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The Automation/IT Magazine

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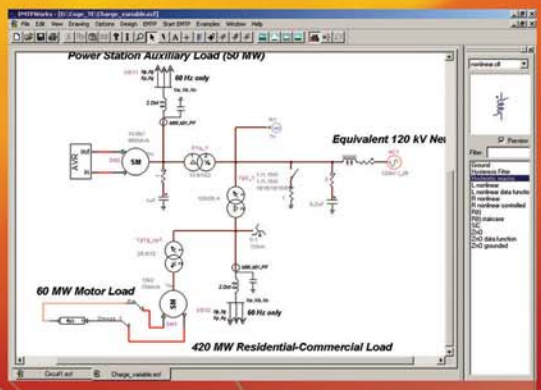
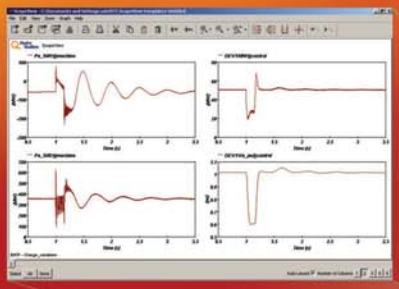
EMTP RV

ElectroMagnetic Transients Program





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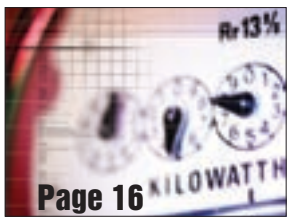

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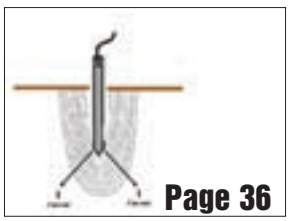
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The August 2003 Blackout: One Year Later

By: Francis Bradley, Vice-President
Canadian Electricity Association, bradley@canelect.ca

This past summer, 50 million people in Ontario and the Midwest and Northeast United States remembered the historical electricity blackout that left them without power. In a matter of seconds on August 14th, 2003, these Canadian and U.S. electricity customers understood first-hand just how vital electricity is in our day to day lives.

Reliability has always been a priority in the North American system, and those who endured the outage witnessed the great resiliency of the electricity system. Within 12 hours, over 2/3 of power generation had been restored to service without any damage to the generation or transmission facilities connected to the grid. However, in today's world, 12 hours is a long wait for a service as essential as electricity, and North Americans have come to expect that such incidents should never occur.

Blackout Investigation

The U.S.-Canada Power System Outage Task Force (the Task Force) was established immediately following the August blackout with two objectives: 1) to determine the causes of the blackout and why it was not contained, and 2) to develop recommendations to reduce the possibility of future outages, and minimize the scope of any that may occur.

Canadians participated actively in the deliberations of the Task Force. They oversaw and reviewed investigations of the conditions and events on the Canadian side of the border to determine whether they may have contributed to, or affected the blackout. Canadian members were also active on the Task Force's three working groups (electric system, nuclear and security) that assisted in the investigation, and the Canadian Electricity Association (CEA) and its member companies also made oral and written submissions to meetings of the Task Force.

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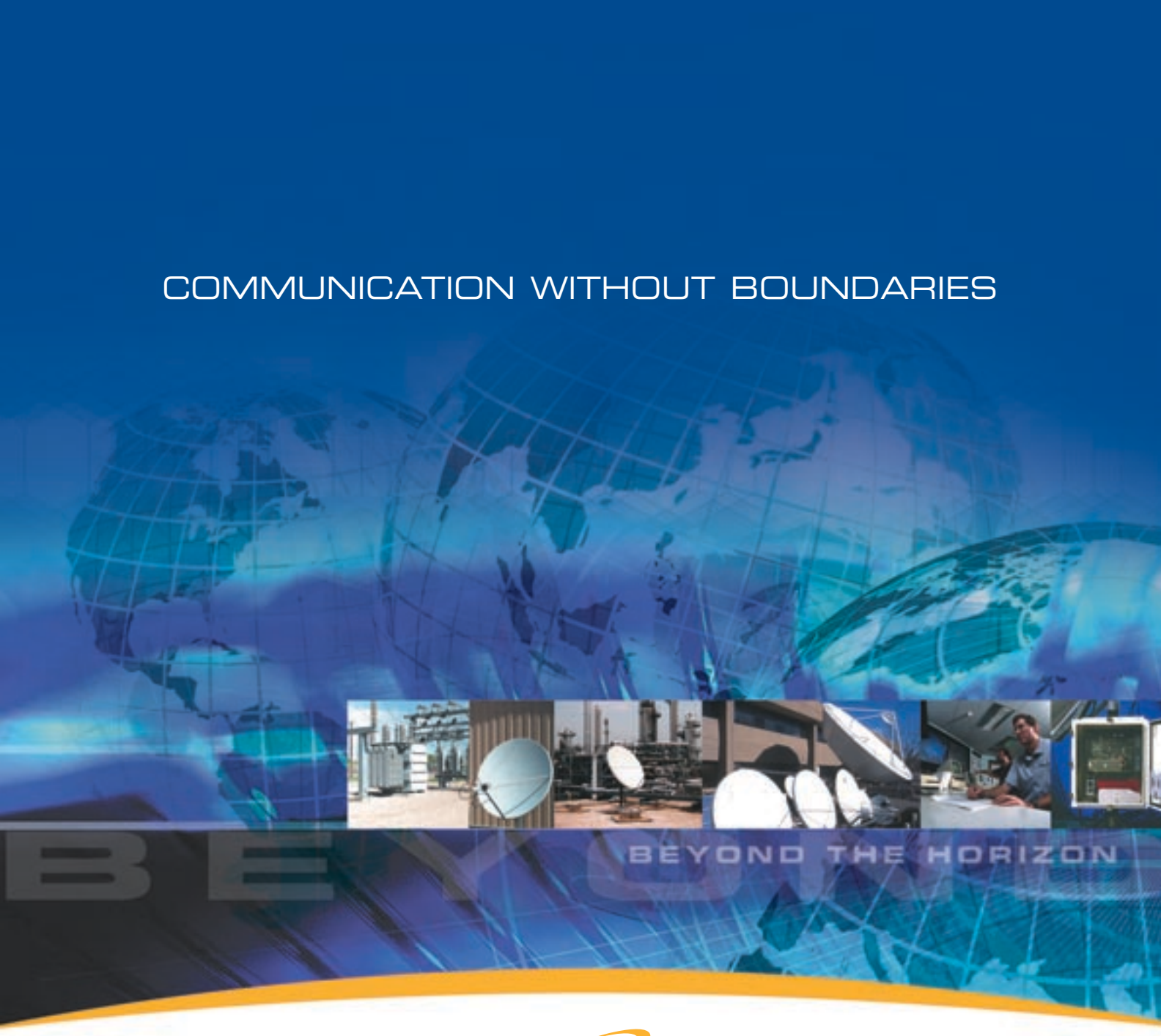

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The August 2003 Blackout

On April 5, 2004, the Task Force released its final report which provided a description and analysis of the blackout and 46 recommendations to prevent or minimize the scope of future blackouts. The mandate of the Task Force was extended in order to oversee the implementation process of these recommendations. In order to facilitate movement on the recommendations, the U.S. Department of Energy and Natural Resources Canada have been in extensive discussions over the shape of the future Electric Reliability Organization (ERO) that would be responsible for developing and enforcing mandatory reliability standards for North America. On September 29, 2004, the Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Council (NERC) will host a joint conference on the reliability readiness review process.

Enhancing North American Reliability

CEA has focused its attention on the taskforce recommendations that have explicit cross-border relevance on institutional issues related to reliability. These include making reliability standards mandatory, an assessment of the role of NERC, and the need for an independent source of reliability performance information.

Since the final blackout report, CEA has contributed to the reliability discussion with the release of two documents. The first in April 2004, summarized the current reliability situation in each province and stated CEA's support for mandatory reliability standards. The second, released in August 2004, outlined specific characteristics of the future ERO that will draft and enforce such standards.

With respect to the latter document, CEA believes the ERO must be independent and international in design and operation, and supports NERC assuming the role of the ERO, with regulatory backstop in Canada and the U.S. This organization is an essential element of a long-term strategy to prevent further major outages.

Conclusion and Next Steps

The North American electricity system, which inter-connects Canadian and U.S. electricity markets, is among the most reliable in the world. Increasingly open markets have brought with them opportunities for new efficiencies, new technologies, and ultimately better customer service and price. However the same system is subject to a host of pressures – aging infrastructures, need for continued new build in generation and transmission to meet demand, and growing regulatory pressures.

These pressures must be alleviated, and the 2003 blackout added urgency to industry and government discussions already underway about how to do that while continuing to deliver a reliable supply of electricity to the North American market.

CEA will remain an active participant in and sponsor of discussions of North American electric reliability. The Association and its member companies are committed to ensuring customers continue to receive affordable, environmentally sound, reliable power to meet their needs day in and day out. Effective enforcement of reliability standards is now recognized as a necessary prerequisite for that commitment to be fulfilled. As we move towards an international mandatory reliability regime, Canadian entities are well-prepared to participate in a manner that will ensure the continued provision of reliable electricity supply across the continent. ■

Industry Measures

CEA member companies have also undertaken significant efforts to implement the Task Force recommendations, and participate in continued follow-up to the blackout investigation. A partial list of measures taken by member companies across the country includes:

- increased expenditure on vegetation management;
- developing processes and documentation to ensure compliance with recommendations on IT security;
- participation in on-going revision of NERC reliability standards;
- addition of 2800 MW of supply in Ontario since August 2003;
- equipment and procedural enhancements;
- at nuclear facilities for a quicker return to service in the event of a blackout;
- participation in NERC internal investigation;
- participation in the drafting of NERC Version 0 standards that will address needs identified in the blackout investigation and provide a transition to the NERC standards currently under development.

ABOUT THE AUTHOR

Francis Bradley, in collaboration with the CEA team

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All of the AT30 controls are located on the front panel, which also provides quick and easy access to available meters and alarms. The AT30 has been engineered for worldwide safety and flexibility and, depending on size, can be floor, wall, or rack mounted.

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Headquartered in Easton, Pennsylvania, HindlePower, Inc. manufactures and distributes stationary battery charger and power systems products in industrial markets throughout the United States, Canada, and Europe. The company's products are an excellent choice for utility, power generation, oil and gas, transportation, mining, chemical plant, shipboard and platform applications. HindlePower products are certified worldwide, meeting the industry's highest standards for quality and safety. For more information www.hindlepowerinc.com, or by calling ●

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A Novel Approach to PCB Analysis in Oil.

Polychlorinated Biphenyl (PCB)

1. Regulatory bodies have become ever more vigilant in the regulation of Polychlorinated Biphenyls (PCBs). In Canada, a draft regulation is proposing a cutoff limit which matches Manitoba Hydro's labs traditional Gas Chromatography/Electron Capture Detection (GC/ECD) method detection limit of 2 ppm for total PCB in insulating oils. Detection limits should always be lower than regulatory limits when technically feasible. While the implementation of this new limit does not come into affect until 2007, generating data which will not comply with the new regulation will be wasteful.

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The GC/ECD method is very cost-effective and relatively simple but will not meet the long-term analytical need of Manitoba Hydro.

An Electron Capture detector is widely recognized as a very sensitive detector but it is not selective to PCBs only. Any electro-negative compound will be detected and this includes both halogenated compounds as well as other compounds to a lesser extent. At 50 ppm, the level of confidence of PCB detection and quantitation will be very high using an Electron Capture detector. However, at 2 ppm or less, the degree of confidence is much lower. One GC detector which is significantly more selective than an ECD is a Mass Spectrometer (MS). Generally, Mass Spectrometers are less sensitive than Electron Capture detectors but by taking advantage of one unique capability of an Ion Trap Mass Spectrometer over a single quadropole Mass Spectrometer, increased sensitivity can be attained. By using the capability of analyzing in MS/MS mode, significant improvements in sensitivity can be realized. Total sensitivity is a function of the signal of the detected compound versus the noise from the sample matrix. In MS/MS mode, noise is reduced to near instrumental noise (instrument background) rather than chromatographic noise (instrument and sample background) providing much lower detection limits.

While inherently sensitive, the Ion Trap MS is prone to trap overloading when matrix is not considered for sample analysis so a suitable method to separate the oil from the PCB was developed. If the Ion Trap would be allowed to overload, very poor results would be generated. The entire preparatory method was micro-scaled to minimize volumes of solvents and sizes of disposable glassware used which kept consumable costs low. By using small volumes of sample and solvent, the preparatory steps can be performed very efficiently. With our method, a single technician can prepare 80 to 100 samples per day for analysis.

Chromatography also is excellent with an analysis time of less than 13 minutes per run. Additionally, the use of mass spectrometry makes the separation of Aroclors easier to recognize. To add to the quality of the data congener surrogates are added prior to extraction to monitor extraction efficiency.

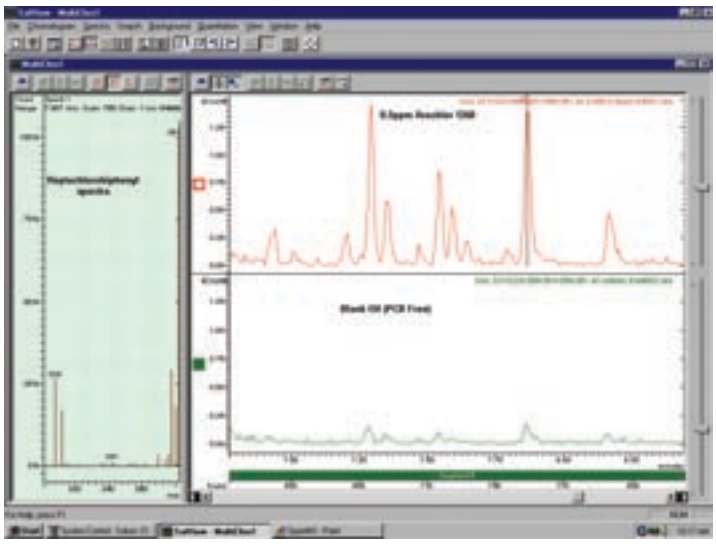


Figure 1: Chromatograms and spectra of 0.5 ppm Standards of Aroclor 1260.

In Figure 1, a chromatogram of a 0.5 ppm standard of Aroclor 1260 is shown along with a blank oil analysis as well as the spectra of one peak in the standard. The spectra clearly shows the very definitive spectra generated from the peaks used for Aroclor 1260 determinations. The information-rich method of detection allows the technician to definitively determine whether PCB is present, or not, in a sample. A GC/ECD analysis relies on one signal while an MS supplies many signals, all of which can be compared with one another to ascertain whether a compound is present.

In summary, Manitoba Hydro Chemical Laboratory Services has successfully adopted this method and is processing well over 1000 samples per month with two technicians. This method is accredited by Standards Council of Canada. Other methods which utilize GC/MS are long and laborious and typically cost in the hundreds of dollars. This novel approach to PCB analysis in oil takes advantage of the inherent sensitivity of an MS/MS analysis, provides excellent selectivity, and yet is also very cost effective. The cost of testing is only marginally more expensive than traditional GC/ECD analysis yet gives much superior results when determining PCB at levels less than 2 ppm. ●

Circle 146 on the Reader Service Card

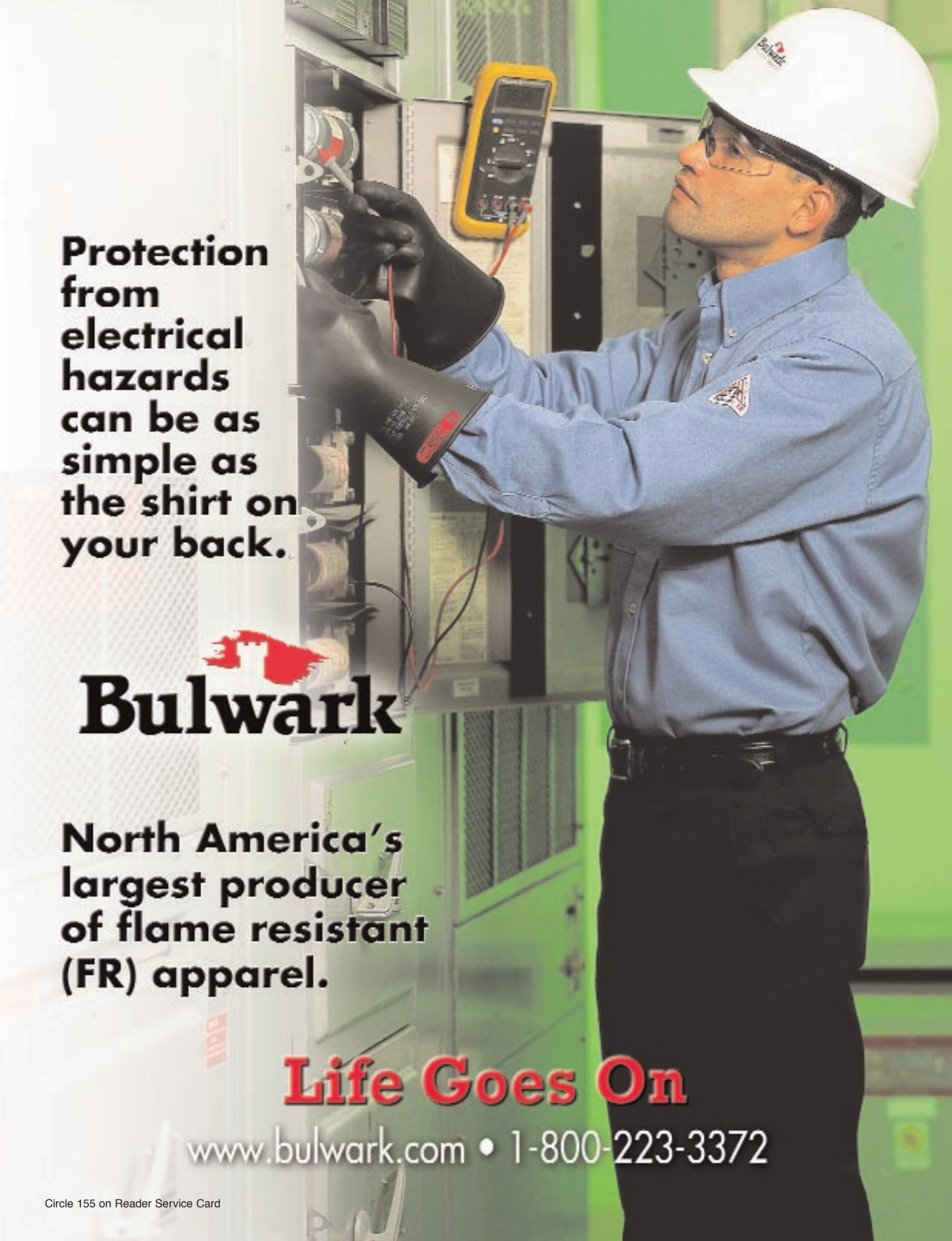
Laminated Wood Structures Bring Quick Relief to Storm Ravaged Area

In late May 2004 a series of tornadoes swept through the peaceful countryside of rural Nebraska. The storm contained no fewer than 7 tornadoes swirling beneath a mammoth super cell, carving a path of destruction nearly 1/2 mile wide, staying on the ground for nearly 1/2 an hour leaving one person dead and 37 hospitalized. The powerful storms leveled 158 homes and severely damaged 57 others, uprooted trees, overturned rail cars full of grain and turned vehicles into airborne missiles. The small town of Hallam, population 300, was almost completely destroyed.

Among the destruction were several transmission lines that connected into the coal-fired generation plant of the Lincoln Electric System (LES). The plant produces electricity for the capital city of Lincoln, 25 miles to the northeast. A 3-mile section of 115kV h-frame transmission line coming out of the plant was directly in the path of the tornado and was almost completely destroyed. Nearly every structure in the 3-mile section of the line was down.

This outage affected not only the surrounding area struck by the storm, but also Lincoln, NE which received some of it's power from the generation plant. The lines needed to be replaced as soon as possible.

The structure design normally used by LES for 115kV construction is single pole steel structures with braced post insulators. The decision was made to replace the older h-frames with the standard single pole structure design however, the utility did not have an adequate number of steel poles in inventory to rebuild the line and suppliers could not deliver new steel poles soon enough to meet the emergency deadline.



Circle 155 on Reader Service Card

Just 2 days after the terrible storm LES contacted Laminated Wood Systems, Inc. (LWS) and requested pricing & delivery on single pole engineered laminated wood structures to replace the 3 miles of h-frame line that had been destroyed. The next day LWS presented the utility with pricing and delivery on twenty-eight PELR-H8 E-LAM® 115kV single pole structure kits ranging in height from 85 to 110 feet, using the utility's standard braced-post construction in the design.

With lamination and treating plants located all across the U.S. and Canada, LWS was in a perfect position to supply the needed structures on time. After approving the engineering drawings LES issued a purchase order on May 27, five days after the storm, and the first two loads of structures were delivered on June 14 (just 17 days after the order). The balance of the structures was delivered to the site by June 24.

LES had used laminated wood structures in the past and were confident with their field proven reliability as a fully engineered product. The fact that the foundation design is included in the package saved engineers at the utility precious time in designing the line as soon as possible.

Since the laminated wood structures are made from a nationwide manufacturing it is possible for structures to be delivered anywhere in North America within 4 to 6 weeks under normal conditions, even faster when disaster strikes. The storm damage structures purchased by LES were manufactured in Minnesota and Alabama. LWS also supplied storm damage structures to Omaha Public Power District (OPPD) and Nebraska Public Power District (NPPD) as a result of this same storm.

Even though the lights are back on in this small Nebraska community, the landscape is filled with the shadows of trees stripped of their leaves, twisted pieces of tin, smoldering piles of burning debris and barren foundations where happy homes once stood.

Some of the surrounding farmsteads are being rebuilt but the only thing being rebuilt in the small town of Hallam is the grain elevator located next to the railroad tracks that will once again hold the bounty of this year's harvest – a sign of hope that life will once again return to normal. ●

Circle 147 on the Reader Service Card

Newmarket Hydro selects Olameter to own, install and operate Elster Electricity's EnergyAxis® System

Smart metering solution offers capital savings and increased customer service levels

Newmarket, Ontario, Canada – Elster Electricity and Olameter Inc. (Olameter) announce that Newmarket Hydro Ltd., headquartered in Newmarket, Ontario, has selected Olameter's meter asset ownership program, under which Olameter will own and manage the installation and operation of Elster Electricity's EnergyAxis® System. Olameter is an energy services provider and an agent in Ontario for Elster's electricity metering products. The implementation of the EnergyAxis System will be the first in a series of initiatives designed to meet the Government of Ontario's smart metering directive. Newmarket Hydro evaluated various solutions and selected the EnergyAxis System because it offered the most advanced technology and flexibility. Newmarket Hydro will be the first Canadian utility to deploy the EnergyAxis System.

"Local distribution companies (LDCs) are actively examining their options to ensure that they can meet the directive of the Government of Ontario with the most advanced technology," said Paul Ferguson, president of Newmarket Hydro. "Together, Olameter and Elster are responding to the industry's requirements by delivering a comprehensive smart metering solution that alleviates the upfront capital and logistical commitments typically associated with a project of this magnitude."

Elster's EnergyAxis System incorporates smart electronic meters with fully automated, intelligent two-way communications, making on-request meter reads and server-initiated commands a reality. The system utilizes a 900Mhz network comprised of Elster's new single phase electronic REX™ meters and A3 ALPHA® meter collectors to read meter billing and instrumentation data; change energy, demand, and time-of-use rates; implement critical tier pricing; start or stop load profile interval recording; and initiate service connects and disconnects. The system provides an economical solution for collecting and reading billing and interval data directly from the meter ensuring that the values on the meter display are the same as those read remotely by the server.

"Elster is excited to be working with Newmarket Hydro and Olameter on the selection of the EnergyAxis System," remarked Mark L. Munday, president of Elster Electricity. "Local distribution companies can now quickly realize the benefits of Elster's advanced two-way technology by using Olameter's rapid implementation methodology."

Under the terms of the agreement, Olameter will own the EnergyAxis System and all associated metering assets for Newmarket Hydro as well as manage the system implementation and ongoing operation. Olameter will provide Newmarket Hydro with a complete turnkey solution encompassing meter supply, verifications, meter file management, meter reading and technology upgrades.

"Olameter is very pleased to be selected as the partner of choice to support Newmarket Hydro's efforts in addressing the provincial smart metering directive," said James Douglas, vice president and general manager of Olameter. "Our meter asset ownership program is designed specifically to enable utilities, such as Newmarket Hydro, to benefit from substantial capital savings and improved service levels through the complete outsourcing of all meter-related functions."

System implementation is scheduled to begin in the fall of 2004 with deployment to be completed by the end of 2004.

For more information about Newmarket Hydro Ltd. www.nmhydro.on.ca

Newmarket Hydro Ltd. is an electric distribution company providing electric distribution services to the greater Newmarket area. Serving over 25,000 customers, Newmarket Hydro continues to meet the challenges of annual growth in its

customer base. As the primary billing agent for these customers, Newmarket Hydro believes it is imperative that new ways of providing continuous and efficient customer support be identified and implemented.

For more information about Olameter Inc. www.olameter.com

Olameter Inc., a Canadian company, is a leading provider of services and solutions to the North American utility industry. Olameter provides a variety of outsourced solutions that include meter reading, collections, billing services, bill printing and mailing, meter procurement, meter installation, demand side management and meter asset ownership. As a single-source provider, Olameter is committed to delivering quality service and technically innovative solutions that improve efficiencies, enhance service levels and reduce operational costs.

For more information about Elster Electricity, LLC (USA) www.elsterelectricity.com }

Elster Electricity, LLC, a subsidiary within E.ON's Ruhrgas Industries, offers integrated, cost-effective solutions including advanced electricity meters, communication solutions and metering automation systems for residential and commercial and industrial applications. Elster Electricity (formerly ABB Electricity Metering) is located in Raleigh, North Carolina and is a leading provider of electricity metering products and services throughout the world. Designed to meet the diverse electricity metering requirements of a global customer base, Elster's metering products include high accuracy ANSI and IEC electricity meters featuring the ALPHA meter line, and the EnergyAxis System with intelligent two-way communications.

For more information about Elster Metering (Canada) www.elsterelectricity.com

Elster Metering is a leading supplier of electricity and water meters and related AMR equipment and systems in Canada. Elster Metering (formerly ABB Metering) is a division of Canadian Meter Company, Canada's leading gas meter supplier, and part of E.ON's Ruhrgas Industries. Elster Metering is located in Burlington, Ontario and offers a wide variety of metering and AMR solutions including the EnergyAxis System and the ALPHA meter line. Elster Metering delivers metering solutions across Canada focusing on helping customers achieve their metering goals. ●

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High Current – High Class Major Expansion for Kinectrics Unique Lab Facility

By Margaret Bennett – Marketing Communications Specialist – Kinectrics Inc.

Kinectrics' Ontario High Current (HC) Lab Test Facility is one of only two of its kind operating in Canada, the other being located in British Columbia. Growing demand throughout North America for the services of Kinectrics' HC Lab necessitated a major expansion of the Toronto facility this summer.

"The external test cell footprint was increased to almost triple its length and the height of the overall test area has been renovated as well", says Claude Maurice, a Lead Technologist at Kinectrics and operator of the HC Lab.

The main advantage of the work for clients is that "it will relieve the bottleneck of a single cell test," explains Maurice. "I will be able to leave one equipment setup in position for later additional work as required, while running another client job in a different part of the test cell," he says. This will eliminate time-consuming and redundant effort in tearing down and setting up equipment for individual tests.

John Kuffel, General Manager of Kinectrics Transmission and Distribution business concurs, "The renovation is improving the material handling capacity of the HC lab to enable us to serve clients much more quickly," says Kuffel. "The time typically required for a project is 2-3 months." "We hope to cut that in half with these renovations, as well as enhance our ability to handle larger equipment and bigger setups." For John Page, Manager of Kinectrics' Electrical Testing Department, the upgrade also means modernization of the internal control room and replacement of supply equipment to match present day technology. He anticipates significant benefits for both clients and Kinectrics' personnel in the form of increased throughput, as well as reduced maintenance and downtime.

Construction commenced in July with completion of the project anticipated for late September 2004. The HC Lab remained closed for the duration of the work. Electrical equipment design and specification was contracted to ABB and Cutler-Hammer.

An essential service

Test items handled by the lab include a large volume of transmission equipment, industrial clothing and materials. These typically include personal protective equipment, temporary grounds, switchgear isolating switches, line hardware and transformers.

Clients are mainly electrical utilities and manufacturers, including many from the United States. A very high percentage of clients attend the HC Lab as test observers. "I typically spend 4 out of 5 days a week working with clients attending the sessions," confirms Maurice.

The HC Lab is highly specialized in clothing testing and has been developed in conjunction with manufacturers' needs. "The current capital investment reflects changes in those needs over the past twenty years," underlines Kuffel.

Kinectrics HC Lab continues to play an ongoing role in developing essential industry and safety standards for FR (flame-resistant) clothing and materials, and remains the only lab of its kind performing this important work in North America.

Data acquired depends on the type of test and whether it is required for product development or product certification. In general clients are seeking knowledge and accurate data on performance. Video plays a key role in this determination according to Maurice. "Controls, monitors and displays can tell you the test item was subjected to the right parameters and specifications, but video provides the best detailed proof of performance on whether or not a passing standard was attained," he emphasizes.

A highly qualified technician, Maurice has been running the HC Lab since 1987 and takes great pride in his work. For Maurice, the most enjoyable part of his job is dealing directly with clients. "At Kinectrics, I can deliver the kind of information and electrical testing services clients can't get anywhere else," he explains.

On completion of the HC Lab renovations this fall, Kinectrics' clients can look forward to a brand new facility, offering both greatly enhanced technical capabilities and faster turnaround for this essential service. ●

Circle 149 on the Reader Service Card

Southern California Edison Revolutionizes the Way Work Gets Done

Southern California Edison (SCE) is one of the largest electric utilities in the United States, and is the largest subsidiary of Edison International. SCE provides a population of 12 million people in central, coastal, and southern California with electricity. SCE's field service organization provides a variety of services including turning electric service on and off, disconnecting electric services for non-payment, responding to inquiries regarding energy consumption, replacing meters, and picking up off-cycle meter readings. Over 300 field service representatives (FSRs) work in the company's 35 service centers, completing approximately 3 million orders annually.

In the late 1990s, SCE decided to replace its outdated field service system with MDSI's Advantex, workforce management solution. Functionally, SCE wanted a "cutting-edge" system that would enable real-time status updates on service orders and FSRs. With their previous system, office and field personnel were challenged with lack of information regarding status updates, cancellations or changes made to schedules that could only be communicated via radio or pager, and the need to enter service order information on paper. Dispatchers found themselves constantly communicating with the field and typing simultaneously, reducing their efficiency.

MDSI Advantex was initially implemented to achieve a number of important goals, including:

- Improvements in the immediate accessibility of customer information to field representatives during the workday.
- Real-time status updates of customer work orders and account histories.
- Optimize the distribution of customer work orders to field representatives according to representative location, availability and skill set.
- Consolidated data and improved visibility into field operations to provide insight into how to maximize work force efficiency.

Advantex provided not only the benefits of the former system, but also enabled the achievement of greater workforce productivity and cost savings. Today, SCE dispatchers automatically assign work order details to the FSRs, who use Advantex to process their work throughout the day, and send status updates and order completion information back to the office – all wirelessly, in real time. As a result of deploying Advantex, SCE has attained the following benefits and performance achievements:

For Field Service Representatives:

Improvement	Result
• Real-time routing, elimination of manual input, reduction in field trips	• Over $1.7 M annual savings in labor
• Overtime reduction	• ~ 100% reduction in overtime • Annual savings of ~ $200,000
• Material and other savings (e.g., uniforms, trucks, etc.) due to fewer FSRs required	• Annual savings of over $350,000
• Work time gained from improved FSR productivity	• 1.13 hours gained per day
• More work orders processed per technician per year	• ~ 5% annual increase
• Reduced travel due to the ability to aggregate and assign work orders based on location	
• More customer information readily accessible to FSRs as a result of host inquiry capability	

For dispatchers:

Improvement	Result
• Eliminated voice dispatching and paging	• Over $500,000 annual savings in labor
• Fewer dispatch positions required	• 90% reduction
• Reduced workload (allowing dispatchers to take on other duties in the phone center)	• Over 50% reduction

For customers:

Improvement	Result
• Improved customer satisfaction	• ~ 14% increase
• Real-time status and information flow, providing customers with up-to-the minute order status	
• Improved billing accuracy	
• Improved response times – new orders sent to FSRs throughout the day are handled immediately since the FSRs are alerted in real time when they receive new orders or schedule changes	

The implementation of Advantex at SCE has yielded significant benefits including improved operational efficiency for its FSRs and its dispatchers. Advantex has allowed for greater flexibility for resource deployment and work reassignment, as well as real-time visibility of the status of customer service orders. Furthermore, Advantex has proved to be a cost-effective replacement of an obsolete legacy system that was becoming increasingly expensive to maintain. Most importantly, the operational benefits achieved by SCE have yielded significant savings and improved service that has been passed on to its customers. Contact Information: E-mail: info@mdsi.ca ●

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Does the Utility Industry Need a Standard for Data Communication with Residential AMR Devices?

By: Robert W. McMichael, Jr. Ph.D., Datamatic Ltd.

Introduction:

Due to the hard work of a group of dedicated individuals in the ANSI C12.17 working groups, a set of five standards for data communications with Commercial and Industrial metering devices have been developed. Three of these standards have been released; C12.18, Protocol Specification for ANSI Type 2 Optical Port; C12.19, Utility Industry End Device Data Tables; and C12.21, Protocol Specification for Telephone Modem Communication. Completing the set are two new standards C12.22, Protocol Specification for Interfacing to Data Communication Networks, and C12.23 Compliance Testing For Standard Protocols and Tables (C12.18, C12.19, C12.21, C12.22). Revisions to the existing documents and the initial version of the new standards should be completed and released to ballot later this year.

The adoption of these standards is expected to provide a great benefit to the utility industry and thus raises the question of whether a similar standard is needed for residential AMR devices. Some argue that it should be so, as all of the advantages for standardizing C&I metering also apply to residential AMR devices. However, the goal of this article is not to make a case for or against this question, but to open a debate on the need for such a standard by examining the advantages and challenges to all of the participants in the industry presented by the development of such a standard.

Advantages:

The value proposition of AMR systems is that they can reduce the cost of collecting individual meter readings. Currently, there are at least three methods for collecting data from residential AMR devices:

- Walk-by systems, where the meter reader reads the devices through a hand-held computer containing a radio transceiver is one method.
- Analogous to the walk-by systems are drive-by systems; where the data-collection system and transceiver are placed in a van that drives the meter-reading route.
- Fixed network systems where the individual AMR devices send their reading to the head end system at the utility through a private or public network. Examples of these networks are power line carrier, radio networks where equipment is placed in fixed locations and act to concentrate the readings from the devices in a defined area and pass them up through a series of hops to the head end system, satellite networks, and the Internet.

One concern in the implementation of these systems is that they tie the utility to a single source for the purchase of both AMR devices and data collection systems. This fact combined with the relatively large initial capital costs associated with deploying a large scale AMR solution raises concerns about the durability and extensibility of the system in the long term, particularly in the case of fixed network solutions. The development of a standard for data communications with residential AMR devices would help alleviate these concerns.

A standard would also spur innovation in the functionality and design of AMR devices by allowing device manufacturers to take the risk of developing devices with innovative designs and functions because their potential customer base would not be limited by the meter reading software used by a customer. In the software segment of the business, innovation can be driven by reassigning resources currently used to develop and maintain communication modules for a variety of manufacturers' proprietary protocols to the development of new functionality desired by their utility customers.

Challenges:

The biggest challenge to the adoption of any standard is achieving buy-in from all participants; in this case utilities, hardware manufacturers and software developers. The industry was fortunate that a wide variety of individuals were involved with the working groups that developed the standards for C&I metering. Likewise, the development of a standard for residential AMR devices will need an equivalent level of participation.

The adoption of a standard will initially be disruptive to AMR device manufacturers and meter reading software developers as they will need to redesign their products to utilize the new standard. The active participation of hardware manufacturers and software developers will be critical to the development of any standard. This will ensure that the standard can be implemented and does not place an undue burden on anyone in particular.

Technical issues will also need to be resolved. These issues include items such as what radio frequency will be used for walk-by or drive-by AMR solutions and how the standard function will operate in fixed networks regardless of whether they are using radio, power line carrier, the Internet, or a combination of these technologies to transmit the data. There will also undoubtedly be new technological innovations that arise which will need to be evaluated and dealt with along the way.

Utility representation is also required so that the standard will meet their needs in terms of functionality. To be useful, every standard must consider how it can be extended in the future to meet the changing needs of the users. Most of companies can provide a handful of data items that would need to be supported in the standard, but looking to the future is much more challenging. The end users, in this case the utilities, are in the best position to provide this insight; thus, their participation in those committees developing the standards is critical.

At WIN Energy, Katie can help her dad, Greg, design jobs using StakeOut's easy interface.

"Find Money in the Field"

Can you afford to let another year go by without using StakeOut?

StakeOut Saves Money and Time

To start out, here are a few facts: WIN Energy reduced time spent managing work orders 40%. In the first few months using StakeOut, Bridger Valley Electric saw a 75% paperwork reduction. Flathead Electric increased work order production 12% annually and significantly reduced the time customers wait for appointments.

StakeOut will pay for itself in 8 to 18 months. StakeOut reduces data entry, increases accuracy and streamlines the work order process. StakeOut does require an initial investment. Now is the time to start thinking about budgeting for that investment.

StakeOut is Easy

Let's face it, buying new software is a daunting task. You need to make everyone happy and, most importantly, find something people will really use. Engineers, stakers and designers love StakeOut for its easy to learn interface. You draw jobs just like you are used to, using a pen and tablet computer. No complex commands or arcane terminology. People like StakeOut because it makes their jobs easier and faster.

StakeOut has the added bonus of increasing the value of your GIS. StakeOut lets you bring GIS data into the field and design right on top of it. New designs are then integrated back into the GIS, cost effectively keeping it up to date and letting your GIS staff focus on higher value analysis activities. StakeOut has similar MultiSpeak interfaces for accounting and CIS.

Complete In-field Design

Lately everyone's talking about "In-Field Design" and "taking GIS to the field." The field is the trendy place to be this year. Unlike other systems, StakeOut was field based in 1996. Longer than most other staking systems have been around. StakeOut runs on a tablet PC with a big enough screen to let you design your whole job in the field.

StakeOut Manages Work

Once a job gets back from the field, who has it? Do you know where work order 24-4235B is right now? How do you account for as-built changes? With StakeOut's work order management tools, you always know who has the job and what changes have been made. No more valuable time spent running around trying to track down the latest version. You can be more responsive to customers when they ask about their job's status.

Helping Plan Your Purchase

From a business perspective, there are a lot of good reasons to buy StakeOut. However, to justify putting it in the budget, many utilities need to see hard data about cost savings. MiniMax's team can work with you to develop a budget estimate and an ROI (return on investment) model showing how quickly the system can pay for itself. For help making the case for StakeOut, please contact MiniMax.

Conclusions:

The development of standards covering the communications and data structures for C&I meters has been seen as a great benefit to the utility industry. It is possible that the benefits will be similar with the development of a standard for residential AMR device. Hopefully this article is a starting point for discussions in the industry on whether this statement is true. Ponder the idea and talk about it among colleagues. It will be up to everyone in the industry to determine whether there is a benefit in creating a standard for residential AMR and whether that benefit is great enough to make a commitment to participating in the process of developing a standard. I, for one, am ready to make this commitment.

About the Author

Robert W. McMichael, Jr., Ph.D. is Director of Software Engineering for Datamatic Energy Systems (www.datamatic.com). The company has been a leading supplier of enterprise meter reading solutions for gas, water and electric utilities worldwide since 1977.

Dr. McMichael is a leading communications protocol expert with extensive experience in C&I metering communications, data extraction, data management and system development and integration. He is a contributing member of the ANSI C12 Committee on Electricity Metering that developed standards for reading energy meters.

Dr. McMichael can be reached for questions or comment at rmcmichael@datamatic.com. ■

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Elster Electricity's EnergyAxis® System with Intelligent Two-Way Communications

Elster's REX™ meter and A3 ALPHA® meter/collector

In today's highly competitive global arena, the utility industry faces challenges and opportunities never seen before. Change has become constant, with innovation the standard rather than the exception. Reducing costs, enhancing customer service, and improving operational efficiencies are business strategies common to every company looking to remain competitive and operate profitably.

As a world-class provider of electricity metering products, communication solutions, and metering automation systems, Elster Electricity is a company aggressively pursuing those challenges. According to Ronald B. Via, vice president of sales and marketing, "Our goal is to increase customer revenues through innovative solutions and reduce costs through streamlined operational strategies. The introduction of our EnergyAxis System represents a major advance in network metering communications and extends beyond typical automated meter reading solutions. It reflects our continued commitment to these goals and enables our customers to compete effectively in a changing environment."

The Power of Two-Way Communications

Built on 900 MHz unlicensed radio communications technology, the EnergyAxis System's new, fully automated, intelligent two-way communications makes on-request meter reads and server-initiated commands a reality. Its powerful two-way communications, coupled with Elster's new electronic single-phase REX™ meter, enables utilities not only to read meters, but to change energy, demand, or time-of-use rates as needed, as well as start or stop load profile interval recording, or initiate a service disconnect. To further enhance a utility's customer service capabilities, the system can automatically receive neighborhood power outage or restoration data, local voltage conditions, outage counts and other information.

Engineered for optimum flexibility and functionality, the EnergyAxis System supports targeted deployments of hundreds or thousands of meters, up to full-scale multi-million point installations. Its flexible two-way communications architecture assures greater wireless coverage through the implementation of a "mesh network" in which individual REX meters can function as repeaters. Since each meter can be designated to receive and transmit messages from other meters, the EnergyAxis System works in areas where obstacles exist.

Meter Readings When and Where You Need Them

Locked gates, unleashed pets, or indoor meters all reduce operational efficiencies, drive up metering costs, and reduce revenues. With the EnergyAxis System, these barriers as well as associated problems of estimated bills or rescheduled meter reads are eliminated. High turnover areas, like apartment complexes, universities, and military housing, represent costly service areas, requiring repeated trips to obtain move-in and move-out meter reads, or to provide disconnect and reconnect services. The on-request reading function and the remote operation of Elster's optional disconnect switch improves the utility's ability to connect or disconnect service reducing operational costs and improving customer service.

Rapid Change Requires Intelligent Metering Products

"With the utility industry experiencing unprecedented change, market pressures have made sophisticated pricing methods for electricity a growing necessity. Our system has been built with advanced features that offer utilities optimum metering and billing flexibility for addressing these issues," says Garry January, Elster Electricity's residential meter product manager.

At the heart of the system is Elster's new single-phase, residential electronic REX meter with built-in EnergyAxis System communications. Innovative in design and multi-tasking in function, the REX meter provides highly accurate kWh consumption, kW demand, time-of-use metering, critical tier pricing, and load profile interval data, all on command. These features reduce costly site visits and eliminate the need for new metering hardware. Utilities can adjust prices daily, a distinct advantage during peak energy demand periods.

The unique design of the REX meter and the intelligent two-way network architecture enables meter self-registration within the network for true "plug-and-go" capability. This feature eliminates the need for on-site programming, making installation and operation both easy and economical. Once installed, each meter automatically registers with the network. Should local conditions change, meters reregister via alternate paths.

The communications network of the EnergyAxis System utilizes spread spectrum frequency-hopping technology to provide secure, reliable communications between meters and collectors. This technology enables individual meters to be designated as repeaters, creating a dynamic path that optimizes signal strength and maximizes communication distances. Communication distances between meters and collectors are increased, and the number of collectors required is dramatically reduced, improving system economics. The system architecture uses Elster's A3 ALPHA meter as the host for local data collection from the REX meter, making collector installations simple while reducing costs.

For more information on the Elster's EnergyAxis System with intelligent two-way communications, contact us today!

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Metering Automation Server

- Two-way communications to all meters
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- Meter functionality and rates changeable on command

ELSTER

Circle 164 on Reader Service Card

Wanted: More Data

Now, like never before, utilities want more data. This is particularly true about when and how much energy is being used. Traditionally, the acquisition of that data has been accomplished with expensive commercial and industrial (C&I) meters that enable satellite, Internet, cellular, RF or modem transmission of usage data back to the utility. There has also been the ability to retrieve this data through expensive power line carrier (PLC) equipment and substation infrastructure that goes with it. However, the cost of these technologies has often put them out of reach of small and medium-sized utilities. But advances in technology have opened some new options to these users making tremendous amounts of useful data available to them at a much lower cost.

The continuous reduction in the cost of non-volatile memory has enabled the capability to collect and store large amounts of this interval data at the meter. The automatic storage of desired data at every meter provides the flexibility for the utility to retrieve and use the data when and how they want, without the overhead and expense of alternative systems and specially skilled personnel. The downside is that most utilities do not have telecommunications expertise or communications infrastructure experience; they also are not usually equipped to provide effective data storage and network management. And there are limitations to traditional drive-by methods of meter reading and data collection that only collect a monthly cumulative read.

Most utilities have purchased, evaluated or at least inquired about AMR systems over the years. Recent studies show a continuing year-over-year increase in the number of AMR units being installed by electric, water and gas utilities. Utilities that haven't already done so will put together cost benefit analyses that review FN AMR as well as mobile AMR. The primary purpose of these evaluations will focus on reducing the cost of getting the read. RF-based FN solutions will substantially reduce the cost of reading the meter but the infrastructure build out is costly. The expense and complexity of purchasing and operating a FN solution doesn't have to keep a utility from getting the data that will allow them to function more effectively or provide a higher level of customer service. Conversely, the desire to have data that will allow a utility to function more effectively or provide a higher level of customer service shouldn't force them to spend the added cost for a FN if it doesn't make sense.

Today, a new generation of mobile AMR systems, like the Datamatic FIREFLY®, allow utilities to collect energy interval data during normal AMR reading operations. These advances now allow mobile AMR to deliver many of the benefits of fixed networks at a much lower cost. In addition to transmitting the current reading (and in the case of the Electric FIREFLY, Peak Demand for the current and previous 30-day periods) FIREFLY Meter Interface Units (MIUs) archive usage patterns at user-definable intervals. When configured to store interval data at 15-minute increments, FIREFLY Electric MIUs store profile data for the previous 165 days. Gas FIREFLY MIUs are typically set to record 60-minute intervals and at that setting, can hold more than 330 days of usage patterns. These large historical "windows" permit utilities to leave the data at the meter and only retrieve what is needed, thus minimizing the need for large-scale data management on the utility's LAN/WAN. And by delivering more data than any other available system in its class, FIREFLY blurs the benefits line between mobile and FN AMR systems.

Now that the data is there and available, what can be done with it? With the right data management, the uses are limited only by the utility's imagination. Common uses for detailed profile data have included peak demand studies, certain types of TOU billing, right-sizing transformers and other transmission infrastructure, customer dispute resolution, theft monitoring and enhancements to customer service. Users should never let the historical uses or 'group-think' keep them from using locally-stored, easily-retrieved and simply-manipulated data in innovative, cost-saving and customer-serving ways.

The need for energy use data can now be met due to the lower MIU costs, advances in technology and new profiling options. Utilities can now choose a cost-effective AMR system that gives them the data they need to provide a higher level of customer service and better understand where and when their energy is being used. This information will lead to more effectively managing infrastructure build out, load management and customer service all without having to build and manage an expensive fixed network infrastructure.

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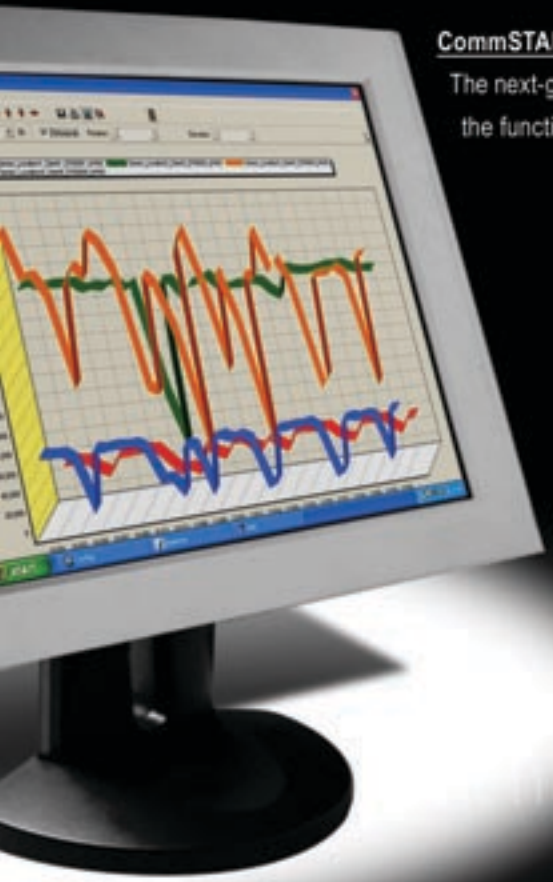

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Brooks UPG sees successes during first year as new organization

New products designed to reduce utilities' costs

By Jeffrey Hanft, Vice President, Brooks Utility Products Group

EK-DISCONNECT

With detailed user instructions and safety guidelines on every device, the EK-Disconnect ensures field personnel are safe and not endangered during the disconnect/reconnect process with lever bypass sockets. It also makes the process quicker, reduces costs and eliminates the possibility of equipment damage.

QUIK LOCK

Brooks UPG's Quik Lock™ high-security locking device fits most ringless meter sockets and CT cabinets, and offers a choice of a steel or plastic body.

SNAP2

Brooks UPG's Snap2™ transformer-rated meter panel reduces installation time from hours to a matter of minutes. It also reduces the chance for time-consuming and costly field mistakes and coordination problems.

FARMINGTON HILLS, Mich., U.S.A. – With slightly less than a year under its belt as Brooks Utility Products Group, the company has seen some early positive impact from the group's formation.

Brooks Utility Products Group, part of the E.J. Brooks family of companies, was formed in late 2003, as a reorganization of three utility industry companies. The formation of Brooks UPG has made it easier for customers and distributors to work with us. While we still have three operating units in Brooks Ekstrom, Brooks Meter Devices and Brooks Security Products, our engineering, billing and other functions perform as one in processing orders, giving technical assistance, and improving or developing new products.

With headquarters in Farmington Hills, Michigan, U.S.A., Brooks Utility Products Group also has manufacturing and office operations in Canton, Ohio; and Livingston, New Jersey.

The capabilities of Brooks UPG's three operating units include:

- **Brooks Ekstrom:** Designs and develops meter changeout adapters, meter extenders and interbases, test and safety equipment, and metering accessories for electric utilities and OEMs that serve utilities.
- **Brooks Meter Devices:** Manufactures meter and relay test switches, NEMA 1, 3R, 4, 4X and 12 enclosures, prewired meter sockets, transockets, primary meter enclosures and sectionalizing equipment, meter warm-up boards, and meter accessories.
- **Brooks Security Products:** Manufactures a full line of security and revenue protection products, from tamper-evident seals to high-level hardened alloy products.

In addition to more effective operations, we are capable of faster product development efforts because we'll be able to spot industry needs quicker, and get customer feedback quicker.

Brooks Meter Devices: Snap2 transformer-rated meter panel

One new product innovation from Brooks UPG is the Snap2™ transformer-rated meter panel. Utility companies save money using the Snap2 meter socket by allowing contractors to install an empty meter enclosure ahead of the actual meter service date.

Then, utility personnel take a pre-wired meter panel to the job site, and snap it into place. This reduces installation time from hours to minutes. It also reduces the possibility for field coordination problems.

According to the strategic marketing director for Brooks Meter Devices, John Gagnon, the Snap2™ pre-wired socket was developed after talking with a Texas utility customer about field installation problems. After reviewing the situation, our sales and marketing personnel worked with engineering to define specifications, and complete a prototype. Within two months of the customer's initial request, we presented it.

The Snap2 panel comes in 6, 8, or 13 terminal designs, prewired to a customer-approved test switch and color-coded wiring specifications. UL-listed, Snap2 panel available models include one- and two-piece ringless, and two-piece ring type covers.

Brooks Security Products: Quik Lock™ security locking device

Another new product from Brooks UPG is the Quik Lock security locking device for ringless electric meter sockets and CT cabinets.

Steven Rios, strategic marketing director for Brooks Security Products, explained that the Quik Lock device offers the choice of two options: a bracket and a choice of either a steel or plastic body. The economical plastic body is steel reinforced and made from high-impact resistant, glass-filled nylon. The steel body is hardened to resist tampering, and plated to resist corrosion.

Quick and easy to use, the Quik Lock requires no holes to be punched in the socket or special tools to install.

Brooks Ekstrom: EK-Disconnect

Like the Snap2 socket, the Brooks Ekstrom operations also worked closely with utility customers to develop the EK-Disconnect. It is designed to ensure field personnel are safe and not endangered during the disconnect/reconnect process with lever bypass sockets; eliminate the need to make arrangements with customers to change service; eliminate the need for expensive service cuts ahead of the meter; and eliminate the possibility of equipment damage.

Mike Lewis, Brooks Ekstrom strategic marketing director, noted that each EK-Disconnect provides detailed user instructions and safety guidelines on every device, and uses a solid polycarbonate housing that is virtually unbreakable. It also features all copper connectors with tin plating, a patented ejector hand for quick and accurate removal, and three load side indicator lights to warn of unwanted potential.

For additional information about Brooks Utility Products Group, visit www.brooksutility.com

INTRODUCING

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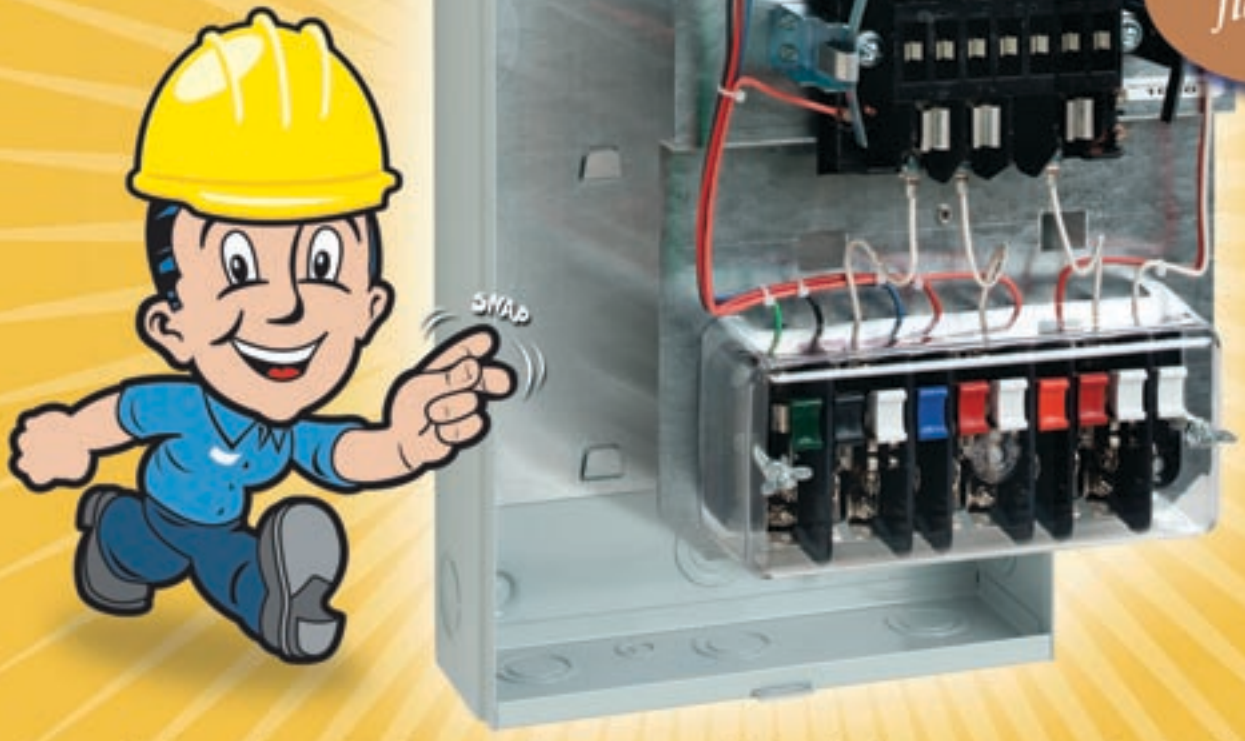

It's the amazing new Brooks Meter Devices' **Snap2** pre-wired meter socket.

It's a money saving device because you avoid the cost of stocking the empty meter socket and cover. You also avoid costly field mistakes and coordination problems.

It's a flexible device. Your installer just snaps a pre-wired panel built to your specification into the empty meter socket previously installed. This patent pending snap together design reduces a field installation from what used to take hours to just a matter of minutes.

And the **Snap2** pre-wired meter socket is just one of the innovative new answers that Brooks Utility Products Group brings to the industry.

So if you're looking for a better way to install transformer-rated meter services, you need to know about the new way to do it.

And **Snap2** it!

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AMRON's Myth Busters

By: Mark Leach, Chief Technology Officer, AMRON Technologies, Inc.

Myths thrive in our industry. It's unfortunate, but myths tend to proliferate faster than cold, hard truths. I hear so many myths I can't keep them all straight. Of the hundreds swirling around, let me bust two of my favorites:

MYTH #112: Advanced metering is the same as automatic meter reading

MYTH #358: "Real time" is an absolute term in advanced metering

MYTH #112

First, if AMR is the promised land, then why in the heck isn't every utility relying on it and preparing to deploy it?

It's because AMR has more holes than the Titanic's hull. All sorts of holes. AMR is more like a wasteland than promised land.

AMR's hype outpaced reality, leaving the marketplace littered with failures. Here's why:

- AMR was viewed as a niche technology with niche benefits rather than as an enabling platform touching every area within a utility.
- Deregulation turned ROI analyses into a fool's game. Outrageously long payback on AMR investments made the risk too high.
- Hardware designs were clunky, and totally underglass designs a pipedream.
- Network coverage, communication costs, and quality issues added layers of complexity, sucking efficiencies.
- Data overload was suffocating and software analysis was complicated, so metered data piled up with no means of understanding what any of it meant.

For AMR to prosper, it must morph into something more significant: Advanced metering.

> Advanced metering is, at its core, a complete system that incorporates and integrates underglass hardware, flexible communications via public or private networks, and software for web-based analysis and sophisticated management

Advanced metering can address AMR's deficiencies. Here are some of its chief benefits:

- The billing department gets a whole lot more efficient in collecting usage data and issuing customer invoices.
- The call center receives far fewer calls (80% of calls are bill related in some fashion) because bills are more accurate.
- Risk management faces less risk with time of use metering.
- Real-time pricing makes sales executives more competitive in retaining or attracting new customers.
- Load management and load aggregation provides a load of new micro and macro efficiencies.
- Marketing adores advanced metering's energy use diagnostics because it changes the selling equation from commodity/cost to one of partner/value.
- Operations and field support enjoy insights into electric power issues such as transients, voltage disturbances, power factors, and harmonics.

A final word or two on this myth…

AMR is yesterday's advanced metering. The former is a hodgepodge of ill-suited, ill-fitting solutions that rarely operate as promised. Advanced metering — performed correctly — offers many more benefits that touch the entire enterprise.

MYTH #358

What the heck does the phrase "real time" mean in the world of business? Everyone talks about business moving in "real time." Real time this. Real time that. It's assumed everyone intuitively understands what "real time" is.

But, in fact, "real time" means different things to different people. To some it means "close to now." To others: "when we can make it happen."

"Real time" has morphed into a relative term, not an absolute one.

I'm no Websters, but to me "real time" should mean real, "real time." Real,"real time" should mean now, not later. Not over a period of many minutes or hours or days or weeks.

AMRON uses the phrase real, "real time" to describe how a connected meter can be read through our M5 advanced metering platform. In real, "real time," our M5 platform initiates a wireless connection to the meter, captures data located anywhere in the ANSI tables, relays the data to our data center, and updates our Advanced Metering Portal. All of this is completed in six to seven seconds. Not once a night in batches. In real, "real time."

Utilities face a number of business challenges that demand an increase in the velocity of their operations. Check under the hood and you'll discover that "real time" is in the eye of the marketer, and real, "real time" is what you want.

A final word or two on this myth…

If you're seeking to move to "real time" operations, consider the real, "real time" M5 advanced metering platform.

About the author –

Mark Leach is the Chief Technology Officer of AMRON Technologies, Inc. and a highly regarded expert on AMR and advanced metering. He can be reached at mleach@amronm5.com.

AMRON™

WITH "SMART" AUTOMATED METER READING TECHNOLOGIES, IT USUALLY TAKES MORE THAN THREE YEARS TO SEE ANY ROI.

DOESN'T SOUND VERY SMART TO US.

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M5 ADVANCED METERING

Introducing the M5 Advanced Metering Platform from AMRON. Beyond the automated meter reading technologies you've already seen, AMRON's M5 is putting a whole new face on the future of advanced metering. M5 fully delivers on the promises of advanced metering, and it generates a payback that will have you smiling in no time. With M5, your company can now Meter, Monitor, Measure, Manage, and Maximize. And that's way beyond smart. It's brilliant.

To arrange a meeting or for more information, visit us at www.amronm5.com or call 888-99AMRON.

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Knowledge. Power. Control.

Get Better Results.

When a storm hits and the power goes out, your customers depend on you to restore it as quickly as possible. Don't leave them in the dark. Make sure you can rely on your AMR system to provide system-wide outage detection.

Better Utility Management Begins with Hunt

This is just one example of how Hunt Technologies' advanced AMR solution provides the information you need to better manage your utility. Hunt's Turtle® System allows you to see every endpoint at once without polling. So, when life's little emergencies pop up, you'll have the information you need to diagnose trouble spots and restore power quickly.

Hunt's Turtle System is fundamentally different from any other AMR system on the market. It delivers constant communication with every endpoint in your distribution network and logs a wealth of data options for retrieval. By seeing the whole system, your utility will see better results.

Hunt provides powerful capabilities to utilities every day:

- Water, gas and electric AMR
- Outage detection and restoration notification without polling
- Dynamic pricing capabilities for better revenue and power management
- Remote system management with .NET® technology
- Compatible with multiple meter manufacturers

Water, Gas and Electric AMR

Find the right mix for your utility's diverse needs. Hunt Technologies delivers the only power line carrier (PLC) solution for electric, water and gas meters. Gain the flexibility to blend AMR technologies to meet your specific operational and financial objectives.

Outage Detection and Restoration Notification without Polling

Get automatic, real-time outage detection and restoration notification without polling your endpoints. Determine the location of each outage and greatly improve the accuracy of your outage management. Your crews will know the job is done before moving to a new location.

Dynamic Pricing Capabilities for Better Revenue and Power Management

Analyze collected data and establish a varied billing rate program that aligns with customer usage patterns. Use dynamic pricing options to help your customers save.

Remote System Management with .NET® Technology

Retrieve information from any location with Web access – in the field or in the office.

No need to rely on a master station to see your system.

Compatible with Multiple Meter Manufacturers

Experience flexible solutions designed to fit your needs, no matter which meters you use. Hunt products are compatible with all major meter manufacturers, including the newest solid-state models.

The Total AMR Solution

Hunt Technologies provides utilities with a full range of system capabilities – from cost-effective monthly reads, to daily reads with outage information, to a system with advanced features for electric, water and gas. Find a solution that is right for you.

Hunt® Technologies, Inc.

turtletech.com

Amazing Results

It's amazing what you can do when you have choices.

Our advanced AMR solution lets you choose the meter you want, use the equipment and components you desire, and capture the information you need for effective customer management. Put the Turtle to work. You'll be amazed by the results.
turtletech.com

Visit us at AMRA Booth #617

Hunt® Technologies, Inc.

- *Daily water, gas and electric AMR*
- *Outage detection and restoration notification without polling*
- *Dynamic pricing capabilities for better revenue and power management*
- *Remote system management with .NET® technology*
- *Compatible with multiple meter manufacturers*

Circle 171 on Reader Service Card

Autovation: The AMRA 2004 International Symposium

September 26-29, Kissimmee, Fla., USA

Advanced sessions cover:

- Business case results and benchmarking
- AMR and CIS
- Tracking and eliminating lost resources
- Revenue protection
- System management and optimization strategies
- Resource management and demand reduction
- Asset management

Utility-only forums are exciting additions to the schedule on Wednesday, Sept. 29, where delegates can discuss:

- Experiences and lessons learned
- Technological challenges and benefits
- Integration efforts
- Return on investment
- Short, mid- and long-term objectives

Dear Colleague,

Nowhere but at Autovation will you learn about the range of AMR technologies that can change the way you see and use automation tools. Autovation: The AMRA 2004 International Symposium — a new, integrated educational forum — will provide useful information and tips to help your utility operate at maximum efficiency.

Autovation takes a fresh look at automation strategies for utilities of all types and sizes. Sessions cover fundamentals as well as advanced issues of interest to veteran AMR managers who now want to further optimize their utilities' AMR investments.

Fundamentals sessions address topics such as:

- Building a business case for AMR technologies
- Financing
- Technology capabilities and needs matching
- AMR system uses
- Information management
- Integration
- Customer service

Meanwhile, the Autovation exhibit hall — filled to capacity with the world's leading equipment and service providers — will display metering, billing, communications and information systems breakthroughs designed to help you best serve your customers. Exhibitors will share additional technological insights during Exhibitor Showcase sessions, dedicated 25-minute presentations open only to utility delegates.

In-depth Pre-Autovation courses cover topics including RFP development, information systems, data-management issues, communications options, business models and market requirements.

AMRA, the world's premier nonprofit association dedicated to AMR and related technologies, can help you identify and reap the benefits of the complete AMR value chain.

Bruce Lackey
AMRA Program Committee Chair

Schedule at a Glance

Saturday, Sept. 25

			Room
3 p.m.–6 p.m.	Registration		Sun Lobby

Sunday, Sept. 26

7 a.m.–5 p.m.	Registration		Sun Lobby
8 a.m.–Noon	Course 1.	AMR Full-Scale Residential Technologies for Realistic Business Cases	Sanibel
8 a.m.–Noon	Course 2.	AMI/AMR Life Cycle Management	Miami 2-3
8 a.m.–Noon	Course 3.	Pre-Assessing Communication Technologies for AMR and Value-Added Applications	Sun 4–6
1 p.m.–5 p.m.	Course 4.	How to Achieve Enterprise-Wide Business Optimization and Benefits Through AMR	Sanibel
1 p.m.–5 p.m.	Course 5.	Implementation and Use of ANSI AMR Communication Protocol Standards for the Transfer of C12.19 Data Tables	Miami 2-3
1 p.m.–5 p.m.	Course 6.	Procurement: How to Know When; How to Get it Right	Sun 4–6
1 p.m.–5 p.m.	Course 7.	Practical Guide to AMR Project Management — From Feasibility Through Installation	Naples

Monday, Sept. 27

7 a.m.–6 p.m.	Registration		Sun Lobby
8 a.m.–Noon	Course 8.	AMR Systems for Water Utilities	Miami
8 a.m.–Noon	Course 9.	AMR Communications Model Based on Draft ANSI Standard C12.22: Protocol Specifications for Interfacing to Data Communication Networks	Tampa 1-2
8 a.m.–Noon	Course 10.	Telecommunications Technologies and Solutions for AMR — Home-Area/WAN, Public and Private Links	Naples
10 a.m.–1 p.m.	Exhibits Open		
11:30 a.m.–1 p.m.	Lunch in Exhibit Hall		Florida E–F
1 p.m.–2:30 p.m.	Opening General Session Terry Jones, Founder of Travelocity Doug Spencer, Vice President of OUCustomer Connection, Orlando Utilities Commission Dusty Fisher, Vice President of Power Delivery and Customer Operations, Gulf Power Co.		Sun A–D
2:30 p.m.–2:45 p.m.	AMRA Awards Presentation		Sun A–D
2:30 p.m.–6 p.m.	Exhibits Open		Florida E–F

Education Session 1
Monday, Sept. 27
3:30–5 p.m.

Macro-Level Perspectives

A — Taking AMR Technology to the Next Level
Room: Tallahassee

One presenter will share his organization's perspective about how they developed an AMR business case, then selected and rolled out a system that exceeded those objectives in the areas of operational requirements, risk management and system integration. This session also will provide a glimpse into new applications of AMR technology, outlining how a large investor-owned electric utility leveraged AMR-collected data throughout the utility to meet critical objectives in distribution system reliability, asset planning and management, customer care and other areas.

Bernie Bujnowski, PPL Electric Utilities
Ken Zagzebski, Xcel Energy

B — Managing the Project — From Research Through Results
Room: Miami

Intelligent management of water resources is critical for water utilities across the country. Hear how one Arizona municipality is using AMR to increase efficiency, enhance conservation, improve customer service and reduce system losses. Another project manager will discuss tangible benefits the utility saw immediately, as well as how managers leveraged the technology post-deployment to optimize benefits related to read rates, system mapping and personnel efficiencies.

Lew Adkins, City of Richmond, Va.
Larry Dobrosky, City of Peoria, Ariz.

C — Technology Is a Key to Success for Future-Minded Utilities
Room: Naples

Ever wonder what customers think about the benefits and services you now can provide through your newly installed AMR system? We Energies found out. After achieving customer-service goals, this multi-service utility surveyed consumers and will share the results with Autovation attendees. Meanwhile, multi-utilities looking to maximize their investments can find out how Wisconsin Public Service Corp. streamlines data collection from electric and gas meters, and partners with a neighboring water utility.

Steve Carrico, Wisconsin Public Service Corp.
Joan Shafer, We Energies

5 p.m.–6 p.m.	Reception in Exhibit Hall	

Schedule at a Glance

Tuesday, Sept. 28

		Room
8 a.m.–5 p.m.	Registration	Sun Lobby

Education Session 2 — Tuesday, Sept. 28, 8:30–10 a.m.

A — AMR Impacts *Room: Miami*

Building Network and Metering Technology Into Company Strategy
Bruce Carpenter, Portland General Electric Co.

Going Beyond AMR: Using AMR as a Customer Service Tool
Ronald Gatz, Empire District Electric Co.
Marisa Miralles, Information Intellect

B — Business Case Results: Benchmarking *Room: Tallahassee*

One Company's Story — Maine Public Service
Rodney Leach, Jack Ireland and Brent Boyles, Maine Public Service Co.

The Real Deal at NU: AMR Business Cases, Deployment and Experiences
Dave Scott, Northeast Utilities Co.

Comparing Benefits of AMR Alternatives
Rick Hackett, Central Vermont Public Service Corp.
Stephen Hadden, Plexus Research Inc.

C — Using AMR to Improve Customer Service and Revenue Protection *Room: Sun D*

Providing Superior Customer Service and Residential Systems Diagnostics With the Help of AMR Technology
Herrika Stratford, Valley Electric Assoc.

Metering at the Transformer — The Elimination of Theft of Power
Paul Elliott, Whitby Hydro Energy Services Inc.

Power Quality and Reliability Aren't Possible Without AMR
Carolyn Kinsman, Automated Communication Links Inc.

10 a.m.–5:30 p.m.	Exhibits Open	Florida E–F
Noon–1:30 p.m	Lunch in Exhibit Hall	Florida E–F

Education Session 3 — Tuesday, Sept. 28, 1:30–3 p.m.

A — AMR Technologies *Room: Miami*

Telephone and Wireless Technologies for C&I Meters
Anthony Hawkins, Austin Energy

PGE's Mesh Metering Tests
Bruce Carpenter, Portland General Electric Co.

Residential Advanced Metering System (RAMS) at the City of Anaheim PUD
Linda LeDuc, City of Anaheim PUD
John Brett, Tantalus Systems Corp.

B — Data Management: Integration *Room: Tallahassee*

AMR at Southern Company
Kevin McDonald, Georgia Power Co.
Ed Fishler, Georgia Power Co.

Augmenting Operational Efficiencies Through Data Flows From AMR
Vicki Trees, Hunt Technologies Inc.

C — Energy Delivery and Management *Room: Sun D*

Mega Load Management System Pays Dividends
Mike Andreolas, Florida Power & Light Co.

Using AMR Data for Load Research: Fact or Fiction?
Shawn Hildebrand, Shenandoah Electric Cooperative
Erin Puryear, Dominian Electric Cooperative
Curt Puckett, RLW Analytics

AMR Is Not Just for Reading Meters
Oliver R. Price, Rappahannock Electric Cooperative

Education Session 4 — Tuesday, Sept. 28, 3:30–5 p.m.

A — Demand Response Opportunity *Room: Miami*

State Regulators — The Gateway to an Advanced Metering Market?
Dan Delurey, Demand Response and Advanced Metering Coalition

The Role of AMR in Demand Response and Reliability
Craig Boice, Boice Dunham Group

B — Outage Management *Room: Tallahassee*

Quality, Management and Reliability — AMR's New Frontier
Ed Malemezian, Ed Malemezian Consulting Inc.
Ed Brill, Florida Power & Light Co.

Mapping the Way to Improved Outage Response
John McClaine, Puget Sound Energy
Venki Ramachandran, WACS

Using AMR to Detect and Map Outages
Ken Hill, PPL Electric Utilities
David Haynes, TWACS by DCSI

C — Project Management *Room: Sun D*

Perspectives on AMR Project Life-Cycle Management — A Panel Discussion
Don Schlenger, Cognyst Consulting LLC
John Wambaugh, eMeter Corp.
Additional panelists TBA

5:30–7:30 p.m.	Autovation Gala Reception

Schedule at a Glance

D — AMR Comes of Age
Room: Naples

Life-Cycle Cost of Automation Control
Thomas Keel, Ph.D., Graduate Teaching Assistant

Development, Evaluation and Implementation of an AMR System
Sally Clem, City of Fort Wayne

Irrigation Pumps AMR Deployment
John Bettencourt, Bluestern EC

E — AMR Planning and Deployment
Room: Sun C

AMR Installation at Metro Water Services
Charles Gregory and Gary Ragland, Metro Water Services

Implementation Plan for AMR
James Harris, Charlotte Mecklenburg Utilities

F — Combined Utility
Room: Sanibel

Business Case and Advanced Applications Results at PECO
David Glenwright and Glenn Pritchard, Exelon Energy Delivery

Maximizing the AMR Infrastructure; Gas, Water & Electric AMR — Operating Experience
Sid Mathur, ATCO Electric Co.

AMR Payback — Unique and Positive Applications
Steve Frifrick, Wisconsin Public Service Co.

Exhibitor Showcase

8:30–9 a.m.
Room: Tampa 3
Neptune Technology Group Inc.

8:30–9 a.m.
Room: Sarasota 3
Molex

9–9:30 a.m.
Room: Sarasota 3
AMRON Technologies Inc.

9:30–10 a.m.
Room: Tampa 3
Sensus Metering Systems

9:30–10 a.m.
Room: Sarasota 3
Hunt Technologies Inc.

D — Technologies
Room: Naples

Communications: Utilities Now Have a Choice
Larry Nardo, Consolidated Edisen of New York
Mark Leach, AMRON Technologies Inc.

Turning CIS Data Into AMR Project Planning Information
Bruce Sisson, Wellington Power Corp.

E — AMR Planning and Deployment III
Room: Sun C

AMR Advantages
Ed Turner, Anniston Water Works

The Human Element in the AMR Equation: Greater Cincinnati Water Works
Dave Bennett and Kevin Moore, Greater Cincinnati Water Works

What AMR Can Accomplish for Your Utility
Mitch Turner, San Juan Water District

F — Combined Utility Presentations
Room: Sanibel

Beyond AMR at PSE
John McClaine, Puget Sound Energy

Advanced Technology in Meter Reading and Integration With Utility Billing
Annie Hickey, City of Daytona Beach

Exhibitor Showcase

1:30–2 p.m.
Room: Tampa 3
Itron Inc.

1:30–2 p.m.
Room: Sarasota 3
RIO Tronics Corp.

2–2:30 p.m.
Room: Tampa 3
BLP Power and Utilities

2–2:30 p.m.
Room: Sarasota 3
Elster Electricity LLC

2:30–3 p.m.
Room: Tampa 3
Meter Solutions

2:30–3 p.m.
Room: Sarasota 3
DB Microware

D — Leveraging Geospatial Technology
Room: Naples

Employing New Tools to Optimize AMR System Performance
William Armstrong, Dominion

Using GIS to Enhance AMR Systems Operations
Brian Crow and Bob O'Connell, ESRI

Optimizing AMR With GIS
Mark Martinez, Southern California Edison Co.
Frank Russell, Meter Smart

E — Post-Deployment Issues
Room: Sun C

AMR: The Next Step — Installation Is Complete; Where to Now?
Robert Morphis, City of Aurora
Daniel Mikesell, City of Aurora

Can Manual Meter Reading Be Justified After AMR?
Bruce Tait, City of Moncton
Carolyn Kinsman, Automated Communication Links Inc.

AMR Metering Program — Lessons Learned
Cliff Deeds, City of Arvada

F — Combined Utility
Room: Sanibel

Results of a Successful AMR Project — Two Years Later
Dennis W. Hammer, Intermountain Gas Co.

Hybrid AMR for Gas and Electric Customers
Jayme Van Campenhout, Wisconsin Public Service Corp.

Exhibitor Showcase

3:30–4 p.m.
Room: Tampa 3
Motorola Inc.

3:30–4 p.m.
Room: Sarasota 3
MARS Co.

4-4:30 p.m.
Room: Tampa 3
Tantalus Systems Corp.

4:30-5 p.m.
Room: Tampa 3
TWACS by DCSI.

Schedule at a Glance




Wednesday, Sept. 29

		Room
	7:45 a.m.–8:15 a.m. Business Meeting	AMRA Annual Sun B
8 a.m.–Noon	Registration	Sun Lobby

Education Session 5
Wednesday, Sept. 29
8:30–10 a.m.

A — Utility-Only Roundtable: Electric
Room: Miami

Looking at AMR as an energy data collection system, this utility-to-utility forum will cover a range of topics for electric utilities. The power of AMR comes to light when it is used as a high-value tool to support demand response, outage programs, engineering/planning initiatives and energy supply issues. The session will include a special focus on how AMR professionals have planned and navigated through cultural difficulties that hamper the acceptance of AMR for a variety of solutions.

Moderator:
Brian Pollom, Puget Sound Energy

B — Utility-Only Roundtable: Water
Room: Sanibel

With so many water utilities now deploying, at the least, pilot projects for AMR, what additional benefit can utilities derive that goes beyond meter reading? That question, more and more, remains top-of-mind for utility professionals who champion AMR. Water conservation through demand management, monitoring unusual consumption patterns and using AMR data to detect leaks are just a few examples of the subjects for this utility-to-utility exchange. Participants will get the most from this session when they are prepared to talk about subjects of intense interest to them, and ready to share their experiences with fellow AMR professionals.

Moderator:
Matt Coletta, North Wales Water Authority

C — Utility-Only Roundtable: Gas
Room: Tallahassee

We've all heard about the many benefits associated with deploying Gas AMR solutions, from meter reading cost savings to having actual monthly reads. But have you ever had the opportunity to hear first-hand from your fellow utilities the gains and pains of their AMR deployments? If your answer is no, now you have the chance. Come join us for an interactive, utility-only, open-forum discussion to share and learn more about real-life deployment experiences, technology constraints, battery issues, business case development, supplier choices and network options. This is one session you won't want to miss.

Moderator:
Clark Pierce, PSE&G

8:45 a.m.–9:15 a.m.	Exhibitor Forum — Opportunities for Exporting AMR Technologies Philip Ouzts, U.S. Department of Commerce
9 a.m.–Noon	Exhibits Open
10 a.m.–Noon	Champagne Brunch in Exhibit Hall

Education Session 6
Wednesday, Sept. 28
11:30 a.m.–1 p.m.

A — Focus on Communications
Room: Miami

Driving Autovation With Communications Technologies

This session covers four communication technologies utilities are using to gather AMR data — mesh networks, power-line carrier, radio frequency and cellular. Panelists will share technology overviews and applications in the AMR arena; afterward, delegates can explore topics that are important to their individual utilities during a moderated question-and-answer period.

Panelists:
John Brett, Tantalus Systems Corp.
Ron Chebra, PA Consulting Group
Todd Headlee, Hunt Technologies
Mike Schleich, Itron

B — Focus on Finance
Room: Sanibel

Alternative Financing Methodologies

in this real-world session, panelists will discuss fundamental yet important issues — including how to build a business case with a total system approach. Panelists then will share tips about improving the business case and identifying leasing options for public- and private-sector utilities.

Panelists:
Bruce Block, Koch Financial
Bob Coffey, Great Bay Management Inc.
Deloris Duquette, Itron
Kerry Linda Martin, CalFirst Utility Finance Group
Joe O'Connor, Honeywell

C — Focus on Trends
Room: Tallahassee

Facts and Figures: Researchers Discuss the Latest Deployment Data

Three esteemed AMR market researchers will discuss recent trends in investment strategies, deployment tactics and technology selection as well as how utilities are using AMR systems to provide fundamental and advanced services, enhance operations and build business.

Panelists:
Patti Harper-Slaboszewicz, UtiliPoint International Inc.
Garrett Johnston, Chartwell Inc.
Howard Scott, Cognyst Consulting LLC

Autovation Exhibitors

Company Name	Booth #(s)
Advanced AMR Technologies	427
AMCO Automated Systems	201
AMCO Water	119
Metering Systems Inc.	
AMRA	TBA
AMRON Technologies Inc.	301
ArKion Systems	552
*Badger Meter	719, 721
BLP	550, 551
Brooks Utility Products Group	330, 332
Cannon Technologies Inc.	516, 518
Caprock Mfg. Inc.	526
*Cellnet	601
Chartwell Inc.	611
Comverge Inc.	709
Data Comm for Business Inc.	309
Datamatic Ltd.	133
dataVoice International	440
DFW Plastics Inc.	341
Electric Energy Magazine	809
Elster Electricity, LLC	317
Energy Markets	237
Energy One Electronics Inc.	821
ESRI	710
FirstPoint Energy Corp.	840
F.S. Brainard & Co./Technolog Ltd.	208
GMI Composites Inc.	833
Hexagram Inc.	401
Honeywell Utility Solutions	210, 212
*Hunt Technologies Inc.	617
Info Energy Inc.	231
InteGride-NERTEC	127
Itron	629
Kaifa Technology	819
KP Electronics Inc.	717
Land-Cellular Corp.	817
Landis+Gyr	441
Lightstat Inc.	105
MARS Co.	313
Marwell Corp.	520
Master Meter Inc.	641
Maxell Corp.	831
MeterSmart	204
Meter Solutions	837
Metretek Inc.	412
Metrum Technologies	442
Microtex Electronics	421
Midland Radio Corp.	200
Molex	741
Motorola Inc.	209
*Neptune Technology Group Inc.	409
Northrop Grumman IT	609
NRECA	233
Olameter Inc.	820
Public Utilities Reports Inc.	743
Radix Corp.	813
RAMAR	334, 336
Renesas Technology America Inc.	841, 843
RIO Tronics Corp.	554, 555
Saft	829
*Sensus Metering Systems	801
Spintelligent (Pty) Ltd.	343
Tadiran	708
Tantalus Systems Corp.	408, 410
Telenetics Corp.	417, 419
Terasen Utility Services	613
Tru-Check Inc.	556
*TWACS by DCSI	431
United Telecom Council	842
U.S. Metering and Technology	311
Utility Automation & Engineering T&D/WaterWorld	835
Verizon Wireless	712
Vitzrocell Co. Ltd. /Cooper Bussmann	816, 818
VSI Meter Services	553
Water and Wastes Digest	202
Xeno Energy Co. Ltd.	235

FLOOR PLAN

The Role of Testing in the Practice of Good Grounding

—Part 1—

By: Jeffrey R. Jowett Megger®

"Meeting Code"

In its common form, grounding is typically thought of as no more than a rod driven into the earth in order to provide a safe diversion of lightning strokes. In a sense, the National Electric Code, (NEC,) indirectly provides a basis for this conception. The Code requires that a single rod or other approved electrode be installed in the soil and tested. If it tests at 25 Ω or less, the installation "meets Code". If not, a second rod or other electrode is installed at least 6 feet away. It need not be retested. The additional electrode can routinely be expected to reduce the measurement by about 40%, but that still says almost nothing about what the final value might be.

However, meeting code is not all there is to ground protection. The Code is a working directive promoting electrical safety. It tacitly acknowledges that soil conditions are so variable that to insist on a universal absolute would be impractical and unfair. A homeowner who has the misfortune to live in an area of high soil resistivity cannot reasonably be expected to drive a ground rod halfway to China. If one is inadequate, the addition of a second will afford substantial improvement, and in the final analysis, "something is better than nothing."

Likewise, in "meeting Code", the implication is that the facility is safe, not necessarily functional. The Code is concerned with safety, not performance. The building may be protected from lightning and electrical faults, but still have "noise" on datacom lines. The familiar 25 Ω standard is actually very forgiving, selected for practicality and basic protection, not optimal design. In theory, one would want to ground an electrical system at zero resistance. But this, of course, is not possible in the real world. A realistic alternative goal is to get as close as possible, substantially cutting down the enormous gap between "making Code" and theoretical perfection.

On the "downstream" side of 25 Ω, there can be a nearly inverse relationship between resistance and performance. Aside from the NEC, no universal ground resistance standard exists. However, industry practices and insurance recommendations have established some familiar guidelines: 5 Ω for a typical commercial ground, 3 Ω for a chemical plant, 2 Ω (or even less!) for computer rooms and process-control operations, 1 Ω for large utility substations and generating plants. And if anything, these practices are becoming more demanding. The increasing reliance on computer operations, process control, and datacom/telecom functions has made the presence of "noise" intolerable. With data signals as narrow as 3 V, or even 1.5, the differences between "Xs" and "Os" can be scrambled by noise that means nothing to the operation of standard 120/240 equipment. Voltage regulation is important as never before, and ground is critical in the mitigation of internally generated noise as well as external faults and disturbances.

Therefore, the popular image of a single rod for lightning protection is only the beginning. This paper will deal with ground testing as it fits in with the implementation of maximum grounding efficiency. To attain a high level of protection, one must first know how to measure. The practice of ground testing is much abused, primarily through failure to recognize its unique properties. Proper measurement breaks down into two elements: equipment and procedure.

The Right Equipment

Good ground measurement begins with proper equipment. Ground testing presents challenges unlike any other in the arena of electrical testing. The first line of error is one of faulty logic: to make a resistance measurement requires an ohmmeter. Wrong! To perform a ground test, it requires a ground tester; that is to say, an instrument specifically designed to meet the unique factors involved in testing unlimited earth. A common mistake is to use a generic multimeter, with one lead connected to the test ground and the other to an arbitrary reference ground. This procedure will provide a measurement, but the critical question is, what is it actually measuring? This technique suffers from at least three potential sources of error: interference, extraneous resistances, and the arbitrary position of the reference.

The fact is easily overlooked, but the earth carries a lot of "noise" from transients trying to find their way back to transformer secondaries. Multimeters are dc testers, and their readings will be influenced by whatever voltages may be present in the soil. The operator may be made aware by destabilization of the display, but there is no specific indicator to provide

warning. Secondly, the reading…influenced or not…is a series resistance that includes the soil and everything else in the loop. It would be nice if this were zero, but that's not likely. The reference ground is assumed to make a negligible contribution, but that is only an assumption, largely untestable. The most commonly employed reference is the water-pipe system, but if this has been repaired with plastic pipe or couplers, its usefulness is negated. Finally, even if there is no interference or additional resistance from the reference, the reading still may not be reliable. Under these latter circumstances, a generic multimeter may provide a good reading of soil resistance between the two points. This may be an accurate measurement of ground resistance…and it may not. It can only be accepted on faith.

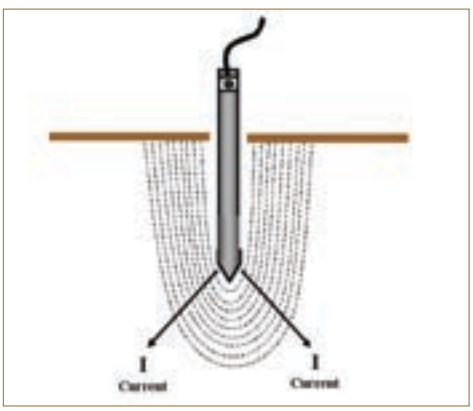

Figure #1: Grounding Electrode & Immediate Surrounding Soil

Most electrical testing is performed on discrete circuits of human design. The elements are known and their properties can be routinely addressed. Not with ground testing. Making an electrical connection to a grounding electrode thereby includes the entire planet Earth. In theory, a "true" resistance measurement would have to be made at "infinite distance"; i.e., including the whole planet. Of course, this cannot be done, and doesn't have to be. The area immediately surrounding the electrode provides 99.999...n% of the resistance, and the rest of the planet is only of theoretical interest. The "test item", then, is the electrode and its immediate surrounding soil (Fig. 1). This cannot be manipulated like a piece of apparatus. Rather, the tester has to be accommodated to the possibilities.

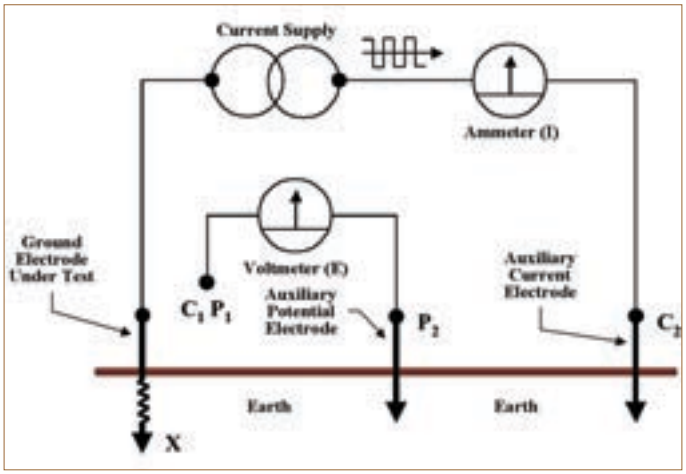

Figure #2: Four-Terminal Ground Tester

Dedicated Ground Testers

Dedicated ground testers operate with an alternating square wave of a distinct frequency apart from what is likely to be produced by utility harmonics (Fig. 2).

They recognize their own signal and, unlike a multimeter, disregard "noise". If soil transients are extreme, to the extent that the tester's filtering capabilities are overridden, warning indicators let the operator know that a problem exists so that faulty readings are not blindly recorded. Furthermore, the ac signal facilitates the use of the virtually limitless lead lengths that are required when testing large grids in poor soil conditions. Finally, a ground tester is not a two-terminal device but is designed according to the four-wire Kelvin bridge principle. Having two separate current and two separate voltage terminals enables the operator to have complete control of the test setup. The reliability of the test is not at the mercy of fixed-position reference grounds. The operator drives probes exactly where desired, so that it is known precisely what is being measured. Furthermore, the separate voltage probe enables surveying of the entire test site in order to recognize local anomalies, determine representative conditions for the area, and proof the readings, as will be described under the discussion of methods. The Kelvin configuration further eliminates all extraneous resistances, as from leads and contacts, so that the tester provides a precise measurement, not an approximation.

Correct Procedure

The right instrumentation must be accompanied by the right procedure. In no area of electrical testing is procedure more important than in ground testing. It is not simply a matter of hooking up and pressing a button. The test item is uncontrolled and uncontrollable…a substantial and unknown volume of earth surrounding the

buried electrode in three dimensions. Electrical circuits are typically made of relatively pure materials with narrow tolerances, but not in this case!

Because soil is almost infinitely variable, both in terms of composition and the temporal effects of weather, there is no way of knowing, prior to testing, what volume comprises the effective resistance at a particular site. The literature is full of tables that provide guidelines, but these are only suggestions meant to give a fair chance of performing an acceptable test on the first trial. To simply place probes and take a reading will provide an accurate measurement of soil resistance between the two points, the test electrode and the potential probe. This may or may not be the effective resistance that a fault current will encounter. To make that determination, the site must be rigorously proofed. Operation of the tester alone does not provide this. It must be augmented by a proper procedure.

Fall of Potential

The basis for all accepted methods is defined by IEEE (Institute of Electrical and Electronics Engineers) Standard 81, and is called "Fall of Potential".

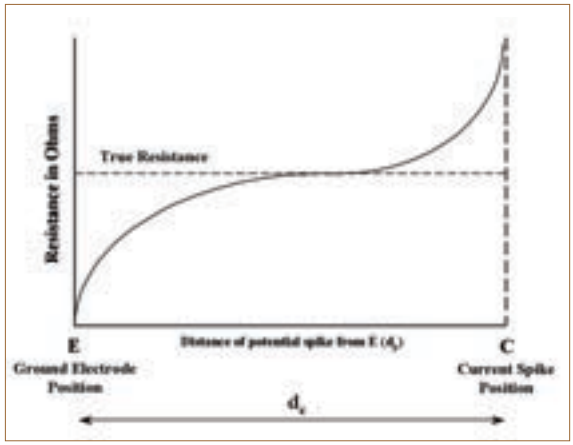

Figure #3: Fall of Potential Graph

Making use of the separate voltage probe, the procedure consists of plotting the resistance from the test electrode to a regular succession of points in the direction of the current probe. This procedure develops a profile of the soil, indicates discontinuities and non-uniformity, and provides much more information than would a single measurement. Ideally, a Fall of Potential test should produce a graph that looks like Fig. 3.

This shows that if the measurement were taken infinitely close to the test ground, the resistance would be infinitely small, as would be expected. This is evident from the simple fact that, at for instance one foot, there is very little soil to offer resistance. Such a measurement would be of no practical value, however (except possibly to fool an unapprised client or inspector!). As the probe is moved farther out and additional readings taken, the increased travel through soil adds resistance, just as a two-foot wire offers more resistance than a one-foot section of the same wire. But a funny thing happens on the way to the current probe! Readings level off and remain essentially flat, until the approach to the current probe constricts the path and superimposes additional resistance. Hence, the graph rises toward the end.

The distinctive shape of the graph is generated by soil volume. Soil is a "good conductor" because of its enormity and ubiquity. Fault current through a grounding electrode isn't restricted to a straight path from point a to b, as in a designed circuit. Rather, it radiates in all directions, 360° from the electrode. The current path spreads out, rather than traveling in a straight line. Soil in the relatively narrow confines around the electrode offers some resistance, but at greater distance, the area becomes so vast that there is no increase in resistance large enough to be measured. Soil volume is the reason that the graph eventually reaches a stable plateau, and if that were not so, grounding itself would not be possible.

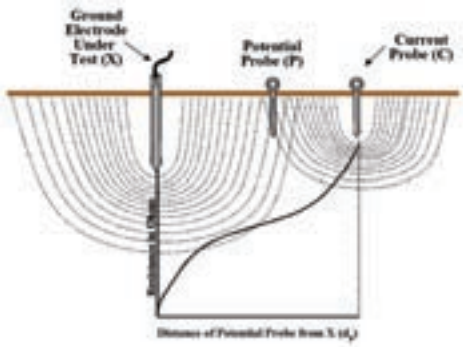

Figure #4: Non-Ideal Graph, Insufficient Probe Spacing

Constructing a Fall of Potential graph, then, shows the relationship between space and resistance. The value where the readings stop increasing is the measure of the effective resistance of the test ground. This could be at virtually any value up into hundreds of ohms. But if it is above 25, it's not meeting Code, and not functioning as an effective ground. The distance at which this occurs marks the volume of soil that is the determining factor. This could be only a few feet in prime soil, but could be hundreds of feet or more in areas of high resistivity. Because this relationship...volume versus resistance…is so flexible, both the tester and the procedure must be adapted to meet the demands.

Performing a full Fall of Potential test is rigorous enough to stand up to any scrutiny. If the test electrode has a large "footprint", or electrical field in the soil…either from physical size or poor soil conductivity…the current probe may overlap and obscure the point of maximum resistance for the test ground. In such a situation, as the potential probe is moved, it would run directly into the superimposed resistance associated with the current probe. This would produce a graph that looks like that in Fig. 4. One of the strengths of this method is that it affords a built-in proof. If a graph like that in Fig. 4 is produced, the current probe is moved farther out and the procedure repeated. No such proof is available with any other instrument than a dedicated ground tester.

Test Methods

A graph as ideal as that in Fig. 3 is not likely to be produced by a real test. Field experience becomes a valuable ally. Buried objects can cause dips and bumps. Soil variations, especially at graded construction sites, can create a wavy plateau. But an unreadable graph is a clear indication of an unacceptable test. The operator has to repeat, perhaps in another direction, but will not be led astray by a "bad" reading, unaware. The limitations of this method are that it is a lot of time and work, and also may require more lead distance than is available, especially at an urban site. Accordingly, many variations and additional methods have been devised, some for general application and some for specific situations. Additional methods are frequently based on simplifications of the Fall of Potential concept, and sometimes on other mathematical abstractions. Test methods serve two purposes: to provide a proof that the reading actually represents the effective resistance and is not some random measurement, and to permit some simplification either in terms of speed or the means of dealing with some specific challenge.

Those aimed at shortening test time are the Simplified Fall of Potential, 62% Rule, "Dead Earth" Method, and one that for want of any real name might be called the "eyeball" method. Those designed to meet challenges, specifically of limited space as opposed to limited time, are the Slope Method, Star-Delta Method, and "Intersecting Curves". Finally, for measuring the electrical conductivity of soil itself, there is the Wenner Method.

In Part2 we will examine each of these test methods in detail. ■

Restoring Reliability to the Nation's Electric Grid

By: Benton Wilcoxon, Chairman & CEO, Composite Technology Corporation

On August 14, 2003, the world was once again reminded about the importance of electricity as a blackout struck the northeast United States and eastern Canada. It was by far the largest power outage in history. The blackout affected over 50 million people and is estimated to have resulted in an economic loss of between $6 billion and $10 billion.

Given the urgency of needed improvements to the nation's electric transmission system in order to avoid future blackouts and better handle the flow of electricity, government policy makers need to focus on the provisions within the National Energy Act now before Congress. The specific provisions will provide strong "backstop" authority to expedite the upgrade of electric transmission systems in instances where the existing regulatory process is incapable of making timely decisions. Such action is contemplated to overcome the slow pace of regulatory restructuring, a process that has been underway for over a decade.

Considering the enormity of the backlog and urgency of needed improvements, policy makers should focus the backstop mechanism on projects to bolster near-term reliability. Stakeholders must be encouraged to bring the restructuring effort to closure so that it can address longer-term projects. In both instances, regulatory uncertainty must be resolved to reduce investment risks that has hampered expansion of the nation's transmission grid.

Frustration with the existing review and approval mechanisms creates temptation to use the prospective new authority to undertake a wide range of backlogged projects. However, under the best of circumstances developing new transmission corridors, acquiring necessary rights-of-way, and constructing miles of transmission towers and lines is a slow and contentious endeavor. While backstop authority consolidates the review and approval process among federal agencies, construction of new transmission corridors would still be subject to much the same scrutiny seen today. Although timelines would be compressed, it would most likely still take many years to achieve real progress. In the interim, key vulnerabilities in the grid would persist.

By some estimates it will take at least a decade and more than $56 billion to update the electric transmission infrastructure. With needs of this magnitude, if even just "key" projects are directed through a backstop mechanism, the process would still likely bog down. Instead, the backstop process must be designed to work in tandem with the restructuring process and not in lieu of it.

The nation's economic health and well-being are dependent on an extremely complex system to deliver safe, affordable, and reliable electric power. That system is comprised of a wide range of technologies, computer systems, and people to make the system work. While efficiencies have greatly improved, the basic architecture of the process in use today is the same used by George Westinghouse to electrify the 1893 Chicago World's Fair: Generation of electric power by central station generating plants; transmission over high voltage transmission lines; and distribution to end use lighting, motors, and other equipment over a low voltage distribution system.

What has changed dramatically is the manner in which the industry is organized and regulated. More than any other single factor, the incomplete restructuring of the electric utility industry from a vertically integrated, regulated rate of return business to an "unbundled" mix of regulated and market-based components is the primary reason why investment in the nation's electric transmission infrastructure has dwindled to dangerously low levels.

While the proponents of unbundling tout the benefits that electric consumers can realize from a competitive market of diverse energy suppliers, the technical, economic, regulatory, and political issues surrounding the reconfiguration of the transmission system have proved to be a daunting challenge. At its core, the issue is an economic one: "who benefits?" and "who pays?" While federal and state regulators grapple with the immense complexity of recasting the regulatory process to accommodate a changing structure, each constituency involved examines the prospective outcome from their own position.

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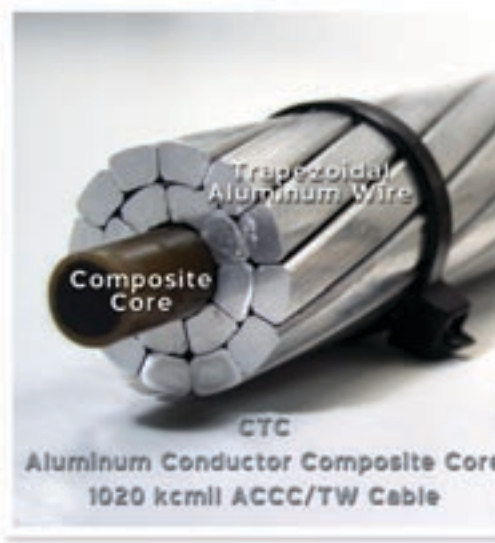
After 12 years consensus remains illusive. While states question if their residents will end up paying more than their fair share to support the grid at large, prospective investors in transmission projects attempt to evaluate the prospects of gaining a return on their investment amid changing sets of rules. The result has been virtual stagnation of resources to expand the grid.

A portfolio of long-term and near-term projects should be pursued in order to improve transmission system reliability as soon as possible while making steady progress on adding long-term capability to the grid. While the exact mix requires careful assessment, using the backstop mechanism to advance near-term projects can quickly dampen the likelihood of outages and blackouts that undermine economic growth, public safety, and national security.

For the near term, deployment of "high temperature-low sag" transmission cables can go a long way to resolve today's problems. Replacing, or reconductoring, existing lines with composite core aluminum conductors, that transmit as much as twice the power of traditional high voltage conductors, is a highly cost-effective option for reinforcing electric paths through congested transmission corridors. It is far easier and less expensive to replace existing wires rather than developing new transmission routes and building new tower corridors. Moreover, this type of cable can be retrofitted in a very cost effective installation that does not require new engineering of tower support systems. Replacing existing cable with composite core conductor can typically be achieved for a capital expenditure of about 6 times less than the current alternative of constructing a new line (exclusive of the cost of land and associated permitting).

Using aluminum conductors with a time-tested, aerospace-derived composite core, made of glass and carbon fibers, provides four critical benefits. These benefits can accrue on the order of months instead of the seven to 10 years it otherwise takes to conduct environmental assessments, resolve public opposition, secure approval, and engage in major construction. Deferring or eliminating the need to build conventional new transmission facilities could save or postpone at least $10 billion of new capital expenditures. Early deployment would also contribute to the reduction of congestion costs, i.e., the extra costs consumers ultimately pay because access to low cost electricity sources is constrained. In the U.S., congestion costs are estimated to be well over a billion dollars per year.



Using backstop authority to pursue an array of good near-term projects makes good public policy. Such projects share desirable attributes including:

• Speed

Near-term projects can be reviewed, approved and installed quickly. The review process is simplified since a much narrower palate of alternatives need be considered and evaluated. Because land acquisition and large scale construction are avoided, implementation can be much faster.

• Quick Payback

To be economical, a near-term project must have relatively short payback of several years or less. Large-scale transmission projects typically have paybacks of 15-20 years or more. Short paybacks enable customers to get immediate relief from congestion costs and accrue economic benefit from reduction in outage frequency.

• "No Regrets" Flexibility

Even if a longer-term solution is implemented later and the near-term fix becomes obsolete, it will have most likely already paid for itself and provided needed relief in the interim. Considering the 7 to 10 years necessary to complete large scale projects, near-term relief can be well-worth the effort.

• Low Cost

Near-term projects can be implemented for a fraction of the cost of large-scale transmission line projects. Adding a third transmission line and towers to relieve congestion on California's notorious 83 mile long Path 15 will cost $323 million or almost $3.9 million per mile. Near-term projects, such as reconductoring to higher capacity, can be undertaken for $40,000 to $120,000 per mile. Lower cost enables more projects to be completed and simplifies financing.

- **Broad and Equitable Coverage**

Because of their relatively low cost, a large number of projects can be pursued across the country for the same price of building one new transmission corridor. This enables more equitable transmission congestion relief nationwide than would otherwise be the case if resources were focused on a few big ticket projects.

- **Measurable Reliability Improvement**

Most important is the economic value obtained by clearing system bottlenecks. Reducing the likelihood of catastrophic outages of the magnitude of risk of an August 14th scale event reduces the expected value of economic disruption by as much as $100 million for every percent improvement obtained in overall grid reliability.

While the near-term solution offers a fairly rapid, cost-effective way to alleviate current grid congestion, increase capacity and enhance reliability, a long term solution is needed that will facilitate the faster deployment of new, more reliable lines while keeping a lid on capital expenditures.

Again, advanced, high-tech composite core aluminum conductors and state-of-the-art composite-based towers offer cost-effective options for resolving the nation's ongoing power demands. Because of their strength, resilience, low-sag, and high-temperature capabilities, new lines can be deployed in many locations that would not be possible due to the excessive sag and the higher electromagnetic fields (EMF) of the traditional steel cored cables.

Composite-based poles and lattice-structure towers are lighter, stronger, easier to erect, safer, more weather resilient and easier to deploy. For example, current steel towers require as many as 14 men, 2 cranes and 5 days' time to erect. Three men can erect a composite-based tower in about a day without a crane – a substantial cost savings in man-hours, equipment, construction time, etc.

Moreover, composite towers are not as easy to bring down. They are typically engineered to withstand 200-mph winds and 6.9-Richter-Scaled earthquakes. They do not burn quickly or buckle in high heat…so they can withstand the ravages of devastating forest fires. And, if attacked with explosives, they dissipate the blast effects over a far greater area rather than in a single point. Therefore, they are less likely to collapse and pull down key transmission infrastructure.

New technologies also provide far more operational control for electric power utilities and distributors. Since 90 percent of all line failures occur at the cable splice, sensors can be integrated into composite core aluminum cable splices enabling providers of electricity to monitor changes in temperature, pressure, tension and vibration. This allows operators to implement preventative maintenance procedures and negate potential problems well before they can occur. New lines and towers can also be color-coded for enhanced safety and security. This is especially important in areas that may suffer "white out" conditions during blizzard conditions. Also, sensors can be used that provide real-time information about local weather and atmospheric gases, so that officials can better monitor and enforce homeland security issues.

In conclusion, Congress has recognized that the vulnerability of the nation's electric grid is a matter of urgent national concern. Focusing backstop authority on projects that can provide relatively quick relief improves the odds that the country will not have to confront a series of avoidable disruptions that undermine the nation's future. ■

ABOUT THE AUTHOR

Benton Wilcoxon, Chairman & CEO, Composite Technology Corporation, a global provider of electric utility solutions featuring its breakthrough composite technologies. CTC's premiere product is a composite-reinforced conductor known as ACCC (Aluminum, Conductor Composite Core) cable, which has the potential to revolutionize electrical grids by offering twice the power of traditional aluminum cables, 25% stronger materials and dramatically improved reliability. CTC is based in Irvine, CA. For ore information visit: www.compositetechcorp.com.

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INDUSTRY NEWS

Power System Security, Blackouts and Unlikely Events

By: Tony Sleva, SEA Consulting Services,

It goes without saying that highly engineered systems, such as the electrical power grid, are able to tolerate a wide variety of component failures without collapsing. Historically, engineered systems have only failed when unlikely events combined with unforeseen conditions occur.

To the layman, the resilience of the power grid creates the impression that the power grid should not fail. To the owner, the fact that electrical service is so reliable makes it difficult to justify improvements that are unnecessary when past failures are considered.

Actual Unlikely Events

When dealing with unlikely events, such as widespread blackouts, it may be necessary to consider notable failures of other highly engineered systems in addition to other blackouts that have occurred. Consider some of the unlikely events that occurred in our lifetimes:

- Three Mile Island Accident
- Space Shuttle Challenger Accident
- World Trade Center Attack
- August 14, 2003 Blackout

Then consider the consequences of these unlikely events. Individual and company reputations were tarnished, industries were drastically changed, regulations were promulgated and implemented, etc. After each of these unlikely events, people demanded change. Business, as usual, was not on anyone's mind.

Have We Done Enough?

This leads to the question "Have we done everything that a reasonable person would do to assure ourselves that a prolonged blackout that affects a good deal of the United States is among the most unlikely events that can be postulated?" We've had three years since 9/11. Are we satisfied with the changes we've made?

Surely, technology has always been implemented to detect electrical failures, to protect against adverse consequences, and to secure the system to enable continued operation. But, have sufficient security measures been implemented to detect vandalism, sabotage and intrusion before major electrical failures occur? Have facilities been hardened so that the response to intruders and saboteurs is quick enough to prevent unacceptable loss of redundant components or facilities?

How Do We Critique Power Systems?

These are tough questions, but they need to be answered. The first step is to rank facilities as to their importance to continued operation of the national electrical power grid. Do you know how the importance of your facilities compare to each other and to other companies' facilities? Have you considered fundamental electrical characteristics of your system and of neighboring power systems?

The next step is to assess visibility, layout and redundancy of critical facilities. For the most critical facilities, on-site inspections should be performed to verify the "hardness" of each subcomponent and to verify response time when intruders or saboteurs are detected. Basic items that need to be considered include: missing locks, missing keys, separate facility keys, and easy facility access over roofs or under fences.

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One Last Thought

Years ago, facilities were designed with business and engineering criteria, such as least cost and ease of maintenance. That philosophy needs to be reviewed in light of today's reality. Our thoughts are that vulnerability assessments can identify high risk facilities and provide a sensible approach to risk reduction. A thorough, independent inspection may uncover undesirable conditions at your most critical facilities. ●

Tony Sleva is Manager – Electrical Engineering at SEA Consulting Services. Tony can be contacted by phone 609-409-9790 or by e-mail tsleva@seacorporate.com SEA's website address is www.seacorporate.com

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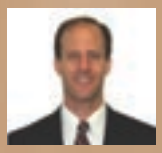

RELIABILITY AND DISTRIBUTION ASSET MANAGEMENT

By: Richard E. Brown, KEMA

IN THE PAST, the distribution aspects of electric utilities were part of vertically integrated monopolies responsible for generation, transmission, distribution, and customer service. Prior to the 1970s, load was doubling more than once per decade and equipment was mostly new. Since rates were declining and earnings were growing, utilities could spend liberally on their distribution systems to achieve high levels of reliability while minimizing most aspects of risk. These days are a distant memory.

Today, the industry is vertically unbundling so that generation, transmission, distribution, and customer service can be operated as separate businesses. Many utilities are now "DISCOs," where the vast majority of spending relates to physical distribution system infrastructure. With slow load growth, aging equipment, depleting rate bases, rate freezes, and regulatory uncertainty, DISCOs are looking for ways to increase earnings, credit ratings, and stock price. At the same time, regulators are expecting distribution reliability to improve, and nobody seems sure of how to properly manage risk. Is asset management a silver bullet? No, but a proper understanding of asset management basics can help DISCOs deal with these issues in a systematic and appropriate manner.

Asset management is a term derived from the financial industry, where its concepts are applied to investment portfolios containing stocks, bonds, cash, options, and other financial instruments. Fundamental to financial asset management is the tradeoff between risk and return. Investors identify acceptable risk. Asset management techniques are used to achieve this level of risk for the highest possible return.

Many techniques of financial asset management are applicable to distribution asset management. Of particular importance is the treatment of reliability and the risk of not meeting reliability targets. However, distribution assets are more complicated to manage than financial assets for a variety of reasons. They have non-financial aspects of performance and risk, they require maintenance and replacement, they are part of a highly complex interconnected system, and there is not a liquid market.

This article discusses asset management for distribution companies, or autonomous divisions of integrated utilities responsible for distribution system investments and operations. It first presents the goals and objectives of asset management, a corporate framework, and the competencies required to make it all work. The remainder focuses on pressing issues facing distribution companies today, and the ability of asset management to help address these issues in an effective manner.

Goals

In its most general sense, asset management is a business approach designed to align the management of asset-related spending to corporate goals. The objective is to make all infrastructure-related decisions according to a single set of stakeholder-driven criteria. The payoff is a set of spending decisions capable of delivering the greatest stakeholder value from the investment dollars available.

Typically, utilities adopt an asset management approach to either reduce spending, more effectively manage risks, or drive corporate objectives throughout an organization. These are good things, but should be considered a result of asset management rather than its objective. For example, asset management is not:

Asset Management is NOT:

- Reliability-centered maintenance
- Equipment condition monitoring
- Loading equipment to higher levels
- Risk reviews for cancelled projects
- A "black box" that tracks assets and prioritizes spending requests

Asset management is a corporate strategy that seeks to balance performance, cost, and risk. Since reliability is the primary driver of discretionary cost, the goal of distribution asset management is to balance reliability, cost, and risk. Achieving this balance requires the alignment of corporate goals, management decisions, and technical decisions. It also requires the corporate culture, business processes, and information systems capable of making rigorous and consistent spending decisions based on asset-level data. The result is a multi-year investment plan that maximizes shareholder value.

Goals of Distribution Asset Management:

- Balance cost, reliability, and risk
- Align corporate objectives with spending decisions
- Create an multi-year asset plan based on a rigorous and data-driven processes

Asset management is ambitious in scope, and requires supporting metrics, organizational design, processes, information systems, and corporate culture. Successful implementation can be quite disruptive, and requires the involvement and support of top management, sufficient resources, and effective change management skills. Generic approaches are likely to fail, but thoughtful approaches can help utilities reach the next level in business success.

Framework

In its classical form, asset management separates itself from asset ownership and asset operations. The asset owner is responsible for setting financial, technical, and risk criteria. The asset manager is responsible for translating these criteria into a asset plan. The asset service provider is responsible for executing these decisions and providing feedback on actual cost and historical reliability.

This decoupled structure allows each asset function to have focus: owners on corporate strategy, managers on planning and budgeting, and service providers on operational excellence (see Figure 1). The asset owner sets the business values, corporate strategy, and corporate objectives in terms of cost, reliability, and risk. The asset manager identifies the best way to achieve these objectives and articulates this in a multi-year asset plan. The service provider executes the plan in an efficient manner, and feeds back asset and reliability data into the asset management process.

Asset management is also about process. Instead of a hierarchical organization where decisions and budgets follow the chain of command into functional silos, asset management is a single process that links asset owners, asset managers, and asset service providers in a manner that allows all spending decisions to be aligned with corporate objectives supported by asset data.

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Figure 1. Asset management is based on three functions (asset owner, asset manager, asset service provider), a single process, and many decisions.

Competencies

A robust asset management structure is supported by three pillars of competency including management, engineering, and information (see Figure 2). Building these competencies is daunting when viewed in isolation. Far more difficult is developing cross-functional expertise so that management, engineering, and information skills can be addressed in a mutually-supporting manner. At a minimum, this requires knowledge of the concerns, jargon, and methodologies associated with each pillar.

There are not many people in the traditional DISCO business who have strong skills relating to all three pillars. As such, many projects and initiatives will be led by project managers who need support when considering the full range of issues related to asset management. Without this support, projects will often achieve tactical goals, but will be incongruent with an overall corporate asset management strategy.

Aging Infrastructure

Most DISCOs in the U.S. have average equipment ages exceeding thirty years. It often seems wasteful to replace old equipment before it fails, but the possibility of drastic increases in equipment failures is unacceptable from all aspects of asset management including cost, reliability, and risk. Typically, the rate of DISCO asset replacement is on the order of 0.5%. In order to be a sustainable strategy, assets must last an average of 200 years! This level of asset replacement is clearly not in the interest of any thoughtful stakeholder, but traditional DISCO thinking seems incapable of proactively addressing this ubiquitous and looming problem.

More than any other issue, aging infrastructure illustrates the potential of asset management to address critical DISCO problems. First, it forces executive management to articulate clear goals in terms of budgets, reliability, and acceptable risk. It also requires an asset registry that tracks, at a minimum, the age of each piece of equipment in the field. Engineers can then perform detailed technical analyses comparing tactics such as inspect, repair, extend life, replace, and make system modifications. This analysis must necessarily take a multi-year approach, since aging infrastructure cannot be addressed in a single budget cycle. If reliability and risk targets cannot be met within budget constraints, asset owners must decide which to relax. When done properly, asset management will produce an aging infrastructure plan that justifies increased capital spending through a rigorous, data-driven, and auditable process.

Figure 2. Asset management must be supported by three pillars of competency: management, engineering, and information.

Reliability

More than thirty five state utility commissions require reliability reporting, and many have set reliability targets that utilities are expected to achieve. The clear trend is towards DISCOs being required to meet reliability targets. This also implies that DISCOs must manage the risk of not meeting these reliability targets. Reliability is also a major cost driver, and should be the major focus of asset management initiatives within distribution companies.

Although reliability is best achieved through proactive planning and design, most reliability initiatives are reactive and not fully aligned with corporate objectives. By taking an asset management approach, reliability is treated explicitly, rigorously, and cross-functionally. All reliability decisions are based on solid historical information relating to equipment performance, system performance, operational performance, and cost. Decisions related to expansion, replacement, reconfiguration, operations, inspection, and maintenance are all considered together. Gains can be profound, and it is not uncommon for an asset management approach to achieve all the reliability benefits of existing programs for less than half of existing levels of spending.

Risk Management

Risk management is perhaps the most misunderstood aspect of asset management. Chief risk officers tend to view this topic in terms of financial risk management, where statistical methods are well established. The tradeoff between financial risk and reward is quantifiable, and risk mitigation can be pursued through diversification, indemnification, options, futures, swaps, and a myriad of other financial instruments.

Reliability risk management is a different animal, and concerns itself with undesirable events such as equipment failure, poor reliability indices, worst performing feeder, and "headline events" related to a reliability incident. Many DISCOs approach risk by looking at the probability and severity of bad things happening if a project is not approved. Although this is a good start, it falls short of true asset management since it is based on projects rather than reliability, and is not rigorous in its approach.

Risk is best thought of as the risk of not meeting reliability targets such as SAIDI, worst-customer reliability, storm response, and major substation outages. Viewed in this way, it is insufficient to just set performance targets such as "achieve a SAIDI of two hours or less." Each target must be accompanied by a risk tolerance such as "achieve a SAIDI of two hours with 90% confidence." If this target is not achieved, the asset management group can confidently state that this was a one-in-ten year occurrence, and that the distribution system is performing as designed.

Proper treatment of risk requires the knowledge of equipment condition, the impact of maintenance and operations on equipment condition, and the impact of equipment condition on the probability of failure. It also requires supporting information systems and business processes that allow risk mitigation in the form of inspection, maintenance, operations, replacement, and system modifications. A complete technical risk management program will be integrated into an overall corporate risk management program, and should be familiar with hedging, real options, scenario analysis, the cost of capital, regulatory affairs, legal affairs, and public relations. Risk management is an explicit goal of asset management, and must become a DISCO core competency.

Budgeting and Project Selection

Ultimately, asset management is responsible for spending decisions. The purpose of a budgeting and project selection process is to ensure that these decisions are made consistently, in the best manner possible, and in full alignment with corporate objectives. Typical utility budgeting processes are insufficient, and it is often helpful to ask the following questions. Are reliability, cost, and risk being truly balanced, or being deal with in another manner? Is reliability being measured in a ways that represent the interests of all stakeholders? Is budgeting based on multiple years and total life cycle costs? Is the risk of meeting budget and reliability targets treated in a rigorous manner?

When implementing an asset management strategy, many utilities begin by focusing on project ranking. By forcing all projects to be assigned a benefit and a cost, projects across departments and functions can be directly compared. By ranking all projects based on the ratio of reliability to cost, projects can be selected in order until reliability targets are reached or budgets are exhausted.

Compelling as project ranking may seem, it is problematic if there is not a single measure of reliability. Within narrow programs such as distribution automation, it may be possible to have a good single measure of benefit (e.g., reduction in customer interruption minutes). Within a greater asset management context, many different reliability issues must be considered, and a single measure becomes meaningless. It is always possible to create a generic index of benefit based on the weighted sum of a wide range of disparate benefits, but the resulting list of ranked projects can often cause more problems than it solves.

To avoid this problem, reliability should be based on an set of measures that address all stakeholder concerns. Once these and budget constraints are identified, optimization techniques can identify a multi-year spending plan that satisfies all reliability, risk, and budget constraints in a way that minimizes total life cycle cost and maximizes shareholder value.

Final Thoughts

Distribution asset management is the art of balancing reliability, cost, and risk. Achieving this balance requires support from three pillars of competency: management, engineering, and information. Initiatives can stem from each of these pillars, but must always consider and coordinate with the other two.

Distribution asset management is capable of addressing the most pressing issues facing the distribution businesses including aging infrastructure, reliability, project selection, and risk management. Each issue is daunting when considering in isolation. More daunting is the thought that true asset management will optimize decisions across all of these issues simultaneously. Asset management can be truly revolutionary, but only when it is based on three functions, a single process, supporting systems, and a robust skill set of management, engineering, and information.

About the Author

Dr. Richard E. Brown is a principal consultant with KEMA, and specializes in helping utilities improve business performance through management and technical consulting. He has published more than 60 technical papers related to reliability and asset management, and is author of the book Electric Power Distribution Reliability. He is a senior member of IEEE, chair of the Working Group on Distribution Planning and Implementation, and recipient of the Walter Fee Outstanding Young Engineer award (2003). Dr. Brown has a BSEE, MSEE, and PhD from the University of Washington, an MBA from the University of North Carolina, and is a registered professional engineer. He can be reached at rebrown@kema.com. ■

EMTP-RV at a glance

By:
Jean Mahseredjian – HQ IREQ
Sébastien Dennetière – HQ IREQ
Omar Saad – TransÉnergie Technologies
Bahram Khodabakhchian – TransÉnergie Technologies

Combined with the powerful graphical user interface (GUI) EMTPWorks, EMTP-RV—the new restructured version of the well-known electromagnetic transient program EMTP—sets a higher level of capabilities in the simulation of large-scale electrical networks. It's now possible to rapidly design, simulate and view large and complex systems, reducing the engineering and development time and allowing more detailed studies on the complex phenomena of power system transients.

Powerful engine

EMTP-RV uses a completely new approach for assembling network equations: sparse modified-augmented-nodal analysis. A new Jacobian-based nonlinear solver eliminates all topological restrictions and allows solving very large-scale nonlinear systems with a minimized number of iterations. All EMTP-RV network models can be combined and solved in any topological configuration without forcing the user to introduce artificial devices to circumvent numerical problems.

In addition to a large library of electrical/electronic circuit and power system devices, EMTP-RV can solve control systems using block diagrams. A library of primitive devices is used to build libraries of specialized control functions. EMTP-RV has a completely new control system solver and an optional Newton method for finding the simultaneous solution of all control system blocks.

Power electronics circuits can be solved using macro-models, such as ideal switches and detailed nonlinear functions. Simultaneous switching is achieved by treating the switches in an iterative loop.

In addition to its time-domain solution, EMTP-RV has a complex matrix-based steady-state solution used primarily in automatic initialization of state-variables. Automatic initialization is for achieving quick harmonic steady-state in the first time-domain simulation cycle. All devices, including the distributed parameter transmission line models and machines with controllers, can be initialized.

The new EMTP-RV code has been rewritten from scratch using modern object-oriented programming and vectorized computations. In addition to flexibility for user-defined modeling, one of the most important benefits to the user is its significantly increased speed of computation and fully automatic dynamic memory management. There are no built-in limits for the number of devices or signals in any topological configurations and device combinations. EMTP-RV is optimized for speed and memory.

EMTP-RV minimizes numerical limitations and topological restrictions for providing an environment of unsurpassed expressive power for the user. Although complex and powerful, it remains straightforward to harness for conducting studies at all user levels.

Intuitive and user-friendly GUI

EMTPWorks is also the simulation environment for EMTP-RV. It's designed to efficiently create and maintain small circuits as well as very large-scale networks. EMTPWorks has an open architecture for maximized user configurability from basic user-defined model assemblies to more advanced script-based programming. EMTPWorks offers script methods from simple data management tasks to more advanced object attribute settings, library functions and network device symbol redrawing and updating. Each device is given its data web using DHTML. Device data Web pages can reside on the user's computer or anywhere on the Web. The script source code of all device data management functions is available to the user. EMTP-RV has automatic subcircuit creation methods with unlimited levels of hierarchy. Subcircuit masking options can accommodate user programming from simple data statements to more complex scripts and data capture panels. Scripts can be also used to launch calls to ActiveX objects or to programs created in other environments.

Multipage design

A circuit can be drawn on one or more pages (up to 1000 in this version). You can elect to draw the entire circuit on a single page or divide it up functionally onto a number of pages.

Each page is viewed in a separate circuit window, and any or all pages in a circuit can be displayed on the screen simultaneously.

A page is drawn on the screen as if it was a single piece of paper, although it may have to be broken up into a number of individual sheets of paper for printing or plotting.

Logical connections can be made between pages using a page connector device.

Due to the the software's ability to connect signals by name, signals with the same name appearing on different pages are automatically connected. The inter-page connections are used to place a visual marker and provide a mechanism for jumping between pages through connected signals.

The entire Hydro-Quebec grid was modeled using this approach. This is a very large network divided into several regions and subcircuits having over 16,000 devices.

Hierarchical design and subcircuits

"Hierarchy" refers to the ability to have a "device" symbol in a schematic actually represent an arbitrary circuit block. The "pins" on the device symbol represent connections to specific input-output points on the internal circuit. Subcircuits (also called subnetworks) are the building blocks of hierarchy.

Hierarchical design provides a powerful way of representing complex designs in a compact and readable form. A top-level diagram of your system can show only major functional blocks. These blocks can then be opened to show more and more design details.

Hierarchical design in effect adds a "third dimension" to a schematic diagram. It also raises some complex issues that should be understood before embarking on a major design.

After creating the subcircuit, the user can mask its data using scripts. Masking is a powerful feature for data hiding and encapsulation. It is part of the open-architecture options in EMTP-EMTPWorks. It provides high-level access to subcircuit contents and allows the creation and programming of a user-defined model.

User-defined symbols and device libraries

Devices with their symbols and data are an important resource in your design creation process. Whether you primarily use the devices provided with EMTPWorks, or you create special libraries for your own use, the completeness and accuracy of device maintenance tools has a major effect on your design flow. Library files generally outlast any one design and

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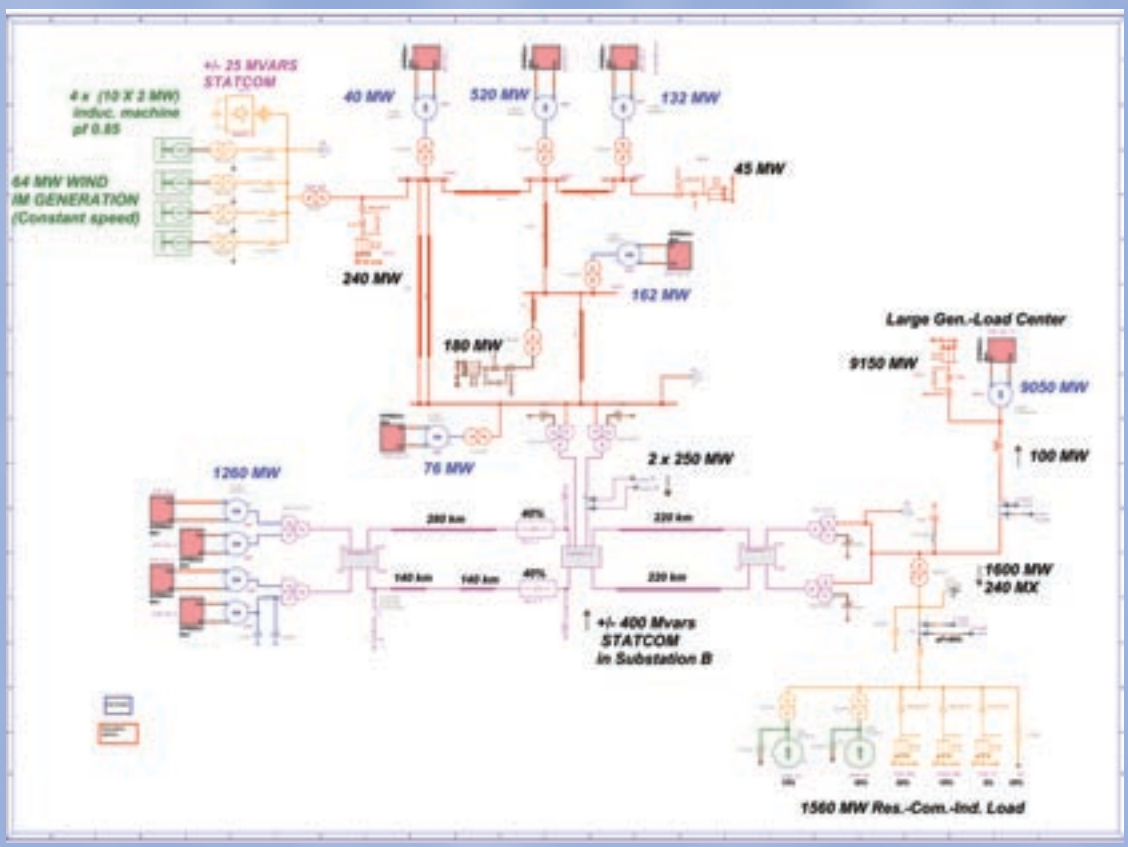
are used for many years across many projects. In addition, many EMTPWorks features rely on specific steps being taken while creating a symbol. For these reasons, EMTPWorks provides a variety of features for creating and editing the device symbols and for maintaining device library files.

Symbols are created and edited using the device Symbol Editor tool. In addition to drawing symbols, the device symbol editor is also used for fixing device behavioral attributes in the schematic. One of the most useful applications of the Symbol Editor is the customization of subcircuit symbols. When a subcircuit is created the first time, EMTPWorks uses a default rectangular symbol. You can right-click on the symbol and select "Edit Symbol" to open the Symbol Editor window and modify the device drawing.

Using the symbol editor, you can customize the device drawing to give a realistic representation. This helps to provide a more comprehensible view of the network.



Efficient output processors

The EMTP-RV package includes an efficient data acquisition and processing software named ScopeView. It is especially well adapted for the simultaneous viewing and mathematical post-processing of EMTP-RV, but can also show MATLAB® and COMTRADE generated signals. ScopeView offers multi-page and multi-column capabilities and an advanced built-in function editor.

EMTP-RV provides another visualization function called MPLOT, suited for waveform viewing and statistical analysis. MPLOT is entirely written using MATLAB®, and is the compiled version of a set of m-files. It's also available as a free download for users who want to used MPLOT directly from MATLAB® for increased flexibility and access to a very large set of data manipulation and calculation functions.

Practical applications

With the new computational and visual environment provided by EMTP-RV, users can now handle a much larger time-scale in their studies. The new speed of computation allows them to study lightning phenomena as well as transient stability problems. It is now possible to simulate much more complex and advanced designs with increased precision. The EMTP-RV software package provides several examples demonstrating its capabilities in various application fields. The list of examples includes:

- Lightning strike near a 765-kV GIS. To assess the wide spectrum of the propagated signals, the transmission lines are modeled using frequency-dependent models. The towers near the substation are modeled in detail using a transmission line model to represent the tower height and a dynamic model for the footing resistance. The GIS substation is also modeled in detail using transmission lines for the busbars and the gas-filled bushing.
- 765-kV line crossing a river with the special use of line arresters. This example simulates the protection provided by the line arresters against the very fast rising current injected by lightning.
- Variable static load modeling and machine dynamics. Here the loads are divided into several types representing real-life consumption: incandescent light, fluorescent light, small motor, large motor and TV load.
- Single-phase induction machine. EMTP-RV is the first simulation program to represent this type of machine in detail. This flexible model provides several initialization modes, with or without capacitor run and with or without the secondary winding.
- Arc instability following shunt reactor breaker failure. The modeling of the arc breaker in this design was able to identify a new transient phenomenon and helped to solve an actual substation breaker failures.
- Distributed generation with wind power and multi-machine transient stability of a large network. This rather large and complex network includes 10 synchronous machines, 4 distributed wind power generators, a dynamic load model, power electronics, STATCOM, etc. This design shows the power of EMTP-RV modeling using multilevel subcircuits with masks to enter the data. symbol editor is used to add clarity and to give a comprehensive view of the entire network.

Additional examples and user contributions are continuously added and made available for EMTP-RV users through the EMTP-RV website (www.emtp.com).

A client oriented product

EMTP-RV is commercialized by TransÉnergie Technologies and is maintained by a research and development team and experienced EMTP users. In addition to providing world-class support and maintenance services, TransÉnergie Technologies offers superior consulting and training options.

A one-week seminar and computer workshops on different aspects of transient system studies and analysis with EMTP-RV is held twice yearly. Short seminars are also organized as part of the major Power System conferences and trade shows. Scheduled EMTP-RV training courses and seminars will be announced in advance on the EMTP-RV website (www.emtp.com). ■

For more information:
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EMTP-RV is developed and maintained by the Development Coordination Group of EMTP which includes American Electric Power, CEA Technologies, CRIEPI of Japan, Electric Power Research Institute, Électricité de France, Hydro One Networks, Hydro-Québec, US Bureau of Reclamation and Western Area Power Administration.

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PSCE

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The IEEE Power Engineering Society's 2004 Power Systems Conference and Exposition (PSCE'04) will be held at the Grand Hyatt Hotel in New York, New York from 10 - 13 October 2004. This inaugural IEEE PES event, hosted by Consolidated Edison of New York, will bring together practicing power systems engineers, operators, planners, policy makers, economists, academics, and others from around the world to address topics under the event theme "New Solutions for New Challenges".

Aim of This Event

This conference and exposition will provide a venue to share and discuss various issues and developments in the multifaceted field of electrical power systems. This event will kick off with a timely and valuable plenary session on the subject "Balancing the Needs of Competitive Markets with Confidentiality and System Security" and will look back and address the lessons learned in the year following the August 14, 2003 North American blackout. The conference will comprise an outstanding combination of technical sessions, panel sessions, and tutorials focusing on the following tracks:

- Track 1: Planning and Operation
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- Track 3: Dynamic Performance of Power Systems
- Track 4: Real-Time Applications
- Educational Track: Understanding Power Systems

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The sold-out exposition will showcase state-of-the-art software and hardware systems as well as consulting services for those involved in the power systems area. There will be times devoted exclusively to the exhibits—with no parallel technical sessions scheduled—so attendees can focus on the displays and have a chance to speak directly with vendors on the latest technologies, systems, software, hardware, and services as well as give exhibitors the opportunity to interact with many potential customers.

Looking Forward to October

Power systems engineers, operators, planners, policy makers, economists, academics, and others working in the areas of planning, operation, implementation, security, and related areas, will greatly benefit from the discussions during meeting sessions and exposition describing, high-lighting, and demonstrating the most up-to-date systems technologies in the industry. Vendors providing software and hardware systems as well as consulting services can access a large number of leaders in fields utilizing their products and services by participating in the PSCE'04 exposition. Both the conference and exposition of this inaugural event are sure to make this a premier international power systems gathering.

We look forward to seeing you in New York in October!!!!!

John Paserba; General Chair – PSCE 2004;
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IEEE Power Engineering Society PSCE

Schedule at a Glance

Sunday, October 10

12:00 - 13:00
- **SPA-1:** Student Professional Awareness Panel Session 1: USA - Job Outlook Edison/Winter Garden/Brooks

13:00 - 14:00
- **SPA-2:** Student Professional Awareness Panel Session 2: Financial Planning - Stocks, Bonds, Investments, & Loans - Managing Your Money Edison/Winter Garden/Brooks

13:00 - 16:30
- **Tutorial:** T1: Enterprise Integration for the Digital Utility, Uris/Julliard
- **Tutorial:** T2: Congestion Management and Transmission Rights, Broadway
- **Tutorial:** T3: Cyber Security of Control Systems, Carnegie/Alvin

14:00 - 15:00
- **SPA-3:** Student Professional Awareness Panel Session 3: Career Outlook – Professional Awareness, Edison/Winter Garden/Brooks

15:00 - 16:00
- **SPA-4:** Student Professional Awareness Panel Session 4: Educational Opportunities - Graduate Programs, Edison/Winter Garden/Brooks

16:00 - 17:00
- **SPA-5:** Student Professional Awareness Panel Session 5: Professional Engineering Licenses, Edison/Winter Garden/Brooks

17:00 - 19:00
- Welcome Reception, Manhattan Ballroom

Monday, October 11

8:00 - 9:00
- General Membership Meeting Empire State Ballroom A/E

9:00 - 12:00
- **Plenary:** PLEN: Plenary Session Empire State Ballroom A/E

12:00
- Exposition Opening Ceremony Empire State Ballroom B/C/D

12:00 - 19:00
- Exposition, Empire State Ballroom B/C/D

14:00 - 16:00
- **POSTER-A:**
- Policy Development, Empire State Ballroom A
- Power System Relaying, Empire State Ballroom A
- Power System Communications Empire State Ballroom A
- Transmission and Distribution A Empire State Ballroom A
- Emerging Technologies in Power Engineering Empire State Ballroom A
- Power System Operations A Empire State Ballroom A

14:00 - 16:00
- **POSTER-A:** (Continued)
- Power System, Planning & Implementation A Empire State Ballroom A
- Switchgear, Empire State Ballroom A
- Substations Committee, Empire State Ballroom A
- Power System, Dynamic Performance A Empire State Ballroom E
- Power System Analysis, Computing and Economics A, Empire State Ballroom E

16:30 - 18:30
- **POSTER-B:**
- Transformers, Empire State Ballroom A
- Power System Planning & Implementation B Empire State Ballroom A
- Power System Instrumentation and Measurements, Empire State Ballroom A
- Transmission and Distribution B Empire State Ballroom A
- Surge Protective Devices Empire State Ballroom A
- Power System Dynamic Performance B Empire State Ballroom A
- Power Engineering Education Empire State Ballroom A
- Energy Development and Power Generation Empire State Ballroom E
- Insulated Conductors, Empire State Ballroom E
- Electric Machinery Analysis and Design Empire State Ballroom E
- Power System Operations B Empire State Ballroom E
- Power System Analysis, Computing and Economics B, Empire State Ballroom E

Tuesday, October 12

9:00 - 12:00
- **PANEL-1:** Market Monitoring, Metrics, Indicators, and Mitigation Empire State Ballroom A
- **PANEL-2:** Simulation Tools for Energy Markets and Physical System Operation Empire State Ballroom E
- **PANEL-3:** Issues Affecting Large RTOs in National Energy Markets Broadway/Carnegie/Alvin
- **PANEL-4:** Model-Driven Integration Techniques and Standards for Enterprise Integration Uris/Julliard

10:00 - 16:00
- Exposition, Empire State Ballroom B/C/D

14:00 - 17:00
- **PANEL-5:** Challenges in Power System Infrastructure Security and Defense Empire State Ballroom A
- **PANEL-6:** Market Clearing Mechanisms Empire State Ballroom E

Tuesday, October 12

14:00 - 17:00 (Continued)
- **PANEL-7:** System Operating Experience with Wind Power Plants, Broadway/Carnegie/Alvin
- **PANEL-8:** Transformational Communications and Control Programs, Uris/Julliard

Wednesday, October 13

9:00 - 12:00
- **PANEL-9:** The Real-Time Stability Challenge Empire State Ballroom E
- **PANEL-10:** Least Cost Planning for Non-Traditional Distribution Systems, Uris/Julliard
- **PANEL-11:** Operating GENCO Assets in New LMP Markets, Empire State Ballroom A
- **SP-1:** Power Markets and Economics Broadway/Carnegie/Alvin

10:00 - 14:00
- Exposition, Empire State Ballroom B/C/D

14:00 - 17:00
- **PANEL-12:** T&D System Asset Management Broadway/Carnegie/Alvin
- **PANEL-13:** Future Power Delivery Options for Long-Term Energy Sustainability, Uris/Julliard
- **PANEL-14:** Real Time Digital Simulation Empire State Ballroom E
- **PANEL-15:** Wide Area Protection and Emergency Control Issues and Solutions Empire State Ballroom A

Thursday, October 14

8:00 - 17:00
- **Special Tutorial:** Power System Basics for Non-Engineering Professionals

IEEE Power Engineering Society PSCE

Exhibitors

(as of August 20, 2004)

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- American Electrical Testing Co., Inc.	616
- AREVA T&D	203
- ConEdison	411
- DIgSILENT GmbH	714
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COMPANY	BOOTH #
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COMPANY	BOOTH #
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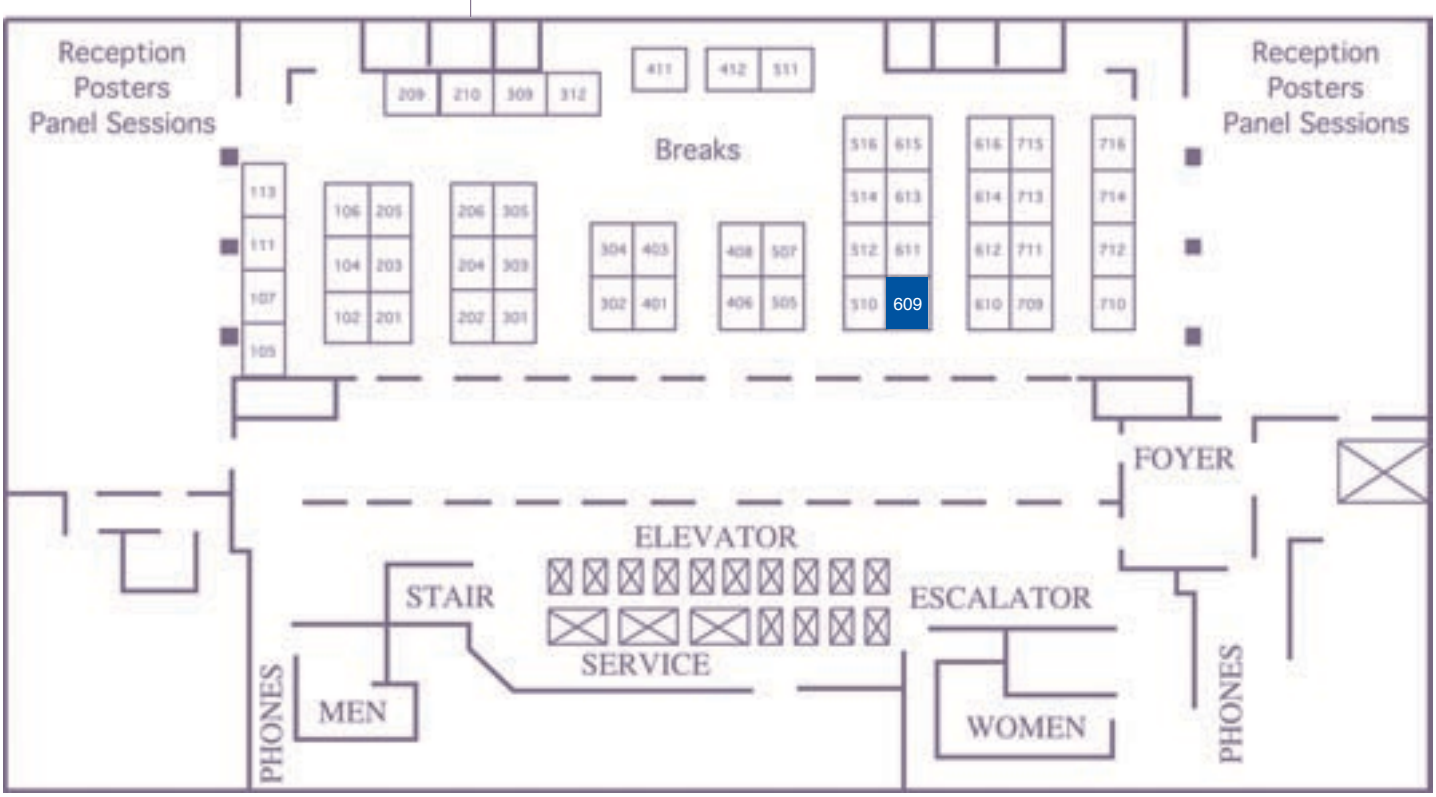
- V&R Energy Systems Research, Inc.	206
- VA TECH Transformers/VA TECH T&D	716
- ZIV USA, Inc.	505, 507

BALLROOM LEVEL



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SCADA System Vulnerabilities to Cyber Attack

By: William T. Shaw, Cyber SECurity Consulting

Summary:

In the aftermath of the 9/11 tragedy, and with the ever-growing threat of "cyber terrorism", a very important question has arisen concerning the vulnerability of the computer-based, supervisory control systems (SCADA) that are used to monitor and control our water distribution systems, our oil and gas pipelines and our electrical grid. Much has been said and written on this subject, but there is no single answer to that basic question. Depending on the particular characteristics of a given SCADA system, it is more or less susceptible to such an assault. The architecture of such systems have evolved, along with computer technology, over the past twenty years and current designs, although more flexible and functional, may also be more vulnerable. Also, it is important to understand that an attack on such a system can come from "within" just as easily as from an external source. This paper discusses the ways in which a SCADA system can be attacked and what can be done to reduce or eliminate the possibilities of such an attack.

Introduction:

Supervisory control (SCADA) systems have been in use since the early 1970's as the means for monitoring, and remotely controlling, geographically widely distributed processes such as water treatment and distribution, oil and gas pipelines and electrical power transmission and distribution. In basic architecture these systems all consist of a "central" computer system (generally fully redundant or "fault tolerant") that communicates, using one or more of a range of possible telecommunication technologies, to numerous, remote, electronic units (called RTUs or remote terminal units) that are interfaced with the field-based process equipment (see Figure 1.0). Over time, through the 1980's and 1990's, as microprocessor, Personal Computer and networking technology evolved, the design of SCADA systems changed to incorporate the latest technologies. In the late 1990's and into the 2000's the Internet and Internet-based technologies started becoming integrated into SCADA system designs. Today, a modern

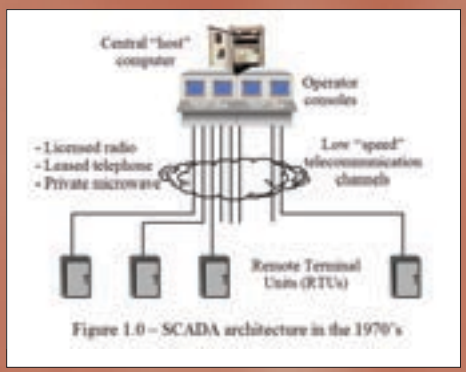


Figure 1.0 – SCADA architecture in the 1970's

SCADA system (architecturally) looks more like a corporate IT network than a "real-time" control system (see Figure 1.1). But, the point is that a SCADA system IS a real-time control system and that a successful attack on such a system could have much more serious and widespread consequences (in terms of loss of life and physical damage) than a "denial of service" attack on a corporate web site.

Purpose of an attack:

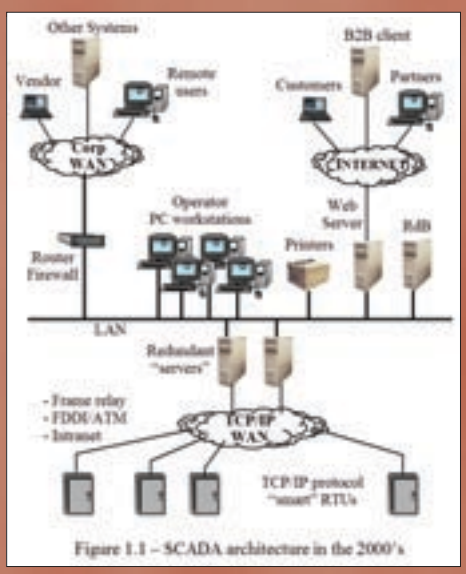


Figure 1.1 – SCADA architecture in the 2000's

The purpose of a cyber attack on a SCADA system could range from a hacker trying to prove he can get through your defenses, to a terrorist that wants to damage a major petroleum products transportation pipeline. Possibly someone might set up an attack for espionage (industrial) purposes or to generate "false" information to the SCADA system. The most serious threats are those that intend to either seriously disable the system (which could include generating false data so that operators are unaware of problems developing) or those attempting to commandeer the system to cause damage to the process or equipment being controlled by sending out improper control commands.

SCADA system robustness:

It is important to remember that most SCADA systems are designed with full redundancy and possibly some additional levels of fault tolerance. This is because (for good reasons) people have never fully trusted the reliability of electronic equipment. That means that such a system is going to be harder to "kill" than an ordinary IT server. None the less, if a serious terrorist were targeting a SCADA system, there are "cyber" ways in which to achieve his goal.

Physical security:

This paper will not address physical security, but it would seem obvious that allowing someone, with a chainsaw, axe or shotgun, near your SCADA system, would be a bad idea and should be prevented if at all possible. And actually, physical security is vital, and the topic is deserving of a whole separate white paper. This paper addresses non-physical attacks (things other than physical damage, power outage, etc.) against SCADA systems.

External connections:

With the old, original, SCADA systems the only external connections to the outside world were the telecommunication channels used to "poll", and communicate with, the RTU equipment at the remote sites (see figure 1.0). The communications technologies used for this could be anything from private, utility-owned and installed, microwave telecom equipment or leased telephone circuits (provided by "Ma Bell" back then) or simply half-duplex, licensed radio. Communications over these circuits was managed using specialized, proprietary, vendor-

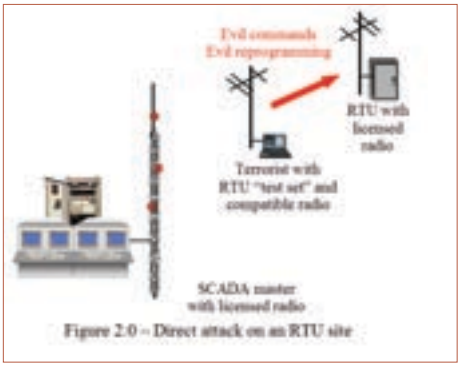


Figure 2.0 – Direct attack on an RTU site

specific, communication protocols. These protocols included basic error detection and correction capabilities, but nothing that guarantees "secure" communications. Over time, the incompatibility among proprietary protocols, combined with SCADA/RTU vendors going out of business, caused RTU and SCADA system customers to push for "standardized" protocols. In the water/waste-water industry these same factors spurred a widespread migration to PLC (programmable logic controllers) equipment for use as RTUs. These moves were good economic and technical decisions, but they increased the options for a cyber assault. For a protocol to be a "Standard" means that it is well published and documented and available from many sources. Someone with an RTU "test set" (a laptop computer running protocol simulation software) and a compatible radio could, in reality, sit near an RTU site and send out control commands that would be accepted by the RTU as coming from the central SCADA system (see figure 2.0). If s/he could gain access to the telephone circuit into a remote site, it would be even easier to commandeer the RTU. This sort of attack totally ignores the "host" system and goes directly to the locations where control and monitoring is actually being performed. Some types of RTUs, and most PLCs, support the downloading of control logic via their communication ports. This opens up the possibility of a terrorist "reprogramming" a remote unit via this same scheme.

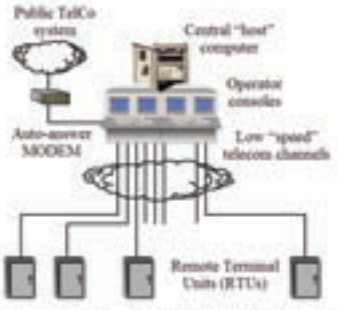


Figure 3.0 – Backdoor dial-in access for support

In order to make it easier for the system vendor's technical and support personnel to correct system software and configuration problems (without traveling to the customer's site) many SCADA systems starting being delivered with a dial-in telephone port (see Figure 3.0). This allowed a person with the phone number and a valid ID/password, to have administrative-level access to the SCADA system. Worse yet, many such access ports supported a "secret" password/ID known only to the vendor (and anyone who ever worked for that vendor) in case the customer totally messed up the system ID/password files. Hackers with "war dialers" and password cracking software could also attack those ports. Entry to the system via such ports often granted the highest level of system access. But, most hackers come out of the UNIX/Microsoft world as these have been the most prevalent operating system environments since "on-line" systems became widespread in the 1980s (starting with bulletin-board systems and leading to the Internet.) This means that many would have little or no familiarity with the operating systems running in these older SCADA systems. This would limit their access.

As P.C.s started becoming the basis for the operator workstations, it became possible to consider supporting additional P.C.s, remotely connected over dial-up telecommunications circuits, so that a plant manager or engineer could "dial-in" from home with their own P.C., rather than having to run back to the plant or control center in an emergency. As with the maintenance and support "ports", this capability offered a point of penetration for a would-be hacker. Without having to know anything about protocols, if access to the dial-in communications circuit were gained, this would be a perfect candidate for a "replay" attack whereby messages are recorded and retransmitted later. Most commercial protocol analyzers would suffice for this task. Many UNIX based systems used the X-Window standard for these remote workstations. This meant that anyone with a PC, X-Window software, and access to the communications circuit, would have a full-function operator's console, typically protected by just an ID/password login.

Since SCADA systems collect a lot of data and generate a lot of reports, it was only reasonable that eventually the SCADA systems would be connected to the business systems for an automatic exchange of this data. In early implementations this might have been done with custom applications software. But, in the past half-dozen years this would have been accomplished with TCP/IP networking and standardized IP applications like "ftp" (file transfer protocol) or XML (web page) data exchanges. Once a system is connected via TCP/IP to another (with any number of others in between them), unless security provisions are enabled, a user on the "other" system has numerous ways to penetrate the target system, much the same as a penetration in through the maintenance port (see Figure 1.1).

Which bring us to the "ultimate" external vulnerability: connectivity to the Internet. As was just mentioned, once a system is connected using TCP/IP networking, a user on any other system on the same network, regardless of how many other computers are "between" them, can gain access to the target system. This is the beauty and power of the Internet "IP" design. But it also means that every wacko, anywhere in the world, with an Internet connection, can be trying to break into your SCADA system. So, unless you make specific provisions with security, if your SCADA system is connected to a system that is connected to a system that is connected to…etc….a system that is connected to the Internet, then YOUR SCADA system is connected to the Internet. This exposes your system to hackers, worms and a variety of cyber attacks.

Most of the old, original SCADA systems (1960s/70s) ran on computers with proprietary, vendor-developed operating systems. Then, in the 1980s, "standard" commercially available operating systems like UNIX and VAX/VMS became available. This made system development and support much easier. But as with standard RTU protocols, this also enabled a large base of people to know a lot about the basic workings of the systems based on this commercial technology. In the past ten years an increasing number of SCADA systems have been based on Microsoft operating system technology. For a number of reasons, hackers just LOVE to assault Microsoft products (many such individuals come out of the UNIX/LINUX world) and there have been (and continue to be) a large number of known and documented security "holes" in Mr. Gates' software products. These can be exploited if proper protections (such as the latest Microsoft service packs) are not employed.

Internal Threats: Erecting a secure cyber-barrier around your SCADA system is a good idea and not an insignificant effort. But many of the ways in which a SCADA system could be disabled, damaged or used to wreak havoc, would involve an "inside job". It is sad but true that disillusionment with the government, a career, or even a relationship, can set an otherwise "normal" person on a path to do damage. The bombings in Oklahoma City are a pointed reminder of that fact. Although we all want to have trust and confidence in our co-workers, managers and employees, they are only human. And in an economic environment where many companies have "down sized" there are ex-co-workers (and former employees of vendors) out on the street with potentially dangerous knowledge.

An internal threat can be in the form of an accidental action that results in damage, or an intentional action. Good security procedures should make either one less possible. As previously mentioned, this paper won't address physical security, which includes topics such as access control, credential verification and surveillance. But security procedural issues are a central component of internal threat prevention and include functions like password management and administration.

There are several possible scenarios for inflicting damage to a SCADA system from the "inside". One way is to introduce malicious software into the system. An employee that brings unauthorized software in from home (possibly downloaded shareware) and puts it into his desktop PC (or a PC that functions as an operator workstation) stands the chance of introducing a virus, worm, Trojan horse or other form of software "infection" into interconnected systems. As operator workstations have evolved into PCs, this

has become a definite threat to SCADA systems. Depending on the system design, and the O.S. of the servers, the results of this might only be the loss of the particular PC, or it could spread across the system.

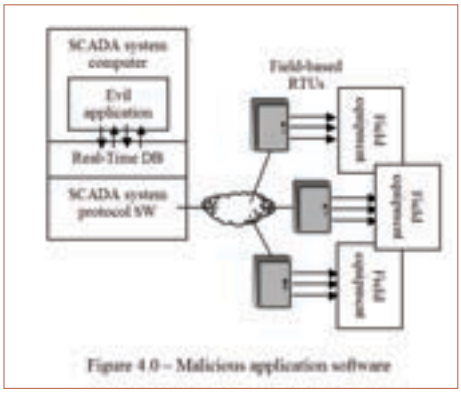


Figure 4.0 – Malicious application software

Application programs running in the central SCADA computer often have indirect access to the control outputs of the field-based RTUs. (They can request that the protocol "drivers" issue commands in the same way the operators can command them through the workstation interface.) It is definitely possible, for a person with programming experience on a given SCADA product (available from the system vendor), to develop and introduce an application program that could turn off selected alarms and issue control commands to the field devices (see Figure 4.0). A variation on this would be making modifications to an existing supervisory application so that it does the intended damage. This would generally require detailed, specific knowledge of the target system. A suitably motivated operator could potentially do the same things through his user console, if no one was watching, and he had password authority (although this would not constitute a "cyber" attack). SCADA systems typically provide for multiple "levels" of access authority. Unfortunately password security is often lax and only newer SCADA systems can support two-component (e.g. mag-card in addition to a password) identity authentication.

A similar attack could be made on systems where there are "settings" that get read from the central computer file systems and converted into parameters and commands that are then dispatched to the field RTUs. In the electric utility world these might be setpoints for voltage regulation or commands to cap banks. In the water industry these might be level and pressure setpoints that vary during the daily load swings. If these tables were modified the results would be similar to launching a malicious application program.

An employee with access to the system (and appropriate passwords) could also run system-level utilities (such as a file manager) that would erase essential system software and shut the system down. Although, unless they could delete the redundant system's software first, the redundant unit would immediately assume control. Most SCADA systems have "watch dog timer" hardware that would be triggered by such actions, but probably only after the damage was done. The efficacy of such an attack is questionable since one would hope that backup copies of the system would be stored locally (and off-site) in a safe and protected location. A system could probably be restored to full operation in about an hour in most cases, presuming that no physical damage was inflicted (probably not a safe assumption). It has also becoming more prevalent for critical SCADA systems to be supported by backup systems, located at alternate geographical sites. Any action that totally shut down the primary SCADA system site (such as an earthquake, flood, terrorist attack or really effective Cyber attack) would cause the backup site to assume control.

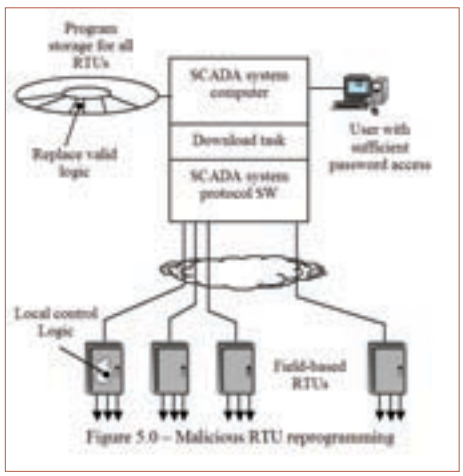


Figure 5.0 – Malicious RTU reprogramming

As part of the "external" threats, one previously discussed was the potential for reprogramming an RTU or PLC by accessing the polling/communication circuit. A similar action could be taken as part of an inside attack. The files containing the valid programming for RTUs and PLCs could be replaced by "evil" software (see Figure 5.0). This could be done and the files downloaded immediately, or by merely replacing the valid software in the file system, the "evil" software would get downloaded at the next point in time where an RTU or PLC required reloading (not normally a frequent occurrence). An immediate, wholesale download to multiple remotes would have a much greater impact. It is important to remember that not all RTUs and protocols support remote downloading over the telecom channel (but many PLCs do!) In the oil & gas pipeline industry it is not uncommon for RTUs to contain a fair amount of sequence control and regulatory control logic. Replacing this logic with malicious logic, or merely downloading dangerous settings, could inflict damage on pipeline equipment and operations. Again, these sorts of attacks would require high-level access plus a fair degree of system knowledge and expertise.

Summary:

SCADA system vendors, like most of us, never thought that 9/11 and Oklahoma City could happen. Therefore no one designed SCADA systems with integral protections against a cyber attack. They were designed to be tolerant of minor human error and to keep out the honest. Some critical SCADA systems have been architected to survive natural catastrophes, which makes them less likely to totally fail under a cyber assault. The SCADA system technology employed today is much more susceptible to a concerted cyber attack, essentially due to the adoption of "IT" technologies and "standards" into the design of such systems. Many older systems would be nearly immune to a remote cyber attack or much more difficult to attack using conventional hacking methods. The IT world has developed a range of technologies and techniques for protection IT assets. Many of these same approaches can be used to safeguard modern SCADA systems. All SCADA systems are open to internal attacks, although an internal cyber attack (not a physical attack) will generally require a high degree of technical knowledge about the system. Direct attacks on an RTU requires physical access to the communications channels, but if this is obtained, generally any/all protections have been bypassed at that point of access. PLC equipment is also more vulnerable to remote reprogramming due the inherent design of these devices and their origins on the factory floor. ■

WIN Energy: A Case Study in using MultiSpeak to Enable Best of Breed Software Selection

By: Greg Wolven, Director of Engineering for WIN Energy REMC

WIN Energy – based in Vincennes, Indiana – is a 16,000 member rural electric cooperative operated by 42 employees working out of three different offices and covering approximately 2,500 miles of distribution lines. With system loads growing at an average of 15 percent over the last several years, WIN Energy's management team made a strategic decision to meet this challenge and keep rates low by investing in technology solutions, rather than increasing staff. Taking advantage of new technologies has helped the utility increase productivity, free up staff time, improve customer satisfaction and facilitate the exchange of information. The solutions implemented include MiniMax's StakeOut for field design and work order automation, LookOut for utility-wide map viewing, an ESRI GIS (Geographic Information System), Hunt Technologies AMR (automated meter reading), NISC's CapsXL+ financial accounting and CIS (Customer Information System) and Milsoft's Engineering Analysis (Windmill) with plans to add Milsoft's DisSPatch Outage package.

Single Vendor vs. Best of Breed

Before starting a large scale automation project, utilities need to choose between two fundamentally different philosophies about how to most effectively share data throughout the organization: Single Vendor or Best of Breed. The Single Vendor approach uses one supplier to provide all software to the utility. In this approach, data transfers between different modules are handled by the single chosen vendor. In contrast, the Best of Breed philosophy enables the utility to choose the vendor that best meets their needs for each application. This does require multiple vendors to be involved in transfers of data from one system to another.

Generally, the Single Vendor approach – purchasing software that is fully integrated – forces utilities to compromise on the quality of the different modules. A vendor may be strong in accounting, but weak in staking, mapping, automated meter reading, etc. In some cases, a vender may indeed offer a module that is the market's best, but rarely can they offer the best technology in each of the application categories that a utility needs. Therefore, the utility is not able to accomplish its overall corporate goals. One department may get good technology, but other departments often have to settle for less than adequate tools. The single vendor approach also creates risk by forcing the utility to be dependant on one software company. If the software company goes out of business, is acquired, or runs into management or production problems, the utility could be left in a precarious position.

Previously, the Best of Breed approach, obtaining software that is the best in each niche, whether it is in accounting, staking, mapping, AMR, etc., had presented its own challenges. Purchasing the best software available required custom interfaces or integration between the various systems. Getting software vendors to

The Difference Between Interfacing and Integrating

Interfacing is linking two or more different systems through some type of connectivity, usually external to both systems. On the other hand, integration is the imbedding of one or more systems inside of another. Integration generally requires no external connectivity since the systems share significant common components.

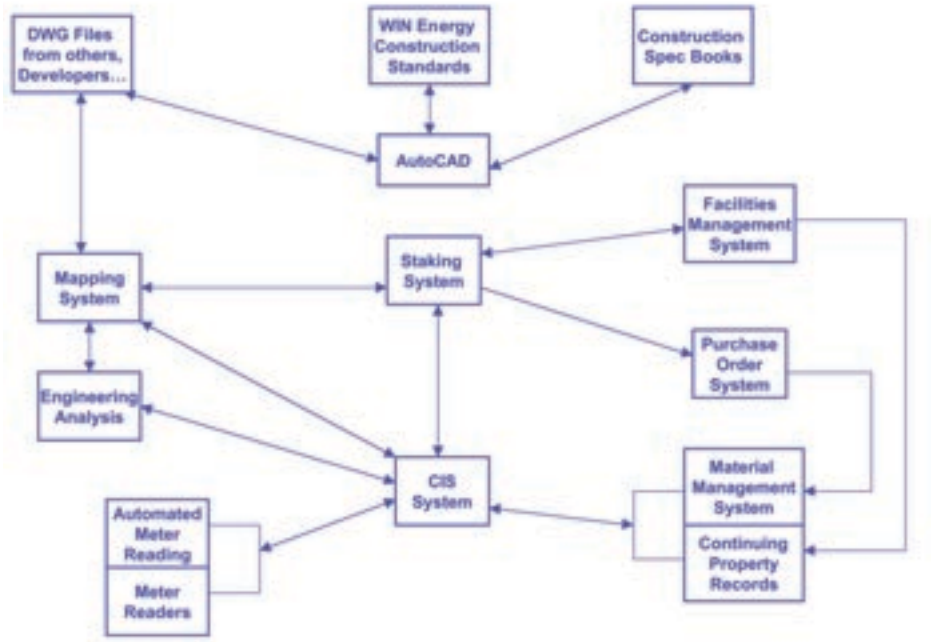
communicate willingly among themselves can be very difficult, especially if they sell competing products. These hard-won custom interfaces often became unusable as soon as one vendor or the other upgraded its software to the latest version. When this happened, a new interface had to be written to bring the electric utility back to where it was before the upgrade, costing the company time in both lost resources and lost production.

Historically, small utilities were often enticed by the one-stop-shop vendors because they lacked the internal I/T resources to support multiple systems. This is direct contrast to larger utilities, which have almost always chosen their applications based on the best fit and greatest functionality criteria. In today's environment, because of the higher performance demands placed on all utilities, having the best tools enterprise wide is essential, necessitating a best of breed strategy.

MultiSpeak's Best of Breed Breakthrough

While many electric utilities today are exploring integrating or interfacing a few selected software systems, WIN Energy REMC and a few other electric utilities have been actively pursuing interfacing their different software system-wide. In 2000, WIN Energy REMC participated in a Cooperative Research Network (CRN) study testing the viability of interfacing different software systems using a software specification called MultiSpeak. Based on the success enjoyed to date using this standard, the cooperative now only purchases MultiSpeak compliant products.

MultiSpeak is a schema that establishes a set of standard interface specifications and defines data entities and their attributes. For example, the "Customer" entity has 14 attributes, including: customer first name, last name, home phone number, billing address, and customer id number. In version 1.1, MultiSpeak defined data transfers between different applications, like CIS, staking, AMR, in a batch process using XML files. In MultiSpeak 2.2, the latest version, data is transferred in real time between defined functions within a program. So instead of just linking the staking package to the CIS package, a utility can link its staking system to either its accounting system or its customer billing system or both. The change to function based transfers allows for the fact that not every CIS, GIS or staking software has exactly the same features and functions. (Please visit www.multispeak.org for more details.)



WIN Energy's Chosen Approach

First, WIN Energy looked at all of the different internal processes it wished to streamline, including mapping, outage management, staking and meter reading. Then, it looked at them together from an enterprise wide perspective. When WIN Energy looked at the big picture, the cooperative team asked, "What processes could feed other processes?" Going through the exercise of examining all the data flows was essential in developing a plan for utility-wide automation.

After reviewing the overall process, WIN Energy decided the top priority was to find a staking and work order automation package that would serve as the single point of entry for all its asset and work order information. This system would need to interface with the existing NISC CIS and financial software. The next steps were to implement a robust GIS and to put in an automated meter reading system. In subsequent phases, WIN Energy decided to integrate staking and GIS, use the GIS to feed data to engineering analysis and outage management, and to use data collected in automated meter reading to drive billing and outage management.

WIN Energy chose MultiSpeak as the vehicle to enable a Best of Breed strategy and optimize the way the cooperative does business. WIN Energy can now select the various software technologies that are the best fit for the utility and, as long as the software packages are MultiSpeak compliant, they will function together regardless of software version upgrades. WIN Energy's first MultiSpeak implementation between its accounting system, NISC's CAPSXL+, and its automated field staking package, MiniMax's StakeOut, was both highly successful and its first step towards a truly system-wide approach.

Since this first step, WIN Energy has been working with additional vendors – Environmental Systems Research Institute (ESRI), Hunt Technologies, and Milsoft Integrated Solutions (Milsoft). ESRI's ArcGIS software has been used in conjunction with MiniMax's StakeOut technology to create a truly integrated application. Additional plans include updating Milsoft Utility Solutions Windmill Engineering Analysis (EA) and DisSPatch OMS packages. WIN Energy was one of the first Hunt Technologies TS2 implementations. This system will be tied, using MultiSpeak, to both the CIS and OMS packages. All of the processes link to each other so that WIN Energy is well on its path to accomplishing all of the above.

Resulting Benefits

In terms of immediate benefits, the integration between MiniMax's staking and NISC's CIS and billing system has allowed WIN Energy to automate the MMS (Material Management System) and CPR's (Continuing Property Records). The labor required for job close outs was reduced from more than 40 man-hours per month to just minutes per week. This direct productivity gain was achieved without redundant data entry, saving additional time and conforming to WIN Energy's strategic objective to use technology to hold down labor costs.

The link between StakeOut and NISC also enables onsite cost estimates. The material and labor costs for each construction and material unit are periodically pulled from the financial accounting system into StakeOut. The field staker can show the customer a cost estimate on site using StakeOut's field tablet computer. Now, if a customer objects to the cost, the staker can show them several design alternatives. This improves customer relations and helps technicians be more efficient because the customer is less likely to request additional site visits.

WIN Energy has taken their automation one step further by integrating StakeOut with their ESRI GIS. StakeOut's application program interface (API) has been used to imbed specific StakeOut functionality directly into ArcGIS. The result of this application melding is that manual map and data updating is a thing of the past. WIN Energy's field designers use StakeOut and seamlessly integrated GPS and laser range finders to design jobs on database-linked background maps, pulled from the GIS. This has allowed them to more easily navigate their existing system and to produce more detailed job sketches by incorporating existing map data. When a job is completed, having been moved by StakeOut through all the steps in WIN Energy's work order process, the new design is incorporated into ESRI without requiring the GIS technician to redraw the field designer's work or retype the construction units into the facilities management database. This has allowed existing staff to maintain this new mapping system without adding staff.

Once WIN has finished integrating their Automated Meter Reading system from Hunt and Milsoft's Outage Management system, the utility will be able to get a complete picture of an outage, in around 20 minutes, rather than working all night without ever really seeing the big picture. The outage management system will get detailed, GPS accurate data out of ESRI's GIS. By enabling the different systems to share data, WIN will be able to better understand future outages, dispatch more efficiently and restore power to their members more quickly.

Lessons Learned

Keeping updated information available to all utility personnel, from the linemen to the dispatch center operators and everyone in-between, will allow WIN Energy to make informed decisions in both disasters and future planning. Therefore, creating methodologies to update and share this essential data that are the least labor intensive will be critical in the future.

In the coming years, providing better service for the best price will become even more meaningful. WIN Energy has taken proactive measures to avoid becoming complacent. This all started with the board and upper management's challenge to maintain distribution rates and service quality without increasing personnel costs. WIN Energy is well on its way towards accomplishing these goals. ■

About the Author:

Greg Wolven, P.E., is a licensed Professional Engineer in both Indiana and Virginia with more than 23 years of experience working for rural electric cooperatives. Mr. Wolven graduated from the Virginia Military Institute in 1981 with a degree in electrical engineering. He has worked at electric cooperatives in Virginia and is currently Director of Engineering for WIN Energy REMC in Vincennes, Indiana, where he is responsible for staking, mapping, system planning, AMR, and telecommunications.

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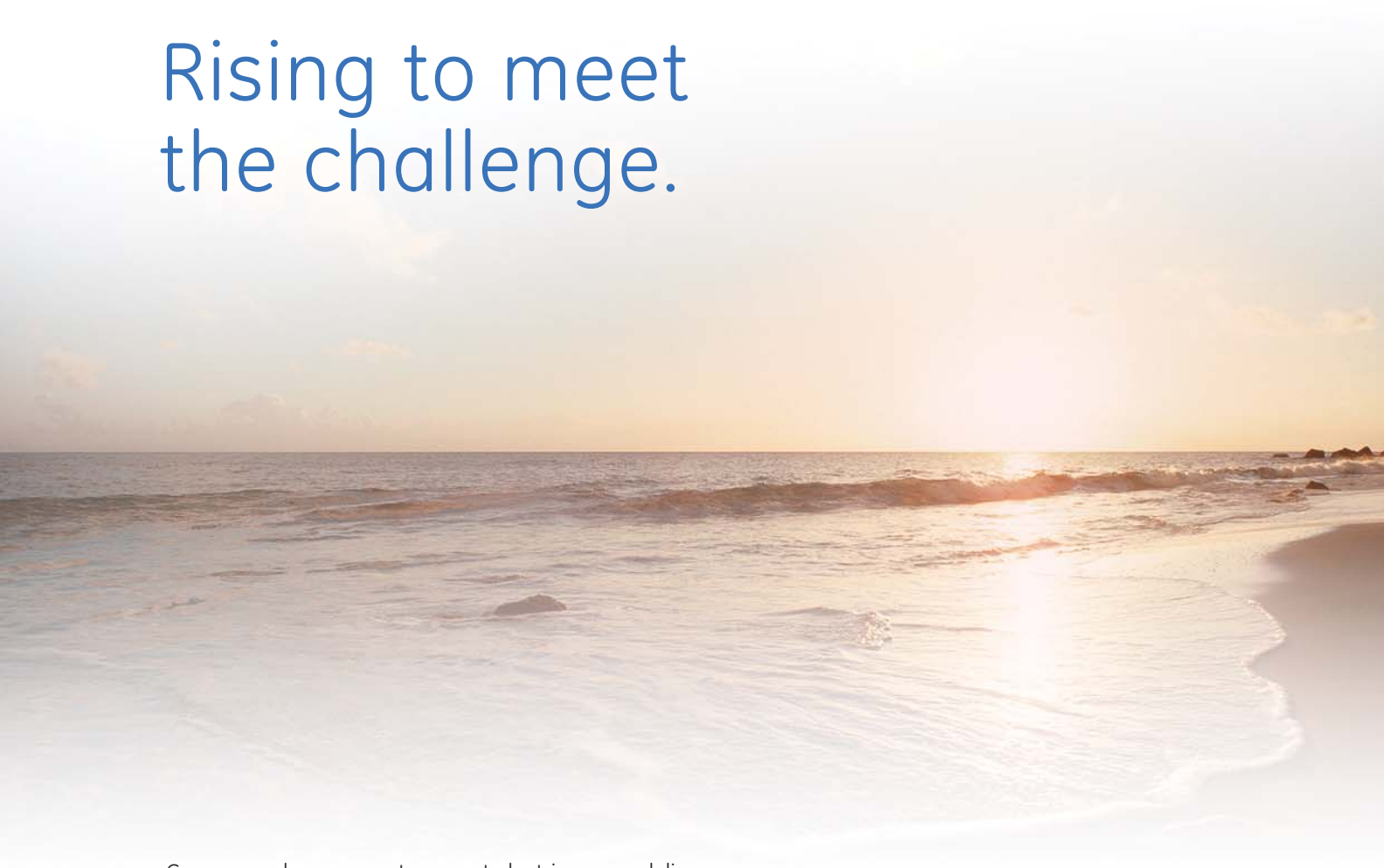

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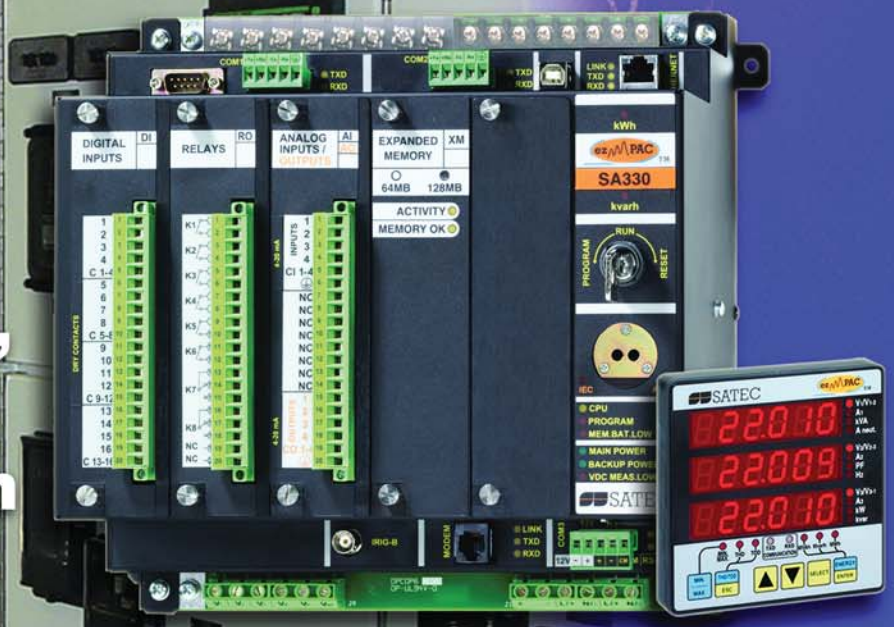

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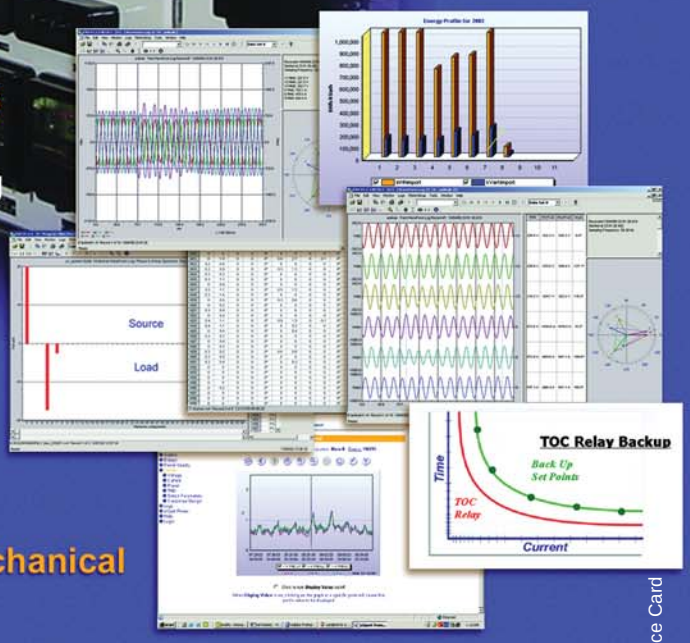

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