondaries, a Distributed Energy Resource (DER) is connected to the primary distribution circuit either in the middle of the feeder or close to the end. The size of the DER is 1/3 of the nominal load of feeder #1, and the power factor of the DER is equal 1.

Figure 7 presents the changes of the total load and of the generation needed to supply the load and the changes of the

corresponding losses for different allocation of Demand Response with and without adjustment of the operating conditions to the changes resulted from Demand Response. In this case, it is assumed that only one feeder (#1) is connected to the substation bus, and the transmission losses are not taken into account (Like only DISCO's interests are considered). As seen in the figure, when the DR is applied to the load close to the substation bus, the change of the total demand in distribution is, practically, equal to the amount of the nominal DR (0.3MW). When the DR is applied to the load in the middle of the feeder, the reduction of the load is less that the DR applied, due to the reduction in the voltage drop in the substation and distribution transformers and in the primary feeder. This increases the voltages in the secondary circuits, where the DR is applied, and also in the primary of the entire feeder, which results in load increase due to load-to-voltage dependencies. All these factors still result in reduction of the total losses in the distribution feeder and in distribution transformers. The generation needed to supply the distribution demand is reduced even more.

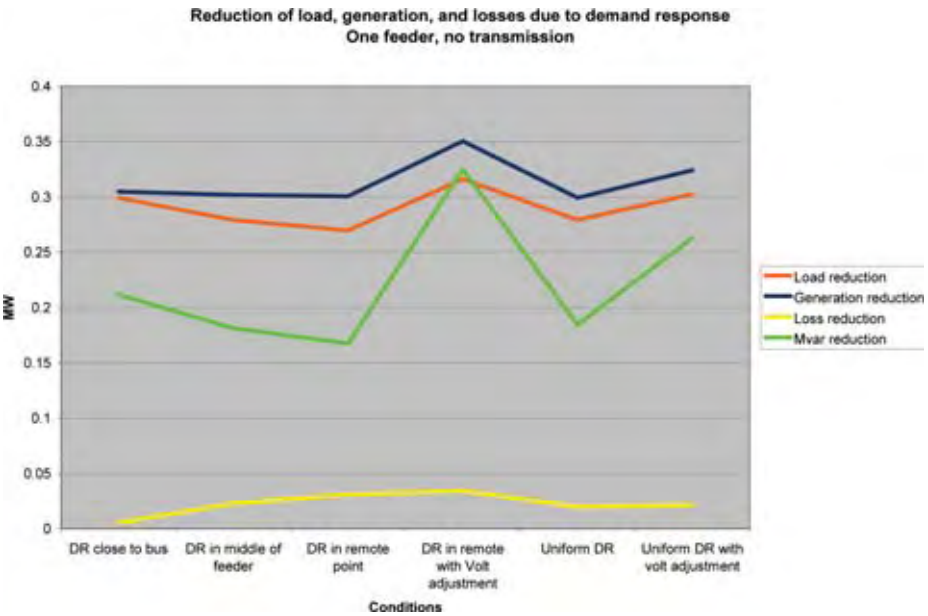

Figure 7. Changes of operational parameters for distribution system due to DR with and without coordinated Volt/Var Optimization, for one feeder

Look in the November December issue of Electricity for Part II

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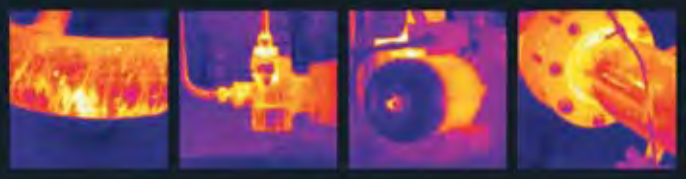

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INFRARED EVOLVED

SMART THERMOSTATS: AVOIDING SURPRISES IN THE COST OF INSTALLATION

By Michael Delage, Energate Inc.

Utilities are increasingly looking to deploy demand response solutions on a large scale. At the heart of many of these efforts are deployments of smart thermostats, because growing air conditioning use is the largest driver for peak demand. Those utilities deploying smart thermostats are quickly learning how to deal with some common installation challenges.

Thermostats have traditionally been installed by qualified HVAC contractors, often at the time of a larger installation of new HVAC equipment (only a very small percentage of thermostats are installed by homeowners). Relatively speaking, the time needed to install a thermostat is small compared to what is needed to install a new furnace or air conditioner, even if the installation has some challenges. However, that's not necessarily the case when it comes to demand response deployments in hundreds or thousands of homes. Utility deployments - where installers are working to deploy multiple smart thermostats every day, always in retrofit situations - are more cost-sensitive to thermostat installation problems, particularly when you consider the costs of customer recruitment and relationship building that can be damaged due to a difficult or failed installation.

The challenges and problems seen frequently include:

• Wiring errors and short circuits.

HVAC equipment wiring normally follows a loose color code convention, however, in retrofit installations, wiring and equipment can be very old and non-standard. Wiring errors can blow fuses, breakers, or even burn the low voltage transformer in the furnace or AC unit when the smart thermostat is activated. This can be difficult for the installer to troubleshoot and repair, and if the smart thermostat being used is difficult to configure and has no inherent protection against short circuits, then it is recommended that installers carry spare transformers so they are able to perform repairs on site.

HVAC wiring colours and purposes vary - common wire may be missing.

• Missing common wire.

Older mechanical, mercury-switch thermostats had no electronics in them, and hence did not need a separate circuit, such as a common wire, to operate. As a result, existing installations can have as few as two wires (a 24VAC supply wire which gets connected to the heating wire when the mercury switch activates). More wires are available in cases where mechanical thermostats were used for heating and cooling, but often have one wire less than is needed for an electronic thermostat, including a smart thermostat. Some jurisdictions will have over 30% of homes with this problem.

The HVAC industry has developed a number of different approaches to solving this problem, including using batteries, or an approach known as "power-stealing", which allows the thermostat to draw small amounts of electric current, using the heating wire as the return connection. This works in many cases, but sometimes the electric current on the heating wire is sufficient to turn on the HVAC equipment (particularly with newer HVAC systems). Installers often complain of "chattering relays" or irregular equipment behavior when power-stealing is incompatible with the furnace or air conditioner. The addition of 2-way radios (and their power requirements) in smart thermostats has further hampered battery and power-stealing. Other approaches include "add-a-wire" kits or other auxiliary devices and have different price points and cover some or all situations. It is important for utilities and their installers to know and understand how they will deal with this issue, to minimize installation time, and to reduce or eliminate failed installations.

Some utilities are taking a hands-off approach, looking for retail sales of smart thermostats to supply the market, although adoption rates are likely to be slower with this approach. Other utilities are being proactive about these issues and looking at the total cost of installation in selecting their partners and the technologies they are using for demand response.

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EPB BUILDING SETS EXAMPLE FOR BETTER ENERGY BEHAVIOR

By Lacie Newton

The EPB of Chattanooga moved into this Brownfield building in 2006.

In 2006, EPB of Chattanooga moved into their newly constructed, energy efficient downtown office building after years of careful planning and construction. Serving as a gateway to a newly revitalized southern city, the 121,000 square foot EPB building stands as a model for urban planning, energy efficiency and sustainability by utilizing new and innovative environmental features and design.

A Brownfield Reclamation site, known for its highly contaminated condition, was selected as the location for the eight-story EPB building with attached parking garage. Once home to a gas station and a dry cleaning business, the block went vacant for decades due to the high cost of removing contaminates that would prove to be a deterrent for private investors.

Through partnerships with the City of Chattanooga, S&ME engineering firm, and the Tennessee Department of Environment and Conservation, the EPB building site became the first in Tennessee to have the construction of an underground remediation system integrated into the construction of the office complex, saving years when compared to the typical property development time frame. The site is now free of all petroleum products and is halfway through a five year plan committed to neutralizing the dry cleaning fluids still found in the soil. Beneath the EPB building and parking garage are housed 45 injection wells at depths of 30 to 50 feet that actively clean ground water, which will ultimately result in a site that protects surrounding properties as well as water resources.

The interior of EPB's new downtown office building reflects the same environmental stewardship as the exterior. Wall coverings, carpet, and fixtures are all either recycled or made from recyclable materials like stone and wood, and workspace flooring is made of long-lasting linoleum or recycled rubber flooring.

And the company's stance on saving energy can be found in the sophisticated, fully integrated, energy efficient smart systems employed throughout the building.

INTEGRATED FACILITIES MANAGEMENT SYSTEM

If the employees make up the heart of EPB's new downtown building, then the Integrated Facilities Management System by Johnson Controls acts as the brain. Combining all the systems, including employee card access, lighting, eight HVAC units, and security and fire alarms, allows one person to manage the system and see all aspects of every area of the building. Universally controlled access provides numerous efficiency benefits, especially in off working hours like weekends and night shifts. For example, once a zone is activated by the swipe of an employee access card, lights will trigger only in the area the employee is utilizing and the temperature is scaled to efficiently meet the need of that one person or small group. With three to four compressors each, HVAC units are located on each floor of the building and manage 20 to 30 zones per floor. Distributed HVAC units create less demand than fewer HVAC units for a building of similar size and permit the building to use sometimes as low as one fourth the energy capacity on a floor at one time. This kind of control through the Integrated Management System allows for greater management of heating and cooling throughout the building.

Demand Side Management is just one energy efficiency measure made possible with Johnson Controls Integrated

The atrium allows natural light to flood into every level.

Facilities Management System. Last summer, TVA and EPB entered into a DSM study, raising the buildings temperature by 2 degrees while dimming lights in the afternoon. Throughout the pilot program, a consistency in the ability to reduce load was experienced, indicating that through automated, predetermined demand reduction steps, load on the distribution system can also be reduced.

ENERGY RECOVERY UNIT

EPB's new downtown office building employs a unique fresh air input system to efficiently heat and cool the building. The sophisticated energy recovery unit by Trane transfers the temperature of outgoing air to incoming air, requiring 8 to 10% less energy.

The Trane unit utilizes an enthalpy wheel to take the temperature of the fresh air coming in from outside and change it to the temperature of the cool or warm air leaving the building."

"The energy recovery unit accomplishes two important things," says Steve Clark, EPB's Vice President of Strategic Systems. "It simplifies the task of distributing fresh air throughout the building, which is better for our employees, and at the same time it also reduces energy that is wasted by trying to cool or heat extremes in air temperature."

ENERGY EFFICIENCY ACHIEVED THROUGH BETTER DESIGN

Building design details were also chosen with energy efficiency in mind. For a building with an open atrium and no core, the building's architects and planners chose to put mechanical and electrical rooms as well as elevators and restrooms in the same place throughout the building, compactly stacked on top of each other on a wall shared with the parking garage. With all piping systems located in the same area, stacked one on top of another, efficiencies are achieved from an operational, structural, and energy standpoint.

"Mike Weaver, Supervisor of EPB's Facilities Management department, makes adjustments to one of the many Johnson Controls units located throughout the building"

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Windows play a key role in not only the building's environment, promoting maximum natural light indoors, but for energy efficiency as well. Windows are Low E grade, slightly tinted, and can be opened in several areas to help with cooling and heating when used properly in spring and fall. And, while some find it surprising, the front lobby's revolving door plays a role in the building's heating and cooling system's efficiency by simply reducing drafts - proof that, from the complex to the simplistic, there are always ways to make a structure more energy efficient.

"We've done our best by taking significant strides to be an energy efficient company, using smart systems, innovative technology, and simple design details throughout the building,' says Clark. "And, as we move into the future, we want to be at the forefront of more energy efficiency measures, like demand side management programs and the possibility of a green roof or solar panels on the building. The options seem limitless and with our new building, we feel we are already positioned in the right direction."

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DIGITAL CONTROL SYSTEMS FOR HIGH-VOLTAGE SUBSTATIONS- PART II

By James Propst, Western Area Power Administration (WAPA) and Mike Dood, Schweitzer Engineering Laboratories, Inc.

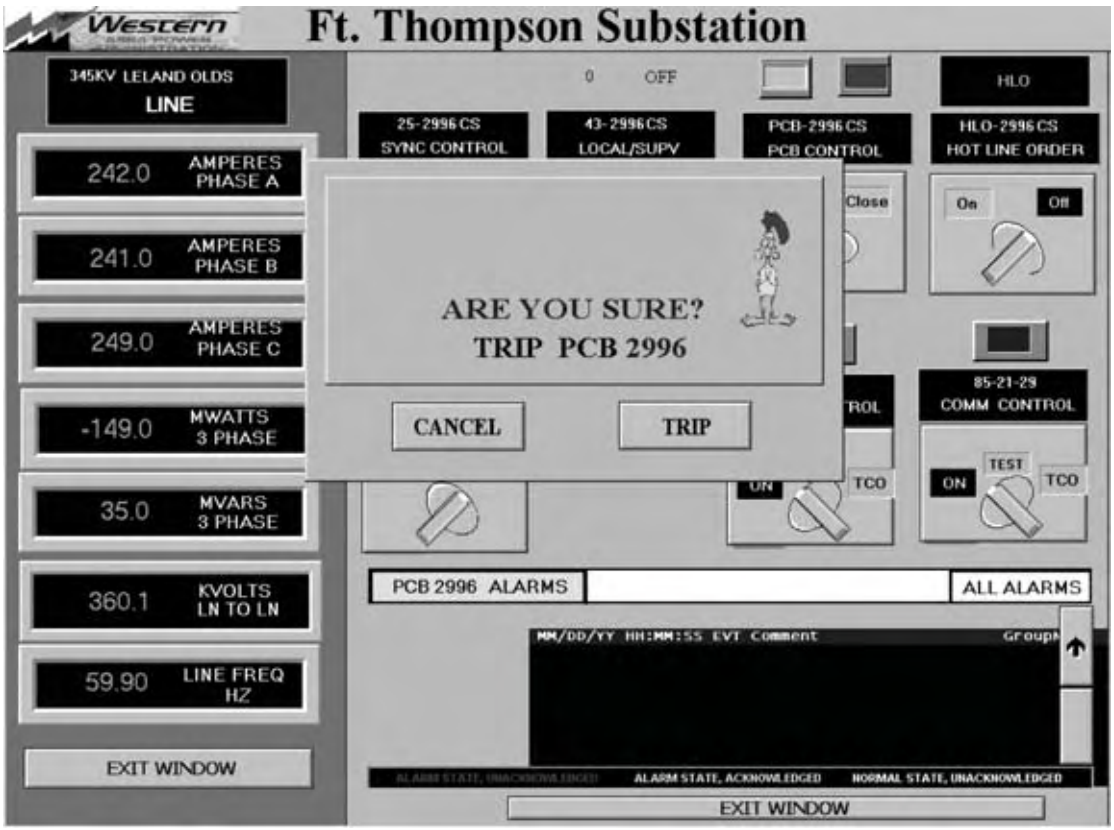

Figure 5 Right Fort Thompson PCB Control Screen. The chicken switch is displayed for confirmation of the control action TRIP PCB2996. Chicken switch confirmation is displayed for trip and close actions.

SUBSTATION COMPUTER

Hardware Design

Western has used Wonderware as the HMI in their digital designs for several years. Due to the very limited knowledge of this software and computers in general in the workforce and the associated concern over the ability to respond to equipment failure, Western chose an industrial PC. Western purchased redundant PCs with hot-swappable redundant power supplies and hotswappable redundant hard drives. The hard drives use a SCSI RAID 1 controller to mirror the drives. The PCs are rack mounted in the control panel. To provide isolation to transients and to power the PCs, Western installed redundant DC-AC inverters that are normally fed from AC but switch to DC upon loss of AC. The inverters served as a universal power supply, because they switch supply sources without causing any disruption in the PC. A keyboard, video, mouse (KVM) device switches the PCs to a single set of LCD displays, keyboard, and mouse.

HMI Application Design

Western uses a dual display for the HMI. The left screen displays the station one-line with status.

They also use the buttons on the left screen to fill in the variables in the right screen template used for PCB control. The buttons rise when the cursor is placed over them. The 43LS, 79, and 85 statuses are shown directly on the screen. The 43LR, 52a, and 52b drive the color of the breaker status. When the 43LR is in the local position in the circuit breaker, the breaker status box is gray, with an M for “Maintenance” indication independent of the breaker position. The circuit breaker closed indication is red — open is green.

Western’s Power System Clearance procedures detail two primary tagging procedures — one for HLO and one for clearances. Western does not tag equipment controls under clearance with power system clearance tags. The only tag included in the HMI was for hot-line orders. The HLO tag indicates reclosing has been turned off and the circuit breaker close path has been interrupted.

Within the HMI, the HLO tag cannot be turned on when reclosing is in place. The HLO is represented on the one-line screen by a yellow HLO tag and flashing indication on the PCB control screen. If the close function is selected, an HLO WARNING screen is displayed, and closing is prevented.

The PCB control screen has a representation of a physical switch for each function. The switch representation was chosen to make the HMI intuitive. The

PCB control screen is the same for all equipment, with only the appropriate functions visible and active. For example, the 85 function is disabled for dedicated transformer breaker, or reclosing for a reactor breaker is disabled. The HMI works by sending the command to the protective relays and then reading the status back via the communications processor to effect changes on the HMI displays. The switch handles rotate and lights change to indicate the appropriate status on the PCB control screen.

Commands to open and close a circuit breaker include a "chicken" or "select-before-operate" switch, which requires confirmation of the selected action. Commands to change the 43, 79, and HLO functions do not require confirmation, as the effect of the command will not immediately impact operation — no circuit breakers will open or close. Placing the 43LS in the supervisory position disables all other controls and is represented with a SUPV label displayed over the control switch handle. The update time on the HMI is about two seconds.

A small alarm window is displayed on the PCB control screen as well, with the option of displaying all alarms or the selected breaker alarms. This function is easily accomplished with the HMI software's built-in displays. The metering associated with the circuit breaker is also displayed on the PCB control screen and can be changed to either line in the case of a ring bus or a breaker-and-a-half bus by selecting the desired meter on the left window of Figure 5. Metering quantities are especially easy to display and scale. The metering quantities are obtained from one of the protective relays.

The current alarms or the alarm history can also be displayed on the right window of Figure 5.

Alarms are displayed with status; red is active and unacknowledged, yellow is active and acknowledged, and white is reset and unacknowledged. Time, date, description, comment, and group name are displayed. Sort functions are also available. Because Western did not latch their alarms or events, the HMI display can miss fast resetting changes. Modbus Plus protocol does not support the SOE function. Western chose this direction because they have access to their SCADA master and believed active alarms would account for the majority of use after commissioning was completed. During commissioning, Western relied on their SCADA master for events.

The HMI interacts with the lower-tier communications processors. If SCADA control is lost, the local platform is still

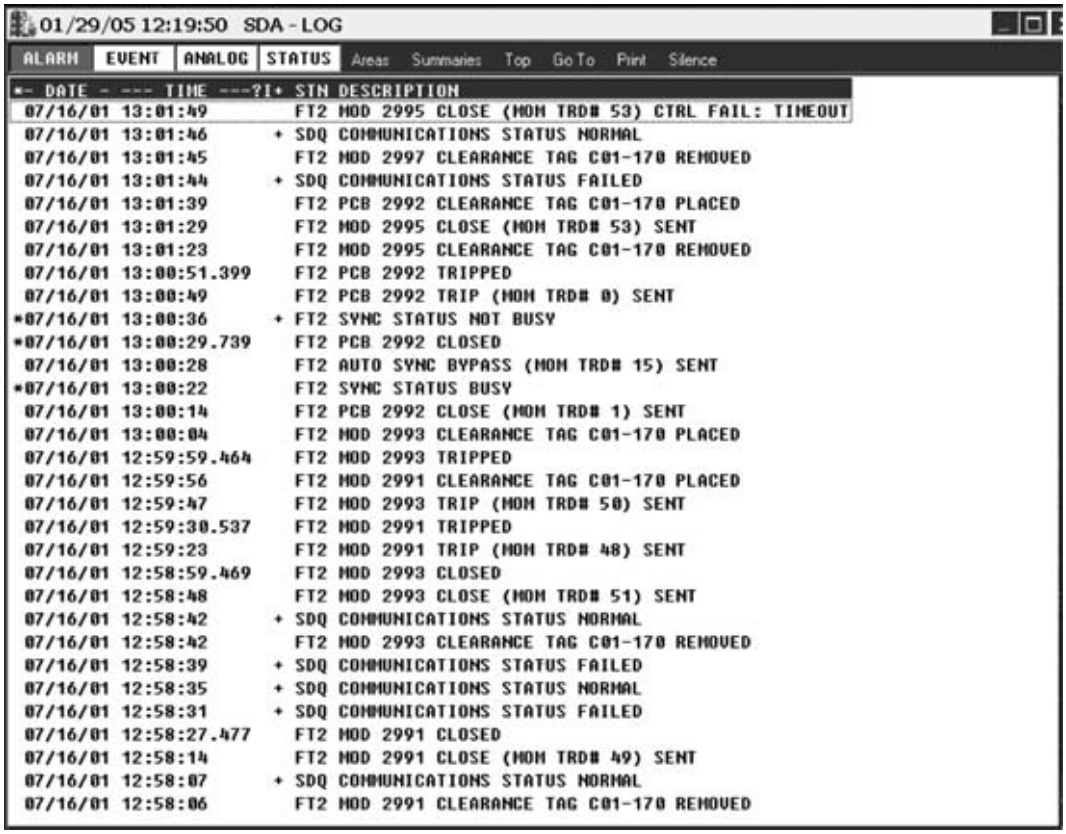

Figure 6 SCADA log was available for commissioning via Ethernet connection

redundant with respect to controls. Metering quantities are obtained only from a single source. Statuses are combined in the HMI. The HLO status is "ANDed" to ensure both reclose paths are turned off and closing is prevented. The 43LS, 85, and reclose paths are "ORed" to allow for relay failure or testing.

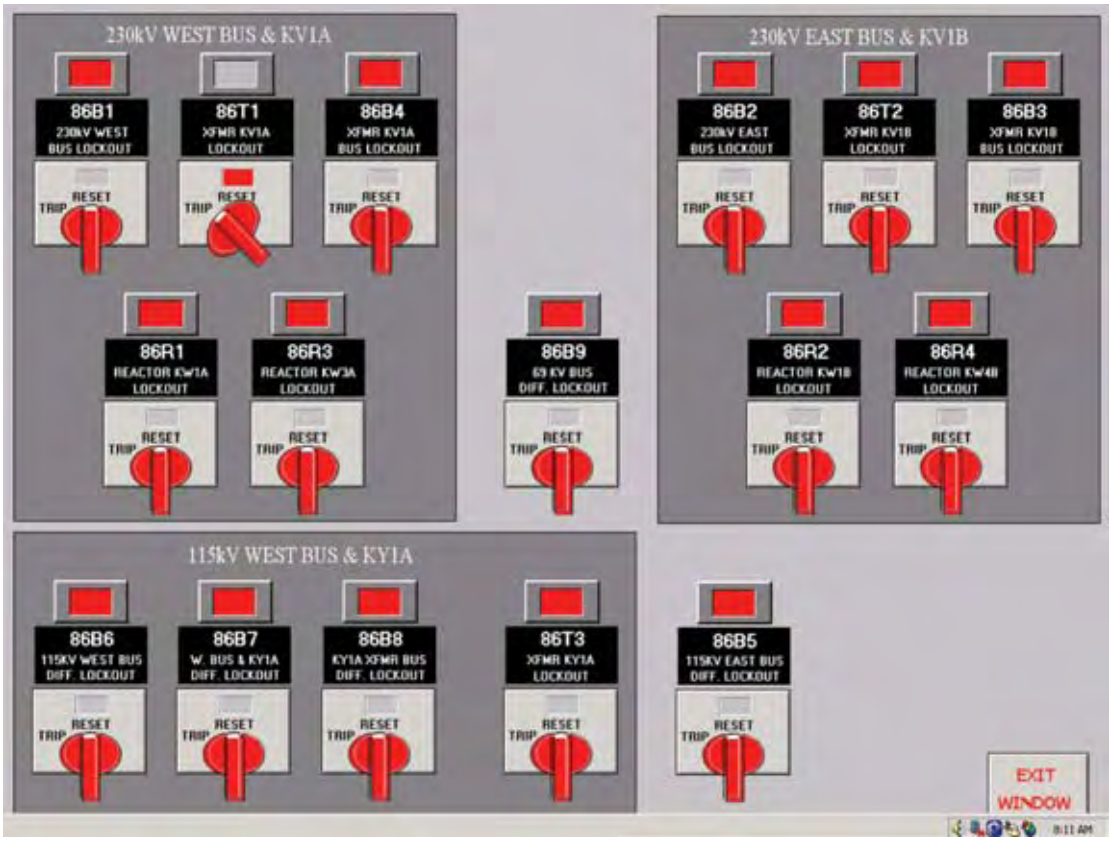

Figure 7 Lockout screen from a Huron Substation with software lockout 86T1 in the TRIP position. The lockout is reset by clicking the on-screen RESET button.

LOCKOUTS

With the first DCS design, Western went digital — no switches, which meant a software lockout.

Wired logic or digital logic is complicated, but mixing them has a cumulative effect and further complicates each portion. Furthermore, the logic in wiring an output from a relay to trip a lockout and then wiring a contact from the lockout back to the same relay to block closing is circular and confusing. Most tripping functions of the software lockout, such as transformer lockouts, are accomplished with relay outputs. Bus lockouts are generally accomplished via the extended digital protection system by relay-to-logic processor-to-relay communication. This may add 4 ms to the tripping time, but because this function is competing with a Zone 2 trip, which in this case can take up to 20 cycles, it is not an issue.

In the DCS design, the lockout function is primarily to block close because the contact multiplication is not necessary. The block close functions are combined in the logic processor to a single bit, which is then sent to the closing relays. The lockout function is maintained until reset by using latch bits that maintain their value through a power cycle. The software lockouts are displayed on the HMI, and the reset function is active when the lockout is in the tripped position.

Software lockouts take less than one minute to manually configure in the HMI and even less time to configure in the logic processor. There are huge savings in design and installation costs with software lockouts. One of the longest wired logic strings — block closing — is completely eliminated.

A solution had to be found to the question of "How do we test it?" Because the lockouts may have distributed tripping via the relay-logic processor-relay communication, the use of logic prints and documentation is required. Because all trips are hardwired from a relay, the key is to use the documentation to find the relay and open the appropriate test switch. Whether lockout tripping is done through every available protective relay or through one chosen path determines which protective elements remain in service during testing. At Fort Thompson, distributed tripping was only through one path for the ease of testing.

On one of the newer designs, Western installed digital test switches. The digital test switches are easily created and take about the same time to create as a lockout — about a minute. They function by toggling between the open and closed state enabling or disabling the protective relay output.

One advantage of the digital test switch is the ability to alarm if a test switch is left open.

DIGITAL PROTECTION SYSTEM

Some of the more extensive wired logic in the control panels is breaker failure initiation. The use of the logic processor simplifies these installations by providing a single logic bit to each appropriate relay eliminating substantial wiring, particularly in a ring bus. The issue that once again goes hand-in-hand with the new technology is how to test it, because the initiation is done using relay-to-logic processor communication. To address the issue, the upper-right protective relay test switch was wired to an input for the relay initiating breaker failure. The input was used to supervise the relay-to-logic processor communication. Therefore, if meter and relay craftspersons open all the test switches before testing, they are safe from initiating a breaker failure operation during routine testing.

The use of a single 52a contact essentially saves a 12/C cable. In traditional designs, Western would need a 52a for the primary relay, secondary relay, breaker failure relay, each RTU

(Western often has more than one), and a 52b for the sync select circuit. The 52a contact is wired to the remote I/O at the circuit breaker and the status is distributed via the logic processor to each relay and the RTU. The RTU distributes the circuit breaker SOE to each utility. Use of the logic processor, like the protective relays, creates an accurate time stamp of change of state. Therefore, even if complicated communications schemes add communications delays, everything is time stamped relative to the same accuracy. In some cases, data moving through multiple IEDs have been measured to have up to an 8 ms delay in transit. This additional delay is not a concern and may actually improve the accuracy of the 52a timing. Usually, the 52a contacts timed in circuit breakers lead the main contacts. Because the auxiliary switches are mechanical, they must close before the main contacts quit moving. And because Western does not routinely adjust the lead times, a range of 1/4 to as much as one cycle of lead time has been observed in the 52a auxiliary switch. The protective relay needs to see a 52a transition after the trip command to complete the reclose initiation sequence. Some communications paths, even with fiber, can take longer to transmit a POTT signal, used in the reclose supervision, than it takes some of the newer SF6 breakers to operate. The delay in the 52a may actually improve reclosing performance by allowing additional time for the transmission of the POTT signal. The use of the 52a is imprecise in analysis work as well, for the same reasons; additionally, there is always some contact assertion time that must be taken into account.

The SOEs were collected by the RTU from the logic processor. Most of the SOEs were already present in the logic processor after the block close strings and breaker failure initiation functions were incorporated into the logic processor. Relay-to-relay protective functions such as POTT or DTT are echoed to the logic processor. The logic processor also provides all equipment alarms directly to SCADA. Equipment alarms were passed to the HMI via the communications processor. Connecting the remote I/O to the logic processor makes the SCADA update time totally dependent on the RTU and the SCADA master, as the logic processor updates information in relay time — every 1/4 cycle.

RTU

Analog quantities are obtained from the protective relays by the lower-tier communications processors, scaled, and sent to the upper-tier communications processor, where they are mapped for DNP. Statuses follow the same path but are combined as appropriate in the upper tier. The 43LS and Reclose functions are "ORed" and the HLO statuses are "ANDed" in the upper tier.

Update time for this process is approximately two seconds, to the point where the data are read by SCADA.

No I/O boards were used with the RTU. Non-operational data such as "personnel on site" were wired to the auxiliary inputs on the communications processors and logic processors. Control for items such as the yard lights was accomplished with the auxiliary outputs on the communications

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processors and logic processors as well. The elimination of RTU direct I/O changes the function of the RTU to a multiport protocol converter. It also represents a significant savings in hardware and labor costs. An RTU for this size of facility would easily cost $20,000 with the peripheral boards. Future designs will eliminate the need for the RTU altogether.

Fiber

As was previously mentioned, part of this project included replacing the copper control cable that had been damaged by rodents. Both technical and cost considerations were taken into account in the decision to replace the copper control cables with fiber-optic cables. Because this project is using communications-dependent schemes for not only monitoring and control but also for protective applications, the reliability and security of the intrasubstation communications have become much more critical aspects of the design.

The electrical substation environment in the upper Midwest includes many environmental challenges to reliable and secure communications. These challenges include high-current faults, temperature extremes, high voltages, electromagnetic interference, and electrostatic discharge. To overcome these communications challenges and to provide economical, reliable, secure, and safe communications, Western chose to use fiber-optic cable to interconnect monitoring and control systems. Fiber-optic cable is ideal for the harsh electrical environment of the substation. In addition, fiber-optic transceivers that required no external power source or external mounting were used. They simply plug into the serial port and are powered from the communications control lines. These transceivers are designed to work dependably in the harsh substation environment, just like the equipment to which they are connected.

Because of the physical arrangement, there are two 345 kV breakers and one reactor with an MOI in each of the two bays of the ring bus. Western ran one pair of fibers to each 345 kV breaker for the breaker 43LR, 52a, 52b, and alarms; another pair of fiber for the MOD 43LR, 52a, 52b and open/close functions for each of the MODs associated with each breaker; and another pair for future use. This required a 6-fiber cable to each piece of equipment. Because each bay required 18 fibers, a 24-fiber cable was run to a central point in the bay, where the three 6-fiber cables were connected to it and placed in a ground-level vault. All fiber-optic cables were installed in conduit with fabric interduct. The conduit was directly buried adjacent to the cable tray. The fiber-optic conduit has a large coefficient of expansion and is difficult to manage in the cable trays because of heat fluctuations. Fiber-optic cable with the heavy PVC jacket was chosen for structural integrity.

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On each piece of equipment, a 2' x 3' x 1' deep enclosure box with a gasket door was mounted.

The fiber termination box, fiber storage trays, and remote I/O were mounted in this enclosure.

Switchboard wire was used for connecting the I/O to the equipment. A 5/C cable was installed from each MOD to the circuit breaker. This saved up to 1000 feet of 12/C for each MOD, as wires were doubled to compensate for voltage drop.

In the control building, the fiber was terminated in storage racks in the control panels. This location made the patch cables easy to install.

During the design process, several recently completed traditional facilities were reviewed. It was interesting, as every circuit breaker had enough alarms combined to limit the total alarms for each breaker to five. This was due to normally installing two 12/C cables to each breaker. Multimode fiber was chosen, as the terminal equipment is less expensive. The 24-fiber cable cost 1.84/foot or about $.15/foot/pair. The 6-fiber cable cost was slightly higher per pair at $.16. So a 1,000-foot installation had a material cost of $160, the remote I/O was $375, the enclosure with termination rack was $200 ($800 split four ways as the equivalent of four 12/C cables were eliminated — two for the breaker and one for each MOD), and a fiber-optic transceiver was $362, for a total of $1,087. With 12/C #10 cables costing about $2/foot, the material cost for copper is $2,000 for each cable. The labor is difficult to compare between the two methods, but 1,000 feet of 12/C cable cannot be pulled by one person, and it takes time to dress out and terminate the four cable ends. Additionally, no further wiring is required in the building using fiber. Because the communications personnel were not wiring an RTU, they had time to fuse the fiber, and the climate-controlled environment was a nice place to work on a hot summer day.

To provide control for the circuit breakers, a 5/C cable was installed. The wires were assigned to positive, negative, trip1, trip2, and close. Therefore, one fiber pair and one 5/C cable replaced two 12/C cables. To provide control for the MODs associated with the circuit breaker, a pair of fiber replaced two 12/C cables. The materials cost for all copper would have been about $8000 for the four 1,000-foot lengths for the circuit breaker and MODs. The fiber/copper combination material cost was less than half that amount at about $3,200 dollars. Not only was the fiber less costly, but an infrastructure was also installed for a future Reliability Centered Maintenance (RCM) program or possible digital current and voltage signals.

Ethernet

Western installed an Ethernet network in the control building, with connections on the control panels. The Ethernet connection was used to access the SCADA master, which was used extensively during commissioning and checkout. The communications processor and HMI were connected to the network as well. Access via Western's intranet was deemed more secure than dialup. These connections allow for remote access into any of the substation IEDs to retrieve event reports. An automated scheme to retrieve these event reports is currently being evaluated.

The HMI connection allows for virus-checking software updates and remote hard-drive maintenance. The client software for the RAID controller allows hard drives to be rebuilt remotely if they stop because of an error. Connection to the Internet during commissioning made file sharing with experts

and the manufacturer's technical staff extremely easy.

Documentation

With the new technology, new ways to document the functionality were required. Traditional ladder logic diagrams for schematics were replaced with logic diagrams as the breaker schematics became two trip contacts and two close contacts. Relay schematics became little more than wiring diagrams because the only wired inputs were trip-coil monitors and relay-to-relay communication disable; wired outputs were trip, close, and alarm.

Spreadsheets were used to track information like RTU and HMI points, tag names, DNP index, and relay element names. Tables were included on schematics to track internal protective relay element usage and function.

LESSONS LEARNED

Training

Craftspersons responsible to keep a site functioning often want to know only about the specific features being used in a system—not every function a particular piece of hardware can perform.

Therefore, Western worked with the vendor in developing a target training course on the communications processors and logic processors. This training was well received, and it was followed by questions such as "Yes, but how does it get from here to there?" and "How do I fix it?" At this point, Western internally developed a three-day block of 101-type training on the functional blocks of the DCS design, how they integrate, and basic troubleshooting.

The internal training was conducted for all meter and relay personnel. Other attendees were individuals from operations, management, and engineering with an interest in DCS. The goal of the training was to present an overview of the DCS system and how each function was accomplished by the components of the system. The type of information needed to troubleshoot the system was presented. Segments included alarms, SOE, control, HMI, DCS control, analogs, Fiber 101, and Ethernet 101.

While basic training is essential, there is no substitute for actually working with the equipment.

The classroom training is a required prerequisite, but the final part of the learning occurs during the installation, commissioning, and final checkout. Training also requires sitting down with the new primary tool — the PC, learning to work with it and developing a new set of analytical tools for the PC.

DCS Design

The architecture chosen for the first project remains unchanged in the Upper Great Plains region.

While there have been advances and changes within the individual pieces, the overall functionality is the same. For example, control interface protocol from the RTU to the communications processor has changed from Modbus to DNP, but from that point through the system, it works the same way from the first substation to the tenth substation. The Upper Great Plains region of Western has installed a DCS control system in 11 substations.

Initially, one team at Western was working with DCS designs, so a standard was not an issue. As the design spread to new projects and other regions of Western starting work on their facilities, a difference in standards developed across Western. Western is in the process of addressing these differences and working toward a common solution. Western experienced some poor results when standards were adopted and implemented without testing and verifying the design. One recent example was the implementation of a fully redundant system with redundant control, redundant SOE, redundant analogs, and redundant status. This approach proved to be very complicated and introduced decision-making logic because SCADA wants only one set of data. It should be noted that the complexity more than doubles each time a redundant data or control source is added; complexity grows exponentially.

Maintenance

The only failure at Fort Thompson was a remote I/O device. An untrained electrician replaced the remote I/O device during normal work hours. The failure was that an input stayed asserted on the I/O device without the input voltage present.

There have been some settings errors related to reclosing and similar functions. These types of errors were not related to the DCS implementation. There have been no problems with the DCS equipment. Routine maintenance consists of cleaning the air filters for the HMI PCs, file cleanup, and periodically verifying hard drive integrity.

Western is changing the way they label some of the DCS alarms in order to give more descriptive information to the operators. An alarm of "21-3A communication failure" does not mean much to our operations personnel. If that alarm is labeled as "GI Line Loss of Primary Control and Status," it has immediate meaning for operations.

HISTORIC MEETING SPEARHEADS BATTLE AGAINST COUNTERFEIT GOODS

History was made when members of the electrical recycling industry sat across the table from major electrical device manufacturers and distributors to discuss how Professional Electrical Apparatus Recyclers League (PEARL) technical standards and procedures can help protect North America from the growing problem of electrical counterfeit goods, while guaranteeing a quality source of surplus and out-of-stock electrical devices.

"This was one of those 11-year 'overnight successes' we all hear about" explains Mark Stone, PEARL's Association Manager. "It took a decade for PEARL to develop electrical recycling standards and to bring together the three key parts to the electrical supply chain – manufacturers, distributors, and supply houses. There was some risk bringing together these groups because of a perception of competing goals, but PEARL's 2008 annual meeting held more surprises than seeing 1 million volts flowing through a 10-foot Tesla Coil; we also took the next step in insuring that electricians in North America can expect a solid supply of quality electrical devices by getting feedback from all the major players in the electrical industry and working to answer all of our concerns about counterfeit products, and safe electrical goods."

At PEARL's recent 11th Electrical Safety and Reliability Conference & Exhibition held in Costa Mesa, California, electrical recyclers met for the first time as a group with several key players in the electrical industry, including Eaton, UL, WESCO, and the National Electrical Manufacturers Association (NEMA). Following two days of presentations and a third of meetings and deliberations, PEARL board members agreed to several items designed to improve safety and efficiency of the electrical industry. Working with industry participants, PEARL members agreed to:

- Finalize procedures and move forward with mandatory 3rd party site and technician compliance and qualification inspections of all PEARL-member testing and remanufacturing facilities as required by PEARL bylaws;
- Improve the ease-of-use of PEARL's Test & Inspect and Remanufacturing standards by creating a member-only repository of technical device specifications and manufacturing recommendations for members to use as a reference when following PEARL's Test & Inspect, or Remanufacturing standards. This database is in addition to publicly accessible section of the PEARL website (www.pearl1.org) that tracks news on counterfeit electrical goods to support the need for greater public safety in the electrical industry;
- Further improve the ease-of-use of PEARL's standards by making computer-based forms for documenting devices covered under PEARL Test & Inspect, and Remanufacturing standards available to all members;
- Promote training and technical knowledge via postings of professional training available throughout North America;
- Develop member discounts for various training, goods and services important to electrical recyclers and requalfiers;
- And finally, to continue discussions with key distributors and manufacturers on the best way to develop new standards and processes that will further improve electrical safety in North America by

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One million volts flows through this 10-ft Tesla Coil built by David Qualls, an engineer at Boeing Corporation and member of the Tesla Society. The coil now resides at ROMAC Supply, in Commerce, California.

fighting the import and sale of counterfeit electrical goods.

In addition to the new policies listed above, PEARL also welcomes Stephen Reames, President of Oregon Breakers Inc. (Portland, OR) to its executive board. Mr. Reames replaces David Rosenfield, charter member and two time past-President of PEARL. Mr. Rosenfield has been an instrumental member of PEARL, sitting on the executive board 10 of PEARL's 11-year history.

After 2 years of discussions, meetings and planning, the Professional Electrical Apparatus Recyclers League (PEARL) was founded in 1997. PEARL creates, collects, and disseminates information, policies, procedures, and standards to ensure the proper recycling and reuse of electrical power equipment. Its 70+ corporate members must adhere to strict technical, safety, and ethical business practices.

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