

# Electric T&D



M A G A Z I N E

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**Current Issues in Underground Transmission**

**Plus**

**- 2006 Suppliers & Buyers Guide Issue**

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# Electric and Magnetic Fields and the Canadian Electricity Industry

By: Francis Bradley, Vice-President, Canadian Electricity Association, [bradley@canelect.ca](mailto:bradley@canelect.ca)

**O**n a daily basis, most individuals are exposed to electric and magnetic fields (EMF) generated by household wiring, lighting, computers and other electrical appliances, such as hair dryers, coffee makers, televisions and power tools.

Since the 1970s, scientists have been researching possible human health effects of EMF, particularly certain cancers including brain cancer, lymphoma, breast cancer and leukemia. Studies of all adult cancers and most childhood cancers have shown no link to EMF. But a few epidemiological studies have suggested a weak association between proximity to power lines and childhood leukemia. The reason for this weak association with power lines remains unclear, as laboratory studies have found no causal connection between exposure to power frequency EMF and childhood leukemia.

## Industry Position on EMF

The Canadian Electricity Association (CEA) recognizes the public concern over potentially adverse health effects from EMF. The Association and its member companies are committed to the health, safety and welfare of the public and our employees. We take seriously our responsibility to work with all stakeholders – including regulatory agencies, the government and the public – to develop and implement appropriate EMF policies.

CEA and its member utilities are also committed to communicating balanced, scientifically accurate and up-to-date information about EMF to the public, to employees and to regulatory agencies. To help this effort, CEA has recently launched a new public Web site entitled “Facts on Electric and Magnetic Fields”, which can be accessed through the CEA Web site at [www.canelect.ca](http://www.canelect.ca), or directly at [www.canelect.ca/emf.html](http://www.canelect.ca/emf.html).

CEA continues to monitor world-wide research, standards and policy developments through its EMF Task Group, and its member companies support further research to answer remaining questions on potential health effects.

## Health Canada's 2005 Statement

Health Canada's It's Your Health fact sheet on EMF states, “At this time, Health Canada does not consider guidelines necessary because scientific evidence is not strong enough to conclude that typical exposures cause health problems.”

On January 20, 2005, the Federal-Provincial-Territorial Radiation Protection Committee (FPTRPC), organized under Health Canada's Radiation Protection Bureau issued a Position Statement wherein the FPTRPC concluded that adverse health effects from exposure to power-frequency EMFs, at levels normally encountered in homes, schools and offices, have not been established.

Moreover, the Committee stated that “[s]ince there is no conclusive evidence that exposure to EMFs at levels normally found in Canadian living and working environments is harmful, FPTRPC is of the opinion that moderate measures and participation in the process of acquiring new knowledge are sufficient.” This is consistent with Canadian utility practices.

## Draper Report on Childhood Leukemia

On June 3, the British Medical Journal released a paper entitled “Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study”. This paper contained findings from a study on childhood cancer carried out by Oxford University that analyzed and compared 33 years of data (from 1962 to 1995) on 29,000 children diagnosed with cancer.

The study finds slightly elevated rates of childhood leukemia in children whose residence at birth was close to these lines. Proponents of the EMF health connection have argued that the magnetic fields produced by the power lines are responsible for this correlation. However, this study finds elevated rates of childhood leukemia at distances out to 600 m from the lines. At these distances, the magnetic fields in homes due to power lines are negligible compared to existing background levels.

Moreover, the authors of the study found no causal link between childhood leukemia and EMF, stating “we emphasize again the uncertainty about whether this statistical association represents a causal relation.” In addition, the authors state “neither the association reported here nor previous findings relating to level of exposure to magnetic fields are supported by convincing laboratory data or any accepted biological mechanism.”

CEA is continuing to study and evaluate the Draper Report and its conclusions. The Association also notes that the authors of the study indicate that the elevated rates of childhood leukemia are more likely due to some characteristics of the areas that the power lines pass through, or of the people who live near them. This would be consistent with the growing evidence from other studies that childhood leukemia is linked to factors such as lifestyle, affluence or exposure to infections.





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## Other International Developments

In light of the evidence and research to date, a number of conclusions have been drawn by international research organizations on the health risks associated with EMF:

- The International Agency for Research on Cancer (IARC) has classified EMF as a 2B carcinogen – a possible carcinogen in relation to childhood leukemia (but not for any other cancers). Other 2B Possible Carcinogens include coffee and gasoline engine exhaust.
- A 1999 report by the U.S. National Institute of Environmental Health Sciences (NIEHS) following a seven-year EMF research programme concluded:

"The scientific evidence suggesting that [EMF] exposures pose any health risk is weak ... [but it] cannot be recognized at this time as entirely safe because of weak scientific evidence that exposures may pose a weak leukemia hazard."

## WHO Review of EMF

The WHO is in the process of developing an environmental health criteria document, and in October 2004 released a draft precaution-based policy for public review ([www.who.int/peh-emf/en](http://www.who.int/peh-emf/en)).

Concerning EMF, the WHO Precautionary Framework considers that childhood leukemia and magnetic fields warrant a thorough consideration of precautionary measures including detailed cost-benefit or cost-effectiveness analysis. The WHO assessment recommends that costs and benefits to society should not be assessed on a project-specific or local basis but rather on a national basis. The report also states that only low-cost measures, are justified, and Canadian utilities are already engaged in many of the measures listed in the report. It was also noted that the report does not set limits for the edge of the right-of-way. A final version is expected in late 2005 or early 2006.

In the meantime, the WHO has organized a "Workshop on Guiding Public Health Policy in Areas of Scientific Uncertainty" to take place in Ottawa from July 11-13, 2005. Participants will discuss the WHO's precautionary framework and review a series of case studies, including one on electromagnetic fields.

In Canada, several federal government agencies, including Health Canada, have

developed a precautionary policy designed to address issues that lack scientific certainty but cause public concern. The intent is to use what is known and develop reasonable approaches that would minimize the impact should the risk prove real. Health Canada's latest assessment is that there isn't sufficient scientific evidence of an EMF health risk to allow the application of the precautionary policy.

## Conclusion

The Canadian electricity industry continues to support scientific research on EMF and possible long-term effects on people. Electricity

supply companies also work to communicate accurate and up-to-date information to the public and employees about the remaining scientific questions regarding EMF.

The Association welcomes the WHO's comprehensive precautionary framework that will integrate all significant research done to date into public health policy. Additionally, the industry will continue to follow closely any similar assessments conducted by Health Canada. ■

*For more information on EMF and the Canadian electricity industry, please visit our Web site at [www.canelect.ca/emf.html](http://www.canelect.ca/emf.html).*

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## **SUPER SESSIONS IDENTIFY KEY SUBJECTS AT 2005 IEEE PES TRANSMISSION AND DISTRIBUTION CONFERENCE AND EXPOSITION**

This year's IEEE PES Transmission and Distribution Conference & Exposition, scheduled from October 9-14 in New Orleans, La., will highlight some of the major issues facing power-delivery professionals worldwide. The four super sessions include: *Transmission Investment—It's Time*, *Wind Power: The Energy Alternative on the Horizon*, *Cyber Security of T&D Assets—How Vulnerable is Your System?* and *Reactive Power: It's All About Reliability*.

The four sessions will take place on Monday, Tuesday and Wednesday, October 10, 11 and 12. Each session will explore each one of the topics in-depth. (For exact time and day of each topic, conference attendees are encouraged to check the conference website: [www.ieeeet-d.org](http://www.ieeeet-d.org).)

The first topic, focusing on Transmission Investment--It's Time, explores the need to modernize the transmission system and increase its efficiency. Estimates suggest that more than \$60 billion will be required to get the system in shape to carry out the transactions being demanded of it in today's world. The session will address several questions that remain unanswered: Who should implement the plan of upgrade and enhancement? Who will pay for it? Should the utilities implement the upgrade? Or should it be the independent operators or the regional transmission operators? Should the cost recovery be through standard utility rate structures determined through state or federal rate proceedings or as a service charge on individual competitive transactions?

The second topic, Wind Power: the Energy Alternative on the Horizon, presents the opportunities that exist in the wind power market for utilities, consulting and contracting companies, RTOs, independent system operators and other groups associated with the industry.

This session will explore in detail, new capacity additions, the investment now being made in wind power capacity and the largest projects being implemented worldwide and the number of states now requiring utilities to provide a certain minimum amount of power from renewable resources such as wind and solar.

The third topic, *Cyber Security of T&D Assets—How Vulnerable is Your System?* presents the scale and scope of the problem as it exists with

some case study examples, and the main measures and practices that the electric utility industry must consider and implement to reduce the risks as much as economically possible.

The session will address the ways in which utility systems are working to protect communications systems as well as their business and power systems from attack by cyber terrorists.

The fourth topic, Reactive Power: It's All About Reliability, will address several problems and concerns including: discriminatory compensation, imprecise interconnection standards that are insensitive to local needs, the lack of consistency in planning and procurement, poor financial incentives to provide or consume reactive power, poor incentives for some system operators to procure reactive power at least cost, failure of system operators to adjust reactive power instructions so as to fully optimize dispatch and short term versus long term reform.

The four super sessions are part of a much larger conference and exposition program that carries the theme; Go With the Flow...Join the Parade of Technology. Included in the program are technical poster sessions and panel sessions, tutorials, educational sessions, info sessions, a collegiate program, technical tours and an exposition that features the latest technologies and services provided by the leading manufacturers from around the world.

For more information about registration, housing, program and exposition content please go to [www.ieeeet-d.org](http://www.ieeeet-d.org). ●

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## **New data logging option for its T/Guard+ Direct Windings Monitoring System.**

Neoptix Fiber-Optic Sensors, a company specialized in fiber optic temperature sensors for cast and oil-filled power transformers, announces a new data logging option for its T/Guard+ Direct Windings Monitoring System.

The Neoptix T/Guard+ System is now available with a data logging option that uses removable MMC cards. This option allows Utilities and transformer operators to record temperature data points and alarm status information directly into their T/Guard+ temperature monitoring system, without the need for permanent connection to a remote acquisition system.

Data collected by the T/Guard+ is saved in a standard MMC/SD multimedia flash card. The

system comes standard with a 64 megabyte MMC card and can accept memory cards of up to 128 megabytes, which is sufficient to log over 6 millions data points. This represent more than twenty years of data logging for a transformer instrumented with 8 temperature transducers!

Data logging does not require a permanent connection to a PC or acquisition system. The T/Guard+ system is a completely independent monitoring solution. Data points are saved with a time stamp that comes from the internal real-time clock of the T/Guard+ System. The MMC card can then be read by any PC through a standard MMC/SD card reader.

"This new direct data logging feature addition to our T/Guard+ System has been one of the most requested features from our customers," stated Michel Plourde, V-P Sales and Marketing of Neoptix. "This solution allows Utilities and large power transformer users to get accurate and useful short- and long-term information on their transformer conditions and transformer life assessment in an easier and more robust way," added Michel.

The information logged in the MMC card can be transferred directly into a PC. The System can accept any number of MMC cards. With a data transfer rate of 2 megabytes per second from the card to the PC, the MMC solution offers superior transfer rate than conventional RS-232 serial communication. This is a clear advantage when large amount of datapoints must be downloaded. Moreover, the same MMC card can be used for future firmware upgrades on the T/Guard+ system.





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"This new data logging feature enables Neoptix to keep its leading edge in terms of product offering and overall features," stated JF Meilleur, President of Neoptix. "This new feature shows our commitment in addressing the needs of Utilities and large power-transformer manufacturers through stable and innovative solutions."

Coupled with Neoptix T2 temperature probes, the T/Guard+ System is specifically designed to directly monitor the winding temperature of oil-filled power transformers. The T/Guard+ offers complete connectivity through CANopen (DeviceNet) and OPC Server. It has 16 programmable Form-C galvanic industrial-type relays and now offers up to 128 megabytes of data logging.

The data logging feature is immediately available as an option for the T/Guard+ Fiber Optic Direct Windings Temperature Monitoring System. The cost of this option is US\$495.

## About Neoptix:

Neoptix designs, manufactures and commercializes a complete range of optical sensors, signal conditioners and accessories for temperature monitoring in electromagnetic and harsh environments. For more information about Neoptix products, visit the company's web site at [www.neoptix.com](http://www.neoptix.com) or call +1-418-687-2500. ●

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## The flexible Boa Lock



The flexible Boa Lock was inspired by necessity. All too often, line technicians must struggle to install the rigid-type disposable locks. It's not surprising, with so many vastly different transformers, enclosures and cabinets to be locked. Boa Lock is the first to address the real need for a better, more versatile lock. Boa Lock is better because it is simply easier to install, wherever you need a lock. The innovative one-piece design means there are no parts to lose, and the 9" adjustable cable makes competitor's fixed aluminum rings obsolete. No need to stock different sizes, Boa Lock does it all!

High quality construction consists of aircraft cable and zinc plated or anodized steel ends. Boa Lock is tamper resistant and nearly indestructible, to pull-test over 2,000 lbs. Best of all, Boa Lock is priced to compete with the less versatile alternatives! Contact us for a free sample. Distributors needed—call now!

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## Sola/Hevi-Duty Targets Industrial Market with Compact, High Density Power UPS

As part of its strategy to ensure customers of total protection from unexpected power disruptions, Sola/Hevi-Duty today introduced its S4K4U Uninterruptible Power System (UPS), setting new industry benchmarks for value, performance and innovative design.

Offering a suite of advanced on-line features in a space-saving, remarkably compact package, the S4K4U is the perfect solution for a broad range of industrial applications, and is especially effective when used with industrial computers, automation systems, robotics and process controls.

The S4K4U combines 6 kVA of power capacity, flexible output voltage, internal batteries and an integrated maintenance bypass switch to provide unsurpassed protection for maximum system uptime. Consisting of two 3 kVA, 120 V inverters, its dual inverter engineering permits flexible output voltages to meet mixed load voltage requirements. The S4K4U automatically senses the input voltage and configures the output inverters to match the input supply to provide simultaneous output voltages, thus enabling users to power a variety of loads with different voltages without an additional transformer.

## Other key features include:

- Self-diagnostic capabilities
- Multiple and simultaneous communication ports
- Wide input voltage range that minimizes battery operation for increased battery life
- An automatic internal bypass and a manual maintenance bypass for maximum availability of output power

- Continuous sinewave output to allow full compatibility with a wide variety of power supplies
- Power factor corrected input to reduce reflected distortion while optimizing utility power.



To simplify maintenance and trouble-shooting, the S4K4U is shipped with a rotary manual bypass switch hardware input and output PAD. Optional PADs in a variety of connection designs are also available from Sola/Hevi-Duty.

## Pricing and availability

The Sola/Hevi-Duty S4K4U UPS is expected to ship end of April 2005. List pricing will vary depending on options selected. It is backed by a two-year limited warranty.

For more information, contact Sola/Hevi-Duty, 9377 W. Higgins Rd., Rosemont, IL, 60018. Call toll-free at 1-888-377-4384 or email at [tech@sola-hevi-duty.com](mailto:tech@sola-hevi-duty.com).

On the web, [www.solaheviduty.com](http://www.solaheviduty.com).

## About Sola/Hevi-Duty

Sola/Hevi-Duty specializes in identifying and providing industrial power quality solutions including power supplies, transformers and uninterruptible power systems. It is a member of the EGS Electrical Group and is headquartered in Rosemont, IL. ●

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## Infrared "first" for predictive maintenance – two new cameras introduce high resolution at low cost

*Combination of high-resolution IR detector, visual camera, laser pointer, and articulating 3.5" LCD brings professional capability to mid-priced thermography*

A first in infrared imaging technology for PdM applications, Mikron's new M7800 and M7815 cameras introduce a high-resolution 320x240 UFPA detector with a 60 Hz refresh rate in a low-cost package. With four times the resolution of a standard 160x120 detector, the two cameras provide superior images – free of pixelating – with correspondingly higher resolution in temperature measurement. The cameras include many other professional-level features, such as a measuring range of -20 to 500°C, on-board storage of 1300 images, and a "big screen" 3.5" articulating LCD that allows easy viewing at any camera angle. The M7800

includes a laser target designator and visual camera for simultaneous visual/IR imaging. The M7815, without the laser and visual camera, is significantly less expensive.

"Resolution is critical in infrared imaging," says Jon Chynoweth, vice president of Mikron Infrared. "In resolution temperature measurement not just quality. 320x240 with 76,800 measuring an area smaller a square inch at the 160x240 just 19,200 pixels, anything smaller than twice that size. Lower resolution means you average in more background on your temperature readings, so



you're less accurate, and you end up with a thermal image that looks like it's made of tiny little squares."

The M7800 and M7815 models are fully radiometric cameras weighing less than three pounds, designed for one-handed, point-and-shoot operation. The cameras measure infrared radiation (in the 8-14 micron spectral band) from the target surface and convert this to an image that relates to the temperature of the target. Temperature measurement accuracy is  $\pm 2^{\circ}\text{C}$ . The temperature distribution can be viewed as a gray-scale or color image in various isotherm color palettes.

For more information on the 7800 and 7815 cameras, contact Jon Chynoweth at 888-506-3900 or email [jon@mikroninfrared.com](mailto:jon@mikroninfrared.com).

Circle 137 on Reader Service Card

## AutoShunt

*An alternative to CT shorting blocks*

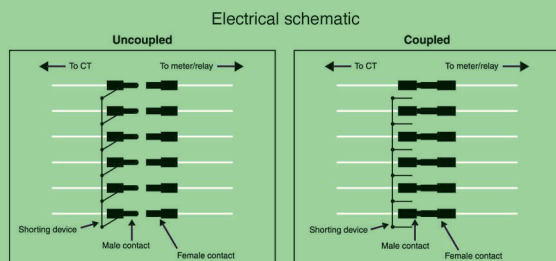
The AutoShunt connector system is an innovative alternative to CT (current transformer) shorting blocks or for applications that require circuits to be shorted together. The functionality of this system hinges on a shorting device housed within the male side of the connector pair. In an uncoupled state, this metallic device makes simultaneous contact with all six male pins, shorting the circuits together (see below). As the connectors are coupled, the shorting device is displaced by the female molding. For more information, contact Positronic Industries or visit [www.connectpositronic.com](http://www.connectpositronic.com).

\*European Union Directive 2002/95/EC  
"Restriction of Hazardous Substances"



Female connector

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## Utility Automation: Isn't it really all about the results?

By Michael A. Marullo, Contributing Editor

SCADA, GIS, OMS, CIS... the list of acronyms goes on and on. In fact, about ten years ago I wrote an editorial about the fact that there are so many acronyms we've had to start recycling them. For example, is ATM an Automated Teller Machine? Or, is it Asynchronous Transfer Mode? Is EMS Energy Management Systems (of several types and varieties on its own!) or Environmental Management Systems? And the list goes on...

Any reasonable person would correctly say that one must look at the context to understand the intended meaning. Context is pretty much a basic underpinning of communications, whether written, spoken or otherwise transmitted from Point A to Point B. However, when it comes to utility automation, it seems like we may be losing track of context.

When utilities look at a new automation project, I think the context tends to be (too much and too often) what it is rather than what it does. You don't hear much about utilities going out for bids to improve reliability, enhance safety or boost efficiency (or reduce rates?!); they usually just go looking for a new SCADA system; a new GIS; or a new OMS. And hardly anyone puts out an RFP labeled: "Customer Service Improvement" request; instead they prepare specifications for a new CIS.

In all fairness, I've personally seen a few specs that attempt to explain a little about what the real objectives of the project are in beneficial terms, but even then, it typically only gets a paragraph or two in the preface. The preface, if you're not familiar with it, is the part of the RFP everyone skips over trying to see what it is that the utility is trying to buy and how much it is likely to cost.

As a former application engineer (and the author of a proposal or two during my supplier days), I can say with some degree of experience that the underlying reasons for automating are frequently lost on the buyer and the seller – the result of being overshadowed by technical, financial and commercial issues. This is not to say that those factors should be ignored or even diminished; only that the benefit side of the cost/benefit analysis should also perhaps be shared more completely and more openly with the suppliers so that everyone can understand the real reason they're being asked to present their wares.

Of course, maybe I'm being a little too presumptuous by assuming that a cost/benefit analysis was actually performed. As a widely respected utility automation consultant said to me a few years ago, "Somewhere between engineering school and deregulation, most utility engineers seem to have forgotten how to do a cost/benefit analysis!" He was lamenting the fact (or at least his recent observations at the time) that too many automation projects were being rushed out the door with hardly a clue of what kind of return the project could be expected to produce, not only in dollars – the cost element of the CBA – but especially in terms of the benefit side of the equation. Sure, sometimes it goes the other way, and it's all about the money and ROI, but that really shouldn't be the end of the story. You'll never be able to claim a successful project if it doesn't deliver the desired results.

In any case, the next time you are called upon to plan or launch a new automation project, make sure that you understand what it is you're really trying to accomplish, and not just what you will buy to accomplish it. It is indeed possible to buy exactly the right thing, but for completely the wrong purpose... and at the end of the day, isn't it really all about the results? ■

### Key to Abbreviations:

**SCADA** - Supervisory Control And Data Acquisition

**GIS** - Geographic Information System

**OMS** - Outage Management System

**RFP** - Request for Proposals

**CIS** - Customer Information System

**ROI** - Return On Investment (Some might argue, however, that this really means: Really Old Information!)

### About the Author

Mike Marullo has been active in the automation, controls and instrumentation field for more than 35 years and is a widely published author of numerous technical articles, industry directories and market research reports. An independent consultant since 1984, he is co-founder and Director of Research & Consulting for InfoNetrix LLC, a New Orleans-based market intelligence firm focused on Utility Automation and IT markets. Inquiries or comments about this column may be directed to Mike at

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*Isn't it really all about the results?*



# A Brief History of OMS and DMS – part I

By: Martin Bass and Bob Fesmire, ABB Inc.

**D**istribution operations, like those at the transmission level, have undergone great change as a result of advances in information technology as well as external forces such as market restructuring. This article is the first in a two-part series that will examine the development of the two primary information systems that underlie distribution operations—outage management and distribution management—and how they are now merging to form a single platform. Part II will cover the convergence, but before we get to that, it's helpful to take a look back at how these two important tools came to be where they are today.

## Outage Management Systems

The need to respond to outages is as old as power delivery systems themselves. To meet this need, Outage Management Systems (OMS) have been used extensively in the US and other countries to manage distribution systems. However, even well after the computer revolution of the 70's and 80's, many distribution systems in the US continued to rely on paper-based systems to identify and track outage patterns. Distribution networks in the US are typically configured radially and cover large distances, making it expensive to monitor the status of the distribution system, particularly outside of the substation. In more densely populated regions, the cost of telemetry and automation could be justified on a cost per customer basis, but for many areas the advantages of automation remained out of reach.

Often the only way that a distribution utility would know there was a problem was when a customer called to report an outage. The utility collected a set of outage calls, and from the pattern of calls received, determined the likely location and cause of the outage. A crew was then sent to the location of the outage to investigate further and affect repairs. Today, of course, reductions in the cost of computing power and the advent of more advanced applications have vastly improved the outage management capabilities of the average utility. But, as any industry veteran can tell you, it was not always so.

## Paper-Based Systems

Prior to the introduction of computerized systems, calls were received by the utility and were either written up by hand on a 'ticket' or were entered into a computer and then printed. These tickets were often then manually sorted by the circuit on which the given customer was connected and placed into a pigeonhole for further action.

The tickets were then reviewed by experienced 'analysts', who looked at each ticket, determined the electrical location of each customer associated with it, and attempted to identify the root cause of the outage. Printed electrical maps were used to identify the location of each outage.

This worked well in day-to-day operations where the volume of calls was light and the number of outages small. However, during large storms, a high volume of calls would overwhelm the system. In addition, there was a high risk of error (e.g., if the ticket was misfiled), and the analysis was time-consuming. Each customer's location had to be identified on the paper map and then a prediction had to be made.

In order to improve customer service and reliability, utilities are required by their regulatory agencies to collect customer outage statistics. With a paper-based system, this was an additional burden and the accuracy of the statistics was often difficult to confirm. In many cases, the utility had a paper form to fill out indicating how many customers were affected. This often amounted to guesswork, especially when a wire-down halfway along a

feeder was the cause of the outage. As a result, in these paper-based systems, outage durations and customer minutes out were often underestimated.

## Early Computer-Based OMS

In order to improve outage prediction accuracy and to reduce the time required to analyze each outage, computer-based outage management systems began to emerge. Initially these were developed in-house by individual utilities. Some of these systems were re-sold to other utilities and their functionality has been augmented through the years.

Two kinds of OMS emerged from this period, each based on a different underlying technology. Connectivity-based systems utilize a database that represents the electrical relationships of the distribution system. These systems harken back to the mainframe days, and have been in use the longest. Spatial-based systems are newer and rely on geographic information system (GIS) or map-based technology that takes advantage of more powerful modern servers.

Many of the connectivity-based systems use a 'feeder tree'. This is usually a static description of each feeder and the position of each protective device (e.g., fuse or recloser) in the feeder hierarchy. Customers are assigned to a particular circuit and upstream protective device. When a customer call is received, the system identifies the problem as an outage call on the given circuit and protective device. A single call on a circuit or one occurring below a protective device in the tree is assumed to be a customer-level problem. If more calls are received on the same protective device, the system may automatically 'roll up' the calls to the protective device level.

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This automatic grouping can eventually cause the predicted outage to roll up all the way to the feeder, where a feeder lockout outage will be predicted.

Connectivity-based systems clearly are a significant improvement on paper-based systems. Their accuracy is much higher, and the analysis time is greatly reduced during high call volumes. Outage statistics are also more accurately maintained. The number of customers downstream of each protective device is known, so the number of customer minutes for an outage can be calculated automatically.

On the down side, these systems utilize a tabular user interface that makes it difficult for the user to visualize the outage location. It is also difficult to reflect the effect of any feeder reconfiguration that may have been performed, especially if the reconfiguration is only temporary.

Finally, it is difficult to indicate partial restorations on such a system. Although partial restorations represent a relatively small percentage of all outages, they can have an impact on the overall system reliability indices if they are not counted correctly. A typical case of a partial restoration is where a wire down causes a protective device to operate. The wire down can be made safe and the protective device can be closed in a very short time. However, the customers downstream of the wire down will take longer to restore. Thus some of the customers (upstream) may experience a short outage, while others (downstream) will experience a longer outage. If the restoration step that occurred when the protective device was closed is not accurately recorded, along with the number of customers restored, then the reliability indices will over-count the customer minutes.

More recently, spatial-based outage management systems have been developed. At their simplest level they do not rely on connectivity, but rather allow the actual location of trouble calls to be displayed on a geographical map. This map may have the electrical data displayed as a graphical layer on top of the geographical features. These systems require the user to visually identify the call pattern and some allow the user to draw a polygon around the calls in order to group them into a single outage. The advantage of spatial-based system is that the extent of the outage can be seen quickly and a detailed connectivity model is not needed. This works well in smaller utilities that do not perform extensive feeder reconfiguration and where the connectivity is unknown. However, spatial-based systems do not usually offer accurate customer minutes counts or partial restoration functionality.

## Second Generation Outage Management Systems

A new breed of outage management systems has evolved over the past ten years or so. These systems are characterized by a graphical user interface that includes the ability to display one or more feeders at the same time, or even the entire distribution system in a single display known as a world map.

These systems require an accurate and complete connectivity model, from the distribution substation breaker down to the customer transformer (the low voltage side is not usually modeled, in the interests of reducing the overall network model size and the cost-effectiveness of collecting and maintaining this level of detailed data).

Second-generation OMS has two origins: distribution planning software and GIS, both of which could display the huge amounts of data required for distribution systems. Early on, the planning-based systems had an edge with their application software, such as power flows and short circuit analysis, while the GIS-based systems had an advantage with their ability to display the geographical data.

These systems were often server-based software and at the time were pushing the limits of the available technology. Consequently, these systems often slowed down as the number of uses increased (e.g., during storms), which presented a secondary problem in that adding manpower only made things worse.

Over time, the functionality continued to evolve and the hardware capabilities eventually caught up with the demands of the software. However, these systems still had their limits with regard to the maximum number of concurrent graphical users and overall scalability.

## Data, Data Everywhere (but not a drop to drink)

One of the challenges facing the second-generation outage management systems was the source of the network connectivity data. Up to this time, there were not many applications that required accurate connectivity data within the utility. Planning applications sometimes had a model, but they did not always include the individual customer connections, instead reducing each lateral to an aggregated load. Legacy OMS would possibly have the feeder trees described earlier, but the exact placement of customers along the feeder was not known. Phasing information was also typically unknown.

Thus a utility looking for an OMS would either be deterred by the high data quality requirements, or would initiate an OMS project

that would later fail due to the lack of quality data. Often a would-be OMS buyer would opt for a GIS, since this was a pre-requisite to running a useful OMS, a trend that in part led to the rise of GIS-based OMS.

The selling point for such systems was that there was no need to develop an interface between the GIS and the OMS, since everything utilized the same network model. In practice however, the GIS network model may need to be customized to suit other enterprise applications. Typically the OMS network model is a subset of the GIS model. The OMS model is also the as-operated model, and represents the current state of feeder configurations and temporary devices, such as line cuts and jumper lines. The GIS model is the as-built model and, increasingly, the as-designed model. Thus the GIS and OMS models have different needs and are usually not the same.

Over the years, utilities have cleaned up their GIS data. This effort was driven by the rise in the use of GIS connectivity data, particularly in OMS systems. Utilities recognized the power of the OMS and introduced work flows to ensure ongoing data quality. At the same time, OMS systems began to provide tools built into the software that would rapidly identify data errors and provide tools for temporary correction, prior to it being corrected permanently in the GIS.

## Distribution Management Systems

While the evolution from paper-based systems to connectivity-based and most recently spatial-based systems in the OMS arena was taking place, a similar progression was happening to the distribution company's other IT staple—the distribution management system (DMS).

DMS systems have their roots in transmission SCADA systems. As automation has moved downwards and into distribution substations, there has been an increasing need to provide functionality for distribution applications. Distribution management systems originated as either extensions to the existing transmission SCADA—by adding additional points to cover the feeder breakers—or as a standalone system. Both types of DMS usually have remote terminal units (RTUs), a communication front-end, alarm systems and picture file-based displays.

What distinguishes these systems from their transmission level predecessors is the addition of distribution-specific functionality such as the ability to add temporary devices like line cuts and jumper lines. Since most distribution systems run in a radial configuration, it is often necessary to operate feeder tie switches to reconfigure



feeders, either to restore outages or to adjust to different loading situations. This dictates a need to dynamically identify whether and from what direction a given line is being energized. In addition, such systems are nearly always unbalanced, meaning that each electrical phase is operated independently.


Another characteristic of a distribution system is that change is the norm. New residential construction and routine maintenance means that the distribution network model changes frequently. It is not uncommon for 10,000 or even 100,000 changes to occur to a distribution system in a single week. Such changes must be applied incrementally to the DMS while it is up and running.

Finally, the number of status points is very large—in the range of 100,000 to 600,000 for a larger utility. Many of these status points are, however, pseudo points, since there is no telemetry. One of the challenges faced by early distribution management systems was the ability to handle the large number of points and also adapt the picture file displays to the geographic world map displays that second-generation outage management systems supported. These early systems would often connect substation one-line diagrams together into a larger display in order to generate the world map. The maintenance of this display was typically performed within the proprietary display building environment of the DMS. This worked well for smaller utilities, and for utilities that did not already have an enterprise-wide GIS. However, the process could quickly become unwieldy.


To illustrate the magnitude of the challenge, a typical large transmission one-line diagram display would have between 5,000 and 10,000 picture elements. By contrast, a large world map display could have between 1,000,000 and 5,000,000 picture elements. Thus the ability to display world maps presented a technical challenge to the DMS vendors. The ability to maintain world maps represented a large and continuous effort on the part of the utility, particularly if they were using the DMS maintenance tools.

Early DMS displays would skirt around this problem by displaying one or more feeders at a time rather than the entire world map. But this made it difficult for the end user to get a good feel for the overall situation occurring with the distribution system, and they would continue to rely on their wallboard maps with pins to indicate switch positions and tags.

The world map display problem has since been solved by applying new algorithms in the display software and by making use of powerful modern PC's to perform much of the display processing. Other approaches use server-based technology, similar to that used by web sites to display geographic maps. The second problem can be solved by integrating the DMS with a GIS, or providing a GIS-like data engineering environment within the DMS. The GIS thus becomes the source of the distribution network model and is used to create the world map displays. However, DMS display software is typically not geared towards distribution operations, and is not currently as full-featured as the displays that are present in OMS-type systems. ■



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# BROADBAND: THE NEWEST FRONTIER IN AMR INNOVATION

By: Sean Doyle, muNet, Inc. and Scott Durham, Datamatic, Ltd.

The explosion of broadband networks in all facets of business has positioned IP-based technologies to be the dominant communications protocols. Broadband networks currently pass through 300 million homes in the US and Western Europe alone. In addition to offerings by traditional cable and DSL providers, a growing number of electric utilities have deployed such networks, including more than 600 municipal utilities.

Several key factors are driving the interest of utilities in IP-based technologies. Less expensive and more efficient networks such as BPL (broadband-over-powerline), WiFi and Fiber have emerged. Utilities can now have realtime, two-way access to metering and control devices, can improve field services and provide added services to both customers and local agencies such as police, fire, schools and government. Finally, the fact that IP networks are "standards-based", rather than proprietary, makes it easier for utilities to maintain the in-house expertise necessary to administer these systems.

## Technology Evolves

While cable and telephony-based broadband networks remain the most widely deployed, wireless and BLP technology are becoming attractive alternatives for utility-deployed IP networks. Both address the issue of "last mile" connectivity that was previously a limiting factor for utility broadband deployment. They also allow utilities to expand the reaches of their current fiber infrastructure commonly deployed in substations and other facilities. WiFi and BPL deliver the same always-on, two-way connectivity that straight fiber networks offer and can support real-time asset management.

"One of the biggest benefits of IP networks to utilities is the inherent versatility of IP architecture," said Vincent Moeyersoms, muNet's Co-CEO. "Although there are many delivery mechanisms for IP (cable, DSL, wireless, BPL, etc.), there are well-established communications standards in place for IP-based networking and application development. Utilities can choose the most appropriate IP network infrastructure for a given application based on factors such as population, terrain, and existing fiber placement.

"Our devices offer the same functionality whether they're connected to WiFi, BPL or a straight fiber network"

More efficient generation, transmission and distribution operations will be required to meet the pressing energy needs of tomorrow. Improving these operational processes requires timely data and analysis from devices on all tiers of the distribution network. As opposed to analyzing data on a monthly or daily basis, realtime metering data enables utility operators to be proactive rather than reactive. The ability to track load magnitude, duration, and specific timing down to the individual meter level insures that resources can be more intelligently allocated.

## A Solution Appears

A new solution on the market is muNet's "WebGate" IP Interface System, which targets utilities that own or operate broadband networks. WebGate uses existing broadband infrastructure for core utility applications including AMR, load management and distribution automation.

Each WebGate IP Interface unit includes: a data acquisition system with non-volatile memory, an embedded processor delivering interval data via XML and a broadband modem. The integral modem allows the WebGate to communicate over any IP-based network, including HFC, Fiber, WiFi, DSL, and BPL.

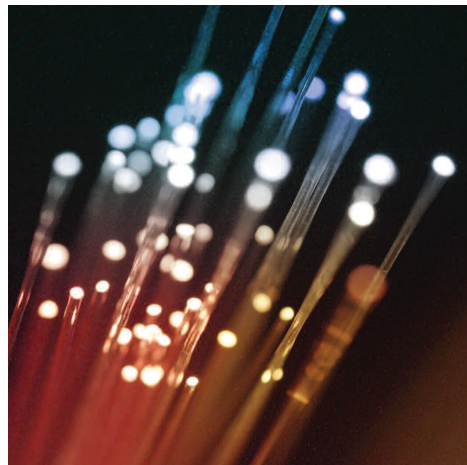
The WebGate iRIS™ IP Interface, is designed for residential electric meters and supports traditional metering applications, such as retrieval of kWh billing and interval data, tamper detection and a range of configuration options targeted at specific business applications. Optional functions include water and gas automated metering, electric disconnect/reconnect, high-speed Internet access, cable TV signal control and load management. muNet also offers a similar product, the WebGate iCIS™ IP Interface targeted at commercial meter-based applications.

## Technology Creates New AMR Innovation

AMR companies are finding new ways of leveraging the explosion in utility broadband systems. muNet and Datamatic created a partnership in 2004 to develop the first AMR solution that would enable utilities to read electric, water and gas meters over any IP-based broadband network. The demand for these AMR "triple deployments" has been increasing as utilities seek to improve efficiencies and make their systems more effective.

The integrated solution integrates Datamatic's FIREFLY® AMR technology into muNet's suite of WebGate® products. The new product allows utilities deploying muNet's WebGate technology to collect their water, gas and some electric readings via Datamatic's wireless RF technology. The wireless collection of the gas, water and non-WebGate electric meter readings offer the best of both muNet's IP and Datamatic's RF technologies for multi service utilities.

Moeyersoms added, "incorporating Datamatic's FIREFLY RF technology into our WebGate systems will provide utilities with a single solution to collect data from all of their electric, gas and water meters over any broadband network. This will maximize a utility's infrastructure investment returns by providing critical operational information such as meter reads, time-stamped interval data and benefit from the other system features such as voltage sensing, turn-on/turn-offs and load management."

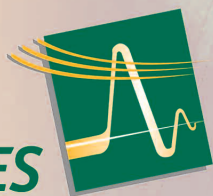




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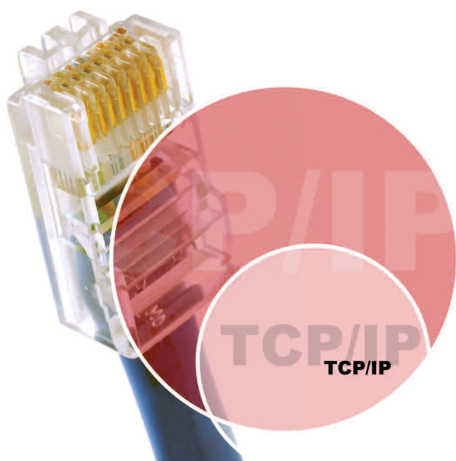
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This hybrid broadband/RF solution dramatically enhances the value of both technologies and slashes data collection costs. The result is a system that leverages investments already made in infrastructure while also improving the bottom line each month.

"Now a utility can collect and store water, gas and electric usage data at a single point until the WebBot collection system goes out over IP to the electric meter and transfers the readings," noted Ken Kercher, President and CEO for Datamatic.

"This type of system provides unparalleled access to information. On demand meter reading, near real-time notification of outages, leaks, tampers and the ability to execute remote disconnect and other control functions provide a tool set not readily available before. Utility operations become proactive rather than after the fact. Another key benefit is that difficult HR issues, such as filling meter collection positions and on the job injuries, are mitigated."

### The Next Step

The fusion of proven technologies has continued to produce "meta-technologies" delivering value that outstrips that of the individual solutions themselves. As utilities investigate and predict the needs of their operations in the future, they would do well to heed this principal and the Gestalt adage: "The whole is greater than the sum of its parts."

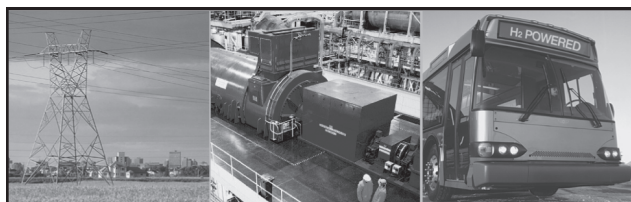
### About the Authors:

As Director of Sales and Marketing at muNet, Sean Doyle is responsible for both direct and channel sales strategies. Over the past five years Sean has been involved with most customer-oriented functions at muNet including project planning, customer service, installation support,

and inside and outside sales. Sean's most recent position prior to joining muNet was as Technical Sales and Support Representative with the Telecommunications Service Provider division of American Power Conversion, the world leader in UPS and power protection solutions. Sean earned a BS from the University of Rhode Island.

Scott Durham is the Vice President of Sales for Datamatic's Energy Systems division. Scott has been with Datamatic for over five years. Scott has a degree in mechanical engineering from the University of California and has been involved in the delivery of Enterprise data collection solutions for over 20 years.

Scott can be reached for comments and questions at [sdurham@datamatic.com](mailto:sdurham@datamatic.com). ■



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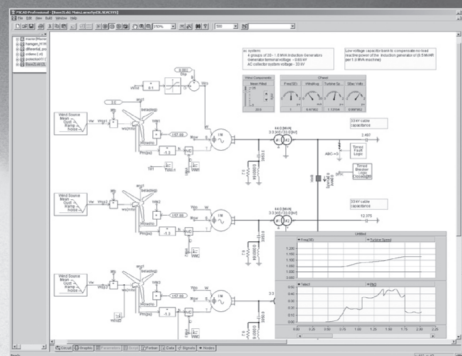
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# Application Security

**In addition to securing the network, securing access to SCADA system components will provide a further defense layer.**

By: Scott Wooldridge, Citect Inc., [ScottWooldridge@citect.com](mailto:ScottWooldridge@citect.com)

**A**uthentication is the software process of identifying a user who is authorized to access the SCADA system. Authorization is the process of defining access permissions on the SCADA system and allowing users with permissions to access respective areas of the system. Authentication and authorization are the mechanisms for single point of control for identifying and allowing only authorized users to access the SCADA system, therefore ensuring a high level of control over the system's security.

To provide effective authentication the system must require each user to enter a unique user name and password. A shared user name implies a lack of responsibility for the protection of the password and any actions completed by that user.

It must be possible for user names to be created, edited and deleted within the system while the system is active to ensure individual passwords can be maintained. In addition it is highly recommended that password aging be implemented. Password aging ensures that operators change their passwords over a controlled time period, such as every week, month, or so on.

To provide authorization the system must be able to control access to every component of the control system. The system must not provide a "back door" by which to bypass the levels of authentication specified in the application.

Critical data pertaining to a SCADA system must be securely stored and communicated. It is essential that critical data like a password be stored using an encryption algorithm. Similarly, remote login processes should use VPNs or encryption to communicate the user name and password over the network.

Critical data like user name and password must be persisted in a secured data repository and access rights monitored and managed using secured mechanisms like Windows authentication and role-based security. It has become common practice for SCADA systems operating in the Windows environment to utilize Windows Domain security to maintain user profiles. This is a recommended approach as it centralizes security and administration while providing an acceptable audit trail of user actions.

## Audit Trails

It is recommended that Audit trails on critical activities like user logins, changes to operational parameters or changes to system access permissions be tracked and monitored at regular intervals. Securing your SCADA application may make it more challenging for external hackers to gain control of the system; however it will not prevent internal sabotage. Regularly tracking and monitoring audit trails on critical areas of your SCADA system will help identify suspicious activities and consequently allow the necessary corrective actions.

## Wireless Networks

The two most common ways of gaining unauthorized access to a wireless network are by using an unauthorized wireless client, such as a laptop or PDA, or by creating a clone of a wireless access point. If no measures have been taken to secure the wireless network then either of these methods can provide full access to the wireless network.

Many commercial wireless networks are available, which range in price, complexity and level of security provided. When implementing a wireless network, a couple of standard security measures can minimize the chance of an attacker gaining access to the wireless network.

- Approved clients – The access points in the wireless network contain a configurable list of all MAC addresses of the authorized clients that are permitted access to the wireless network. A client not listed in an access point cannot access the wireless network.
- Server Set ID (SSID) – This is an identification string that can be configured on all clients and access points in your wireless network. Any client or access point participating on the wireless network must have the same SSID configured. The SSID is, however, transmitted as a readable text string over the network. Therefore, an SSID alone is not sufficient to secure the wireless network.
- Wired Equivalent Privacy (WEP) – All clients and access points should have a

configurable static WEP. This is a 40, 64 or 128-bit encryption string that is entered in all clients and access points. Without a correct WEP string, no access can be gained to the wireless network. The SSID is also encrypted using this string. In most cases, using an SSID and a WEP provides a secure solution.

- 802.1X EAP (Extensible Authentication Protocol) – WEP is the minimum level of security recommended for wireless client access. The disadvantage with WEP is the management of the network strings. It is possible to decode these, and updating to new keys is a manual process. EAP is a relatively new standard that dynamically alters keys while providing built-in authentication requirements. It is recommended where possible EAP authentication is enabled for wireless devices.
- VPN (described earlier) was developed to provide secure connections through the Internet to internal corporate networks. A VPN simplistically creates a secure tunnel through open networks such as the Internet or a wireless network. Data transmitted through the tunnel is encrypted on the client then decrypted and validated in a VPN gateway inside the wireless access point. VPN is a single solution providing security both for the wireless and wired network, thus reducing implementation and maintenance costs.

## Intrusion Detection

Firewalls and other simple boundary devices currently available lack some degree of intelligence when it comes to observing, recognizing and identifying attack signatures that may be present in the traffic they monitor and the log files they collect. This deficiency explains why intrusion detection systems (IDS) are becoming increasingly important in helping to maintain network security.

In a nutshell, an IDS is a specialized tool that reads and interprets the contents of log files from routers, firewalls, servers and other network devices. Furthermore, an IDS often stores a



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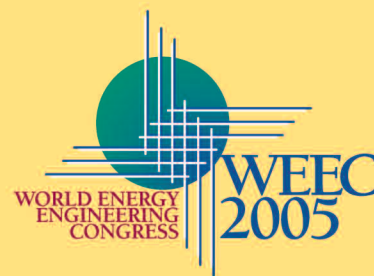
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database of known attack signatures to compare patterns of activity, traffic or behavior it identifies in the logs it monitors against those signatures. There are various types of IDS monitoring approaches:

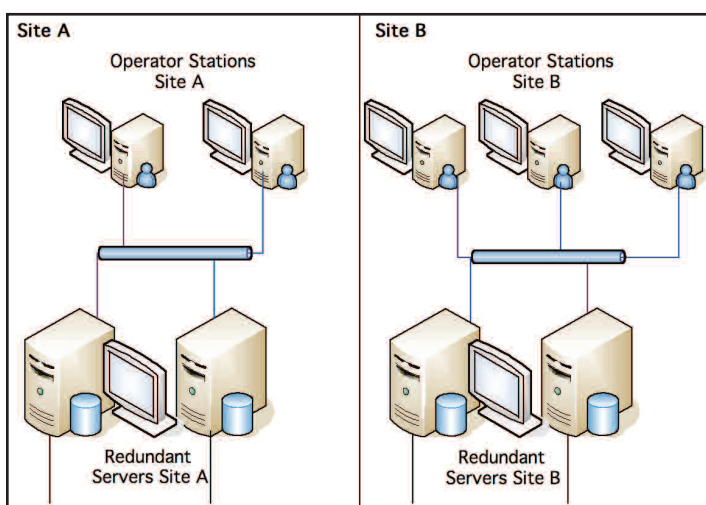
- Network-based IDS characteristics – A network-based IDS monitors an entire, large network with only a few well-situated nodes or devices and impose little overhead on a network.
- Host-based IDS characteristics – A host-based IDS analyzes activities on the host it monitors at a high level of detail. It can often determine which processes and/or users are involved in suspicious activities.
- Application-based IDS characteristics – An application-based IDS concentrates on events occurring within a specific application. They often detect attacks through the analysis of application log files and can usually identify many types of attack or suspicious activities.

In practice, most utilities use a combination of network, host and/or application-based IDS systems for observing network activity while also monitoring key hosts and applications more closely.

## Redundant Control Centers

For both physical disaster recovery and IT intrusion and isolation purposes most utility companies are now adopting SCADA solutions that incorporate at least one off site control center. In some utility sectors this is now mandatory. This should be seriously considered as part of the overall security assessment of the IT infrastructure. For a redundant off-site center to operate effectively the following items need to be considered as part of the infrastructure requirements:

- Automatic failover of all controller-based communications
- Full historical data replication between each of the servers deployed within the system.



**Redundant Control Centers**

## Additional Resources

This discussion is intended as an overview of the security measures to protect an integrated SCADA network. In no way is it fully comprehensive or intended as the sole source for network security. Listed below are some agencies that publish current standards and security measures that can aid you in your security planning.

### The Instrumentation, Systems and Automation Society (ISA)

[www.isa.org](http://www.isa.org)

### National Institute of Standards and Technology (NIST)

[www.csrc.nist.gov](http://www.csrc.nist.gov)

### North American Electric Reliability Council (NERC)

[www.nerc.com](http://www.nerc.com)

### United States Department of Energy (DOE)

[www.energy.gov](http://www.energy.gov)

### U.S. Department of Homeland Security

[www.nipc.gov](http://www.nipc.gov)

### Sandia National Laboratories – The Center for SCADA Security

[www.sandia.gov/scada/home.htm](http://www.sandia.gov/scada/home.htm)

## About the Author:

Scott Wooldridge holds degrees in electrical and mechanical engineering as well as an M.B.A. He has over 15 years experience providing production improvement engineering, IT, Project Management and Consultancy services to a variety of industrial, process, food and mining customers including: Rio Tinto, BHP Billiton, ALCOA, PG & E, Mitsubishi, Caterpillar and GM.

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## Sources:

*The Instrumentation, Systems and Automation Society (ISA). 2004.*

*Integrating Electronic Security into the Manufacturing and Control Systems Environment.*

*North American Electric Reliability Council (NERC). 2004. Implementation Plan – Renewal of Urgent Action Cyber Security Standard.*



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# Current Issues in Underground Transmission

By: Mark Michailuk, TUCIG Project Coordinator

The Transmission Underground Cables Interest Group (TUCIG) of CEA Technologies Inc. (CEATI) provides a forum for the exchange of information on transmission cable asset management and the establishment and promotion of techniques and tools for improving the management of fluid-filled and XLPE high-voltage underground cable systems.

Underground cables offer a number of distinct advantages over traditional overhead designs, both technically and in simple aesthetics. Because of their basic design, underground systems can often have a lesser environmental impact, without a need for vegetation clearances and with reduced rights-of-way. This approach also means that customer property values are kept intact, as the lack of visible towers is inherently pleasing to the eye. The simpler routing of underground cable systems, due to less stringent rights-of-way requirements and tower placement, also means that the cost of basic equipment is reduced, which is certainly a benefit to asset managers. For these reasons, underground systems are often ideal for urban environments.

Transmission cables are without doubt critical arteries of the electrical power grid; it is necessary that they be highly reliable. Certain older transmission cables, including high-pressure fluid-filled pipe type (HPFF) cables or low-pressure self contained fluid-filled (SCFF) cables, have been in service for sixty years or longer. The reliability of both types of cables has been, and continues to be, exceptional. However, there are several important issues with these cables that will need to be addressed in the coming years. There are concerns regarding the potential impact on the environment from fluid leaks, concerns about increasing maintenance costs as the older circuits continue in service, concerns about the loss of expertise to carry out this maintenance due to demographic shifts, and concerns over a possible reduction in the reliability of the cables with time.

The alternative to fluid-filled cable systems is polymer insulated cables. Some of the first extruded transmission cables, using polyethylene as the insulation, were installed in the 1960s but operated at an electrical stress level of less than half that used in HPFF and SCFF cables. Cross-linked polyethylene (XLPE), because of its superior mechanical properties, replaced thermoplastic polyethylene as the insulation of choice and is now used almost exclusively in extruded transmission cables, particularly at higher transmission voltages up to 500 kV. There was an early reluctance to use extruded transmission cables, partly because the "older technology" fluid-filled cable systems were highly reliable, partly due to poor experience in many utilities with extruded medium voltage cables due to water treeing, and partly due to the lack of economic incentives to switch to a relatively "unproven" technology. The increased reliability of extruded medium voltage cables in the 1980s, the realization that transmission cables had to be sealed to prevent the ingress of moisture, and the operational experience with installed extruded cables gradually overcame this reluctance in the 1990s. Today, XLPE transmission cable systems are in widespread use and have a major environmental advantage in the absence of oil leaks. However, there are still concerns about the high stress levels used in the new extruded cable designs and the long-term performance of extruded cables particularly when they are operated at high temperatures for long periods.

The scope of the TUCIG covers all the above-mentioned issues for both fluid-filled and extruded cable systems. A sampling of the group's projects currently underway includes:

## Cable Health Index (CHI)

It is very important for utilities to assess the condition of their cable circuits, particularly their older circuits. Currently, no methods exist for quantifying re-use, refurbishment or replacement needs. The cable health index will provide a clear,

concise, verifiable and repeatable methodology for this assessment. The index will consider electrical (outage records, loading history), maintenance (oil testing, insulation condition), and corrosion protection (stray currents) issues, environmental (installation location, sheath grounding), safety and other risk issues, as well as maintenance costs and investment issues, so that a set of numerical values for each cable circuit can be derived. The CHI, including precise grading and weighting factors, is a technical assessment of cable circuits and can be used on both fluid-filled and extruded cable systems that will allow for comparison to be made between different circuits so that cable assets can be managed accordingly.

## Maintenance Survey

A survey of the TUCIG participant utilities was carried out to determine the different maintenance procedures (function tests, visual checks, infrared inspections, etc.), and the frequency at which they are carried out on transmission cable circuits, in order to establish industry best practices. Utility procedures can vary according to the age or importance of the circuit, and utilities often have different "default" frequencies at which many procedures are carried out on "normal" circuits that are not suspected of having any serious problems. Certain utilities carry out routine inspections every three months, while others perform these inspections annually.

## PD testing of Fluid-Filled Cable Systems

Partial Discharge testing has long been recognized as a technique for detecting potentially harmful defects in medium voltage cables and in extruded transmission cables. This technique is now being applied by a number of utilities on problematic HPFF and SCFF cables suspected of having some form of degradation or damage. In order to interpret the test data, conventional tests such as dissolved gas analysis



(DGA) have also been performed to establish whether there may be a correlation with results from PD testing, and as to whether PD testing can reliably indicate the presence of contaminants and fault gases (such as H<sub>2</sub> and C<sub>2</sub>H<sub>2</sub>).

## Mitigation of Stray Currents on Underground Cable Systems

Corrosion of underground cable systems is a major concern for utilities. It can lead to environmentally harmful oil leaks and the loss of insulation integrity in fluid-filled cables and the ingress of moisture into extruded cable systems, potentially leading to failure. A key focus of this research concerns DC stray currents from Light Rail and Transit systems, as these can create corrosion problems in nearby underground transmission systems. This project is being initiated to evaluate the methods, equipment, materials, and programs that will eliminate or mitigate corrosion problems in the underground transmission systems.

## Cable Selection Guide

Utilities have an increasing number of choices in the types of transmission cables available to replace existing circuits or when planning to install new ones. The choice includes HPFF and SCFF cables and different designs of extruded cables (for example, high and low stress designs). There are advantages and disadvantages for each cable type and design, which makes the final choice a complex decision for utilities. The Cable Selection Guide will list and discuss the technical and economic issues (test equipment, trade-offs, installation and maintenance issues) and help utilities make the best choice for their particular

application. The guide will give an impartial assessment of the types of cable designs available and will provide selection criteria for a number of different scenarios that will include environmental and logistical factors.

## Joining Together to Fund Underground Cable Research

As deregulation continues to impact the electricity industry, utilities are often forced to cut back on research spending to lower their expenditures. Simply put, the costs associated with research and technology development are very often prohibitive for individual utilities. The collaborative nature of the CEA Technologies Inc. (CEATI) program and the Transmission Underground Cables Interest Group helps utilities undertake projects that respond to their strategic goals at a fraction of the cost of doing so independently.

CEATI operates a number of interest groups consisting of participants from electrical utilities from all over the world. Each interest group focuses on particular technical issues and carries out projects critical to the participating utilities. The Transmission Underground Cable Interest Group (TUCIG) is made up of thirteen utilities from the USA, Canada and Europe.


Along with the projects listed above, the TUCIG also has a number of internal projects underway to collect information on failure statistics for each different type of cable, new developments in cable installation techniques, cable diagnostics and new materials. Group meetings provide excellent opportunities for participants to discuss day-to-day operating problems and concerns.

Participation is open to all electrical utilities, independent system operators, regional transmission operators, independent market operators, and government agencies that have an interest in underground system issues. The group identifies areas of common concern and defines research objectives to solve those concerns. Individual group participants can select to co-fund projects of interest that will be of benefit to their organizations. This flexible, user-driven, responsive and collaborative approach provides substantial cost-benefit advantages to the participants. ■

## About the Author

Mark Michailuk, B.Eng., currently oversees the Transmission Underground Cables Interest Group of CEA Technologies Inc. (CEATI). A graduate of McGill University in Montreal, as well as *L'Institut en génie de l'énergie électrique*, his primary area of focus is power systems analysis.





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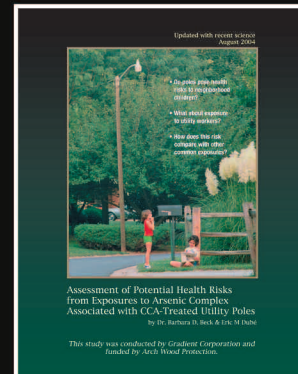
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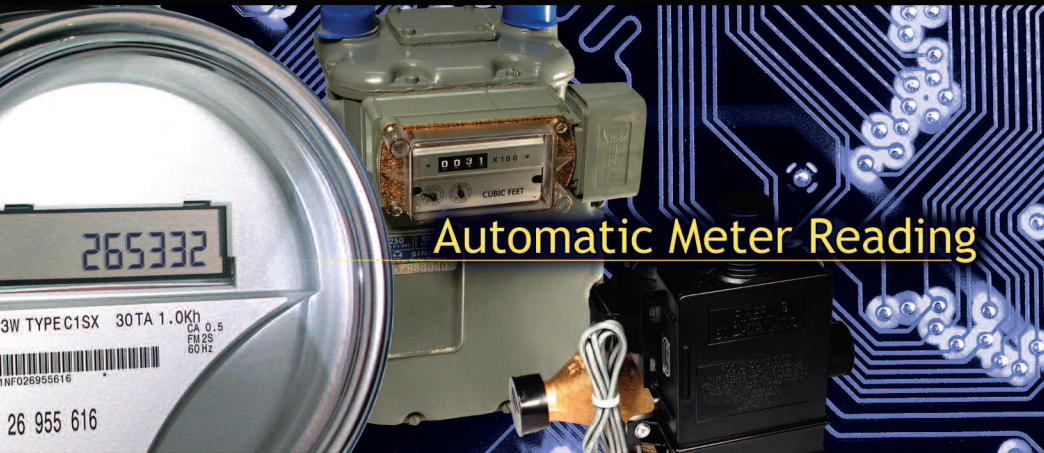
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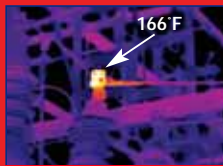


Bad bus-breaker connection

A major manufacturer suffered a \$100,000 switchgear fire loss. After the switchgear was

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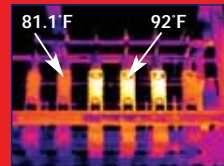


Overheating bushing connection

A large paper manufacturer used infrared to scan their onsite substation. The inspection crew discovered a

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Tel: (310) 689-1610  
Fax: (310) 208-6133  
Web: www.magnetek.com

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Tel: (630) 766-7800 / 1-800-304-5665  
Fax: (630) 766-2813  
Web: www.magnetic-shield.com  
E-Mail: rdasso@magnetic-shield.com  
Bob Dasso, Sls. Mgr.

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Web: www.magspecinc.com  
E-Mail: maa@solarimgf.com

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P.O. Box 532  
Champlain, NY, USA 12919  
Tel: (514) 369-4919  
Fax: (514) 369-4817  
Web: www.majorpower.com  
E-Mail: sales@majorpower.com

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RESEARCH CENTRE INC.**

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Winnipeg, MB, Canada R3J 3W1  
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E-Mail: info@pscad.com  
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Fax: (973) 537-1581  
Web: www.manningsusa.com  
E-Mail: sales@manningsusa.com  
Daniel Ciarlariello

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Fax: (214) 741-2283  
Web: www.mapframe.com  
E-Mail: info@mapframe.com

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E-Mail: barry.batson@mastec.com

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Dallas, TX, USA 75237-1088  
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175 Science Parkway  
Rochester, NY, USA 14620  
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Fax: (585) 242-9620  
Web: www.microwavedata.com  
E-Mail: sales@microwavedata.com  
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Web: www.mikroninfrared.com  
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Web: www.motorola.com/cgiss  
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E-Mail: info@neoptix.com  
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Fax: (905) 944-4330  
Web: www.nexansenergy.com  
E-Mail: rick.vascotto@nexans.com

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E-Mail: info@nxtphase.com

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E-Mail: info@pennseparator.com  
Steve McNeil, President

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E-Mail: info@phenixtech.com  
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Web: www.positronpower.com  
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Mike Herzog, Project Manager

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E-Mail: jnaylor@structural.net  
Contact: Jim Naylor

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John Benckenstein

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E-Mail: ranpro@ranpro.com  
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E-Mail: rambo@survalent.com

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Contact: Ben Taylor  
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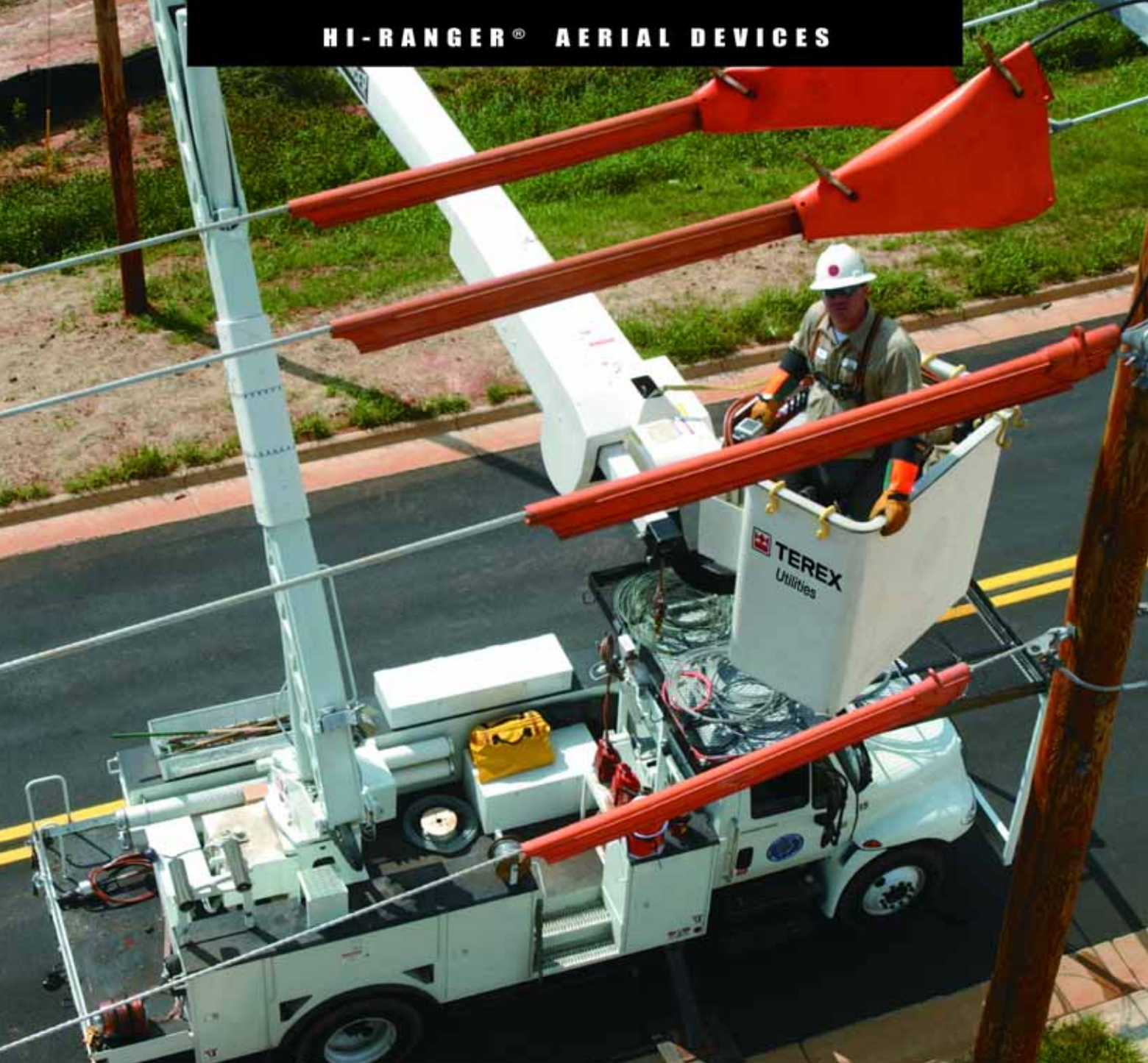
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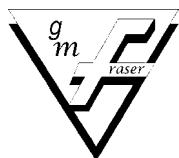
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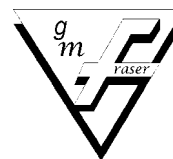
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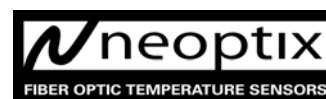


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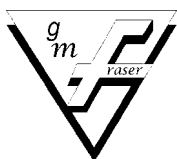
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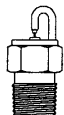


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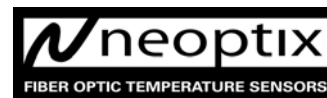
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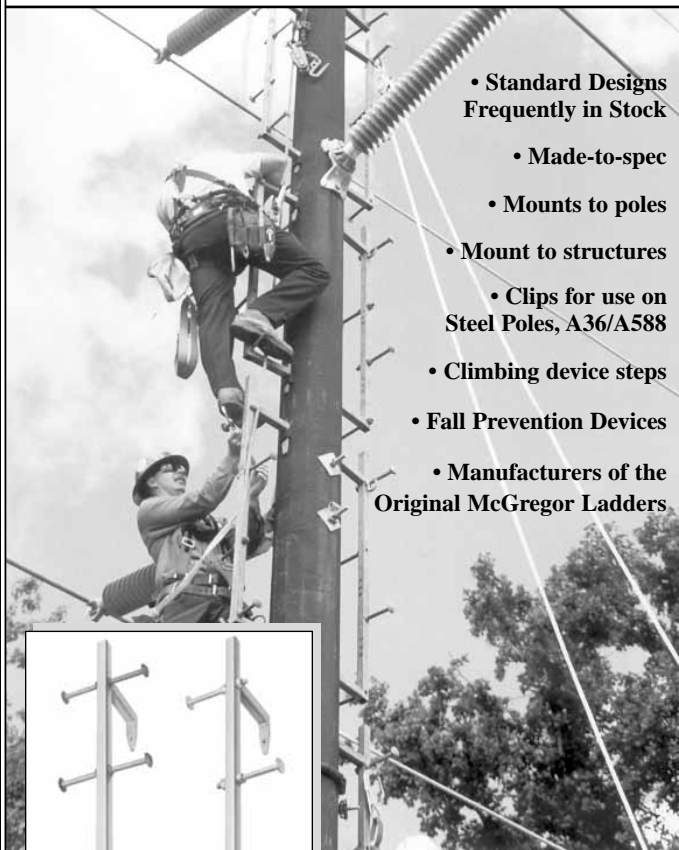
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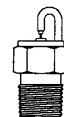
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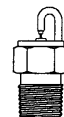


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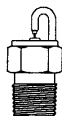
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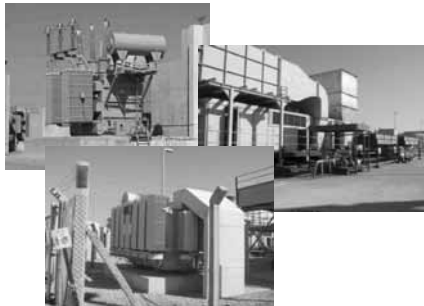
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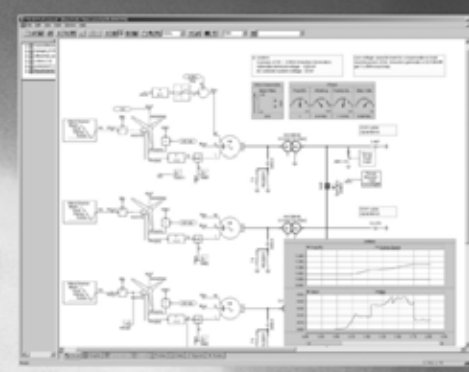
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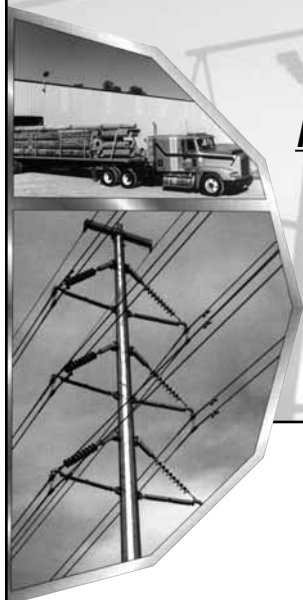
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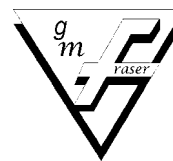
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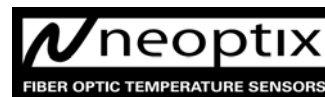
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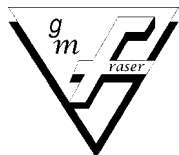
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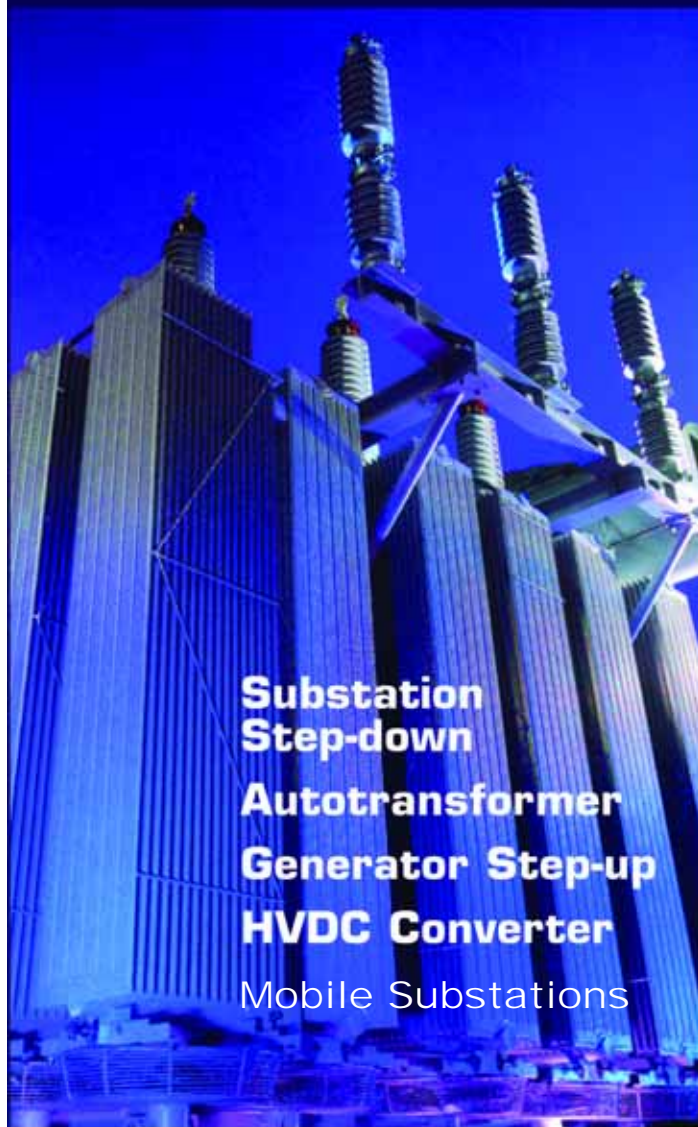
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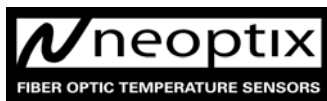
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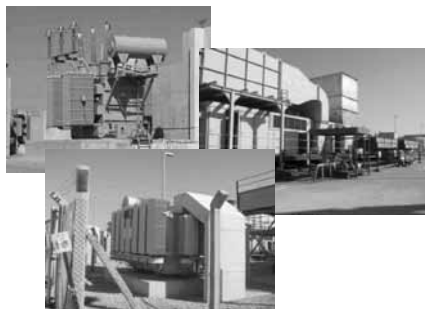
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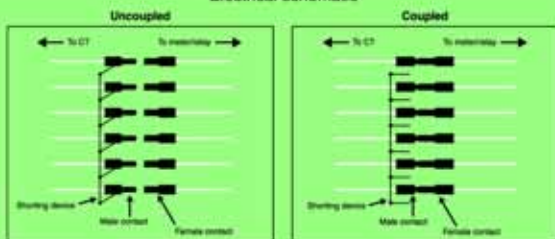
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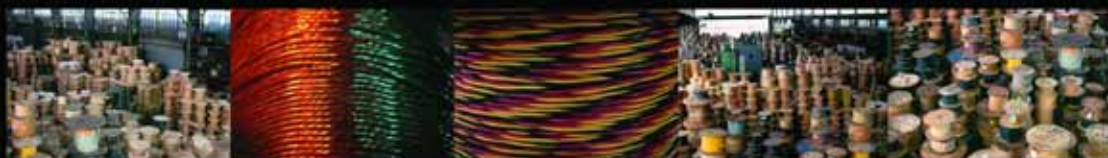
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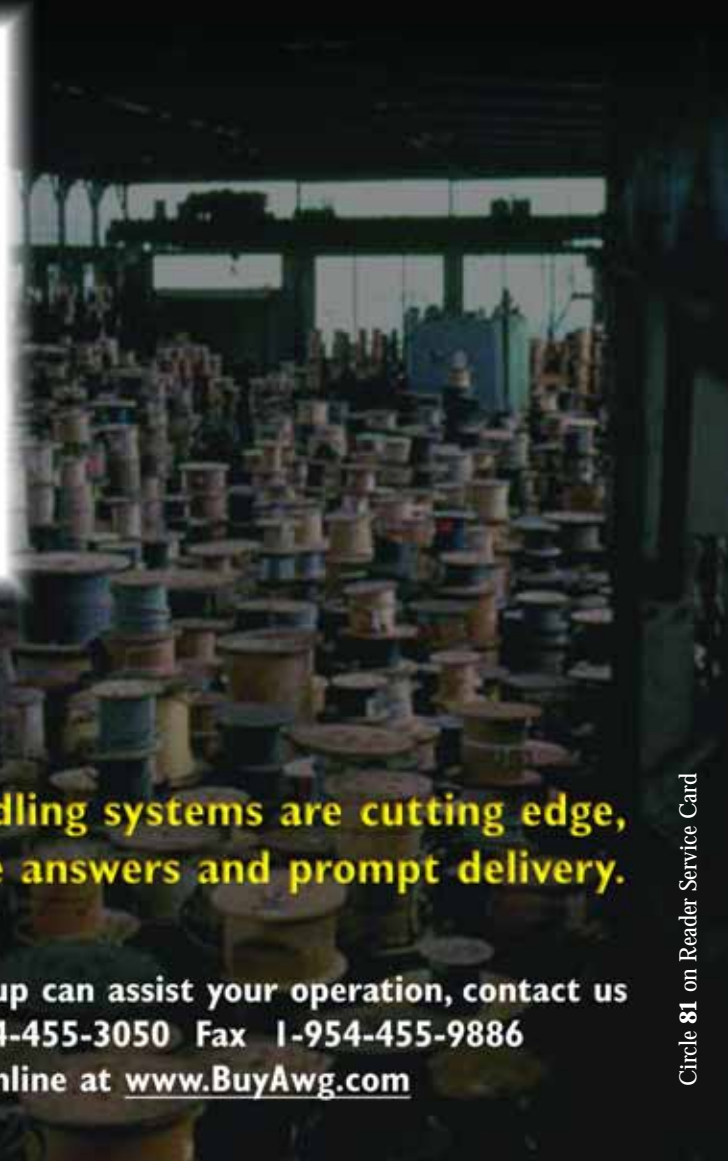
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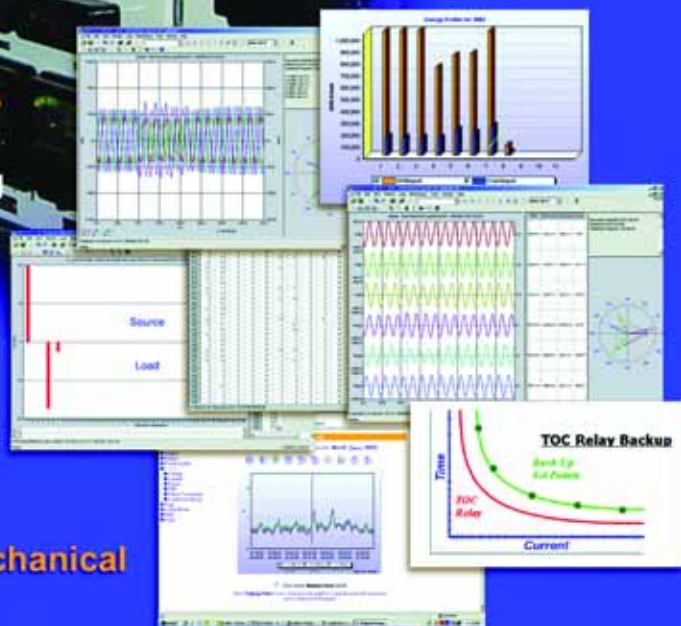
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