North American Policies and Technologies

# ELECTRICITY Transmission & Distribution TODAY

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## Composite core connectors help increase capacity

**Phase shifting with transformers**

**Manitoba Hydro's new headquarters stresses energy efficiency**

**The hazards of re-electrification in hurricane ravaged areas**

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# GROWING DEMAND FOR POWER OUTWEIGHING FEARS OF THE NUCLEAR BOGEYMAN

By Don Horne

The voices are becoming louder and more confident - nuclear power is once again the first, best option to meet the world's growing energy demands.

Those vivid images of the Chernobyl reactor on fire some two decades ago have dulled with the passage of time.

However, in Ontario, memories remain fresh of the summer blackout of 2003. A recent poll of that province's residents revealed that 41 per cent believe more nuclear power is needed (with only 23 per cent opposing and 27 per cent happy with the status quo). Rising electricity rates spell increased heating costs, and that has attitudes changing toward how new generation should be created.

Also, the spectre of Kyoto-mothballed coal-burning plants and the reality of having to decommission the current aging family of CANDU reactors by 2020 means action has to be taken now - considering that new nuclear generating facilities require up to 15 years to go online.

In the United States, incentive programs have sprung up to encourage new nuclear generation construction, and nuclear power has reappeared on the agenda for the next Group of Eight Industrialized Nations summit in the summer of 2006.

The Energy Department predicts a 45 to 50 percent increase in electricity demand between now and 2025. Skip Bowman, President and Chief Executive Officer of the Nuclear Energy Institute, said in a recent speech in Los Angeles California that "since 1992, when the United States last enacted major energy policy legislation, the industry has built approximately 270,000 megawatts of new gas-fired electric generating capacity. By contrast, only 14,000 megawatts of new nuclear and coal-fired capacity have entered service."

Coal and nuclear energy together represent approximately 70 percent of U.S. electricity supply. "They provide the highest degree of price stability, but investment in new nuclear and coal-fired power plants has virtually disappeared in the last 10 to 15 years," Mr. Bowman points out.

On the other side of the Pacific Ocean, China is hoping their experimental super-efficient nuclear reactors will drastically reduce waste and ease uranium demand. If their scientists are right, their next-generation fast reactors (set to go into operation in 2010) would burn 60-70 per cent of the uranium fuel, instead of the conventional 0.7 percent.

A quantum leap, to say the least.

China's current nuclear megawatt production is 8,700; their aim is to increase that number to 36,000MW by 2020.

A concurrent technology is China's gas-cooled nuclear reactors, which can operate at higher temperatures for a higher power generating capacity.

Perhaps the best indicator of the renewed interest in nuclear power is a request from the IAEA for a 5-10 year moratorium on new nuclear facility construction, citing the some 50 countries who are not sure what to do with their spent nuclear fuel.

An analyst from the World Nuclear Association has stated that nuclear could be providing 50 per cent of the world's electricity needs by 2050.

However, Greenpeace has told the European Parliament that reviving the nuclear program would "replace one environmental catastrophe - polluting fossil fuel power - with another environmental disaster - nuclear energy".

The most telling argument is that of a lack of options.

Although nuclear has a high start-up cost, the price of running a plant is quite low in comparison to coal, oil and liquid natural gas (not to mention that the megawattage produced by nuclear dwarfs other forms of generation). And the cost of these two fuels will undoubtedly rise considerably in the next 10 to 20 years as China's ravenous appetite for power pushes the price of these commodities higher and higher.

Gas-fired generation was the answer when it was $2 to $3 per million Btu, but that has exploded to near $11 per million Btu.

With numbers like that, I think it's safe to say so long nuclear bogeyman.

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# INCREASING POWER CAPACITY WITH NEW COMPOSITE CORE CABLES AND CONNECTORS

By Ben Crutcher

The ACC cable technology replaces the traditional steel core with composite material comprised of glass and carbon fibers bonded with a special polymer resin.

When you think of hotbeds of cutting edge technology, Kingman, Kansas may not jump to the front of your mind. But it is here in America's heartland where a major advancement in electrical conductors is providing dramatic improvements in the delivery of power to the city's growing clientele.

"Because of our increasing population, combined with the recent volatility of natural gas prices, we needed to seek an alternative, more cost-effective source of energy," said Ira Hart, Superintendent of Utilities for the city of Kingman. "We are located in a part of Kansas that is somewhat distant from the Aquila system, so that was not a viable option. We came to the realization that we would have to prepare the distribution side of our system for integration with a new transmission line that would allow us to buy power when it makes financial sense."

While meeting with a number of energy providers, Hart and his team learned that Composite Technology Corporation (CTC), a developer of high-performance composite core cable for electrical transmission and distribution lines, was looking for a demonstration project for their new Aluminum Conductor Composite Core (ACCC) cable.

"We were intrigued by the prospect of a system upgrade that would allow us to meet increased demand while providing a reliable source of electrical power more economically," Hart explained. "Our confidence in this solution was strengthened by the fact the ACCC cable would be paired exclusively with FCI-Burndy connectors – we've been using their products for years and consider them to be a very valuable vendor."

According to CTC Chairman and CEO, Benton Wilcoxon, "The new ACCC cable technology represents a dramatic improvement over the old design which has existed for over 100 years. It is a cost effective solution that delivers significantly better performance than conventional cable."

The ACCC cable technology replaces the traditional steel core with a composite material comprised of glass and carbon fibers bonded with a special polymer resin, which allows the conductor to carry twice the power at higher temperatures with very little expansion and virtually no potentially dangerous sag.

By the end of 2004, Kingman Municipal Utility had installed one thousand feet of Hawk-sized conductor in the municipality's power distribution system between the city's power generation plant and a new substation, anticipating a project tying into the regional electrical grid with the installation of a new twenty-one mile transmission line featuring the ACCC cable and custom-designed termination ends.

CTC's decision to partner with FCI-Burndy on this project was a relatively easy one.

"We considered a few other connector manufacturers," said Mr. Wilcoxon. "Their experience and long-established position as a world leader in the electrical industry, coupled with our technology, enabled our engineers to work closely to design and develop cost-effective hardware components which exceed industry standards. Also, their commitment to and endorsement of our transmission conductors and their composite core was a key part of our decision to work with them."

All splices and dead ends required for the entire 21 circuit miles of transmission lines, as well as the new substation tie-lines to the generator and trans-

**Continued on Page 10**


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## Connectors

**Continued from Page 8**

mission, will utilize FCI-Burndy hardware developed specifically for the ACCC composite core conductor. The connectors are unique in design and application – the composite core of the ACCC cable required Burndy to rethink the dead end.

While a perfect fit for the ACCC cable, the FCI hardware was designed to also closely mimic standard ACSR cable in look and feel, ensuring that linemen would not need any special tooling or training.

"All the component parts of the dead end connectors fit nicely," lauded Hart. "The workmanship on the dead end connectors truly helped to speed the assembly process, to the point where our guys were crimping a dead end in just 17 minutes."

The results of the new transmission lines have already been significant. "With the ACCC cable and Burndy dead ends," said Hart, "we have been able to upsize capacity by a factor of four, without needing to resize any structures. We could not be happier with the performance of the cables and the connectors.

The connectors are unique in design and application.

"We are more convinced than ever that the new ACCC cable and FCI connectors are the most cost-effective solution that will allow us to greatly increase system capacity as our community grows. Also, the cable's high temperature performance characteristic will improve reliability."

CTC is thrilled with the success of the Kingman project thus far, and is currently working with several key developers and engineers formulating plans for major new transmission systems in various parts of the world.

It seems that the world of electric transmission and distribution may soon be changing on an international scale. And to think this powerful revolution all started in the relatively small midwestern city of Kingman, Kansas.

*Ben Crutcher is the Utility Market Manager for FCI-Burndy Products.*

# CALIFORNIA GETS ITS ENERGY POLICY AFFAIRS IN ORDER

By Stephen Heins, VP of Corporate Communication, Orion Energy Services

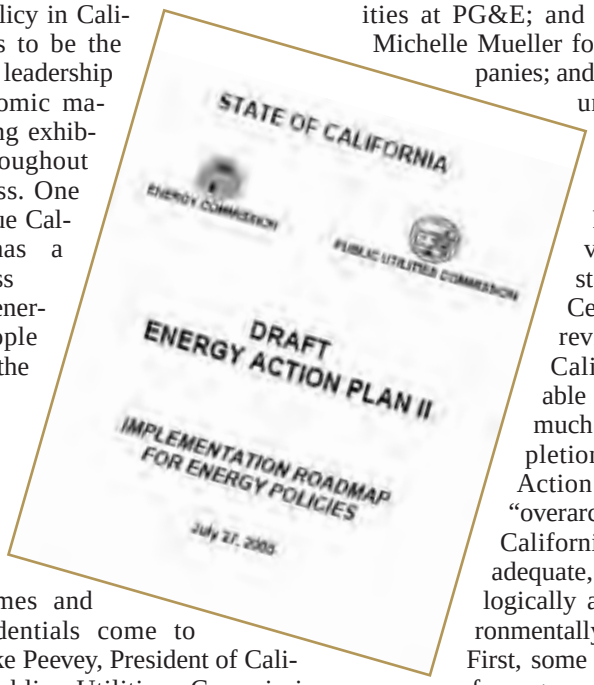
Now that California is in the last stages of adopting its Energy Action Plan II, it is an opportune time to discuss the comprehensive solutions being enacted there. First and foremost, California has been able to conduct a thorough discussion of energy policy and legislation without sounding like a house divided. It is for these reasons that I celebrate California as a leader in "best practices" for state energy policy.

While there are many areas of energy where California has been able to adopt a leadership role, the single greatest achievement must be the spirit of cooperation permeating the entire process. Unlike the old "business model" for getting energy policy done, California has stopped the name-calling and the public displays of discord between stakeholders.

This means that the important issues surrounding California energy policy are now being decided by the California Public Utility Commission, the CA Energy Commission, the CA EPA, the California Legislature, the Business, Transportation and Housing Agency, the Resources Agency, the State and Consumer Services Agency, the California Independent System Operator (CAISO), the CA Investor Owned Utilities (IOU), the CA municipal utilities, the state consumer groups, the state environmental groups like the Natural Resource Defense Council, Governor Schwarzenegger and his Cabinet, the California Climate Registry, the California Lighting Technology Center, the CA educational community and the private sector without the usual politicization. In addition, the well-respected Lawrence Berkeley Laboratory has provided analysis, information, research studies and policy recommendations to California decision-makers.

There are several reasons for this development. However, the over-riding fact is that California has come through the gut-wrenching problems caused by the Energy Crisis of 2001. Some people liken that experience to having viewed one's own hangman. In fact, it could be argued that California did not need any other reason to get its energy policy affairs in order.

There is a "perfect storm" of forces that have helped create this new spirit of cooperation. The single most important reason for the sanity of energy policy in California has to be the quality of leadership and economic maturity being exhibited throughout the process. One could argue California has a world-class roster of energy people ready for the challenge.


STATE OF CALIFORNIA

ENERGY COMMISSION

PUBLIC UTILITIES COMMISSION

DRAFT
ENERGY ACTION PLAN II

IMPLEMENTATION ROADMAP
FOR ENERGY POLICIES

July 27, 2005

With apologies to those not mentioned, some obvious names and their credentials come to mind: Mike Peevey, President of California Public Utilities Commission (CPUC) and 2005 Charles H. Percy Award winner; Dr. Arthur Rosenfeld, Commissioner of California Energy Commission and co-founder of the American Council for an Energy Efficiency Economy (ACEEE), the University of California's Institute for Energy Efficiency (CIEE), and the Washington-based Center for Energy and Climate Solutions (CECS); Joe Desmond, Chairman of the California Energy Commission and former energy consultant; Susan Kennedy, a Commissioner of CPUC and the CPUC's Assigned Commissioner for energy efficiency; Dian Grueneich, a Commissioner of the CPUC with more than 25 years of experience in energy efficiency and environmental policy and law; Diane Wittenberg, President of California Climate Action Registry; Dr. Sev Borenstein, Director of the University of California Energy Institute; Dr. Michael Siminovitch, Director of California Lighting Technology Center; Gene Rodriquez, Director of Energy Efficiency for Southern California Edison Company, Steve McCarty and Roland Risser, who share EE responsibilities at PG&E; and Patty Wagner and Michelle Mueller for the Sempra companies; and Sheryl Carter, Natural Resources Defense Council's (NRDC) Director of Western Energy Programs and Devra Wang, NRDC's staff scientist.

Certainly, it is worth reviewing how California has been able to accomplish so much including the completion of the Energy Action Plan II, whose "overarching goal was for California's energy to be adequate, affordable, technologically advanced and environmentally-sound."

First, some of the sacred cows of energy and energy policy had to be amended. In the case of public benefits for electricity, free-ridership (i.e. providing a rebate for products or services that the customer would buy anyway) is still tracked but it does not hinder achievable energy efficiency savings. In essence, California is providing open-ended rebates for all prescribed acts of measurable energy efficiency. With significantly expanded budgets and energy efficiency goals, California has chosen not to chose winners and losers. For electricity, a kilowatt saved is a kilowatt saved, period.

Also, California has adopted a "loading order" for new sources of elec-

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# RECLASSIFICATION OF RELAY-CLASS CURRENT TRANSFORMERS FOR REVENUE METERING APPLICATIONS

By Paul Doig, Colin Gunn, and Marcie Cochrane, Power Measurement, and Larry Durante and Clayton Burns, National Grid

Abstract— A system has been developed to enable the reuse of existing relay-class current transformers (CT) for revenue metering applications. In this paper, a new methodology demonstrates the ability to perform live, dynamic characterization and reclassification of existing relay-class CTs. The system relies on a highly accurate split-core reference current sensor that is live-line deployed at high voltage (HV) substations, and rated up to 765 kV. Through the comparison of the measurements from the reference current sensor and the existing relay-class CT, the system can produce error correction parameters for the reclassification of the existing CT. These error correction parameters are programmed into an advanced revenue meter which, in turn, dynamically corrects and effectively reclassifies the accuracy rating of the existing relay-class CT. Experimental results from laboratory and field testing illustrate the effectiveness of the new system and its ability to increase the accuracy of the overall revenue metering system.

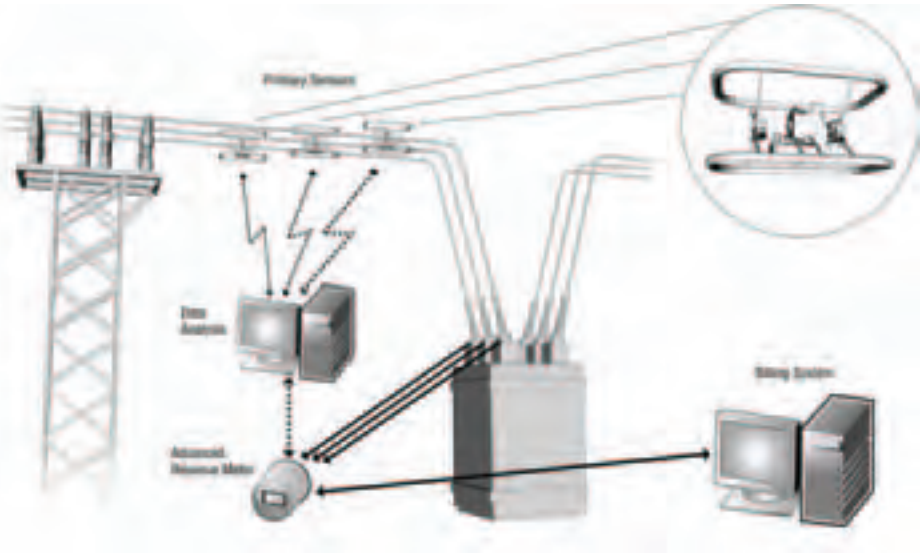

Fig. 1. CT reclassification system with three primary sensors installed on the high voltage line and an advanced revenue meter connected to the secondary wiring of the existing relay-class CTs under test.

## I. INTRODUCTION

The electric utility industry has experienced a lot of change recently due to pressures to open the competitive landscape in the electricity market. As a result of these changes, new regulatory requirements mandate that utilities meter previously un-metered locations on the power network with highly accurate revenue metering equipment. The financial burden to upgrade these metering points has forced the industry to explore the possibility of re-using the existing relay-class current transformers (CT) for high accuracy revenue metering applications. The true accuracy of the existing CTs is typically unknown and utilities and manufacturers are working together to understand the accuracy characteristics and determine if these CTs can be reused for revenue metering.

This paper will detail the various components within a new CT reclassification system that has been developed for this purpose. Focus is given specifically to the highly accurate reference current sensor that is at the core of the system. Details on its design and technology reveal the nature of its high accuracy and its ability to be deployed using live-line methods in a high voltage (HV) environment.

Test results and analysis of the data collected illustrate that the technology in each system component contributes to the overall increase in accuracy when a relay-class CT is reclassified.

Through analysis of the test data, the characteristic performance of the individual CT is calculated and the corresponding error correction parameters are derived and programmed into an advanced revenue meter.

Through the experiences gained at a 138kV utility substation, the system components and their respective technology were proven in a live, operational high voltage environment.

The research outlined in this paper illustrates the effectiveness of this new system to perform live, dynamic accuracy reclassification of existing relay-class CTs while operational in the field.

## II. CT RECLASSIFICATION SYSTEM OVERVIEW

At the core of the CT reclassification system is a highly accurate reference current sensor, known as the primary sensor,

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# California

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tricity. The loading order prioritizes all new sources, with the most environmentally-friendly source being the first options and the least friendly being the last. Therefore, California's first response to meeting growing energy needs is energy efficiency and demand response; then, renewable sources and distributed generation will be deployed; and lastly, clean and efficient fossil-fired generation will be utilized. This emphasis on clean power allows the CPUC to play an active role in California's emission reduction efforts and Greenhouse Gas reporting being spearheaded by the California Climate Action Registry.

In addition, California is using a two-pronged attack to distribute rebates for energy efficiency, with a combination of utility administered public benefits programs and energy efficiency procurement programs mandated by the CPUC and run by the utilities are both being used to reduce overall electrical consumption. The other benefits of these energy efficiency programs are that they come with technical and design assistance along with energy education and product information. In fact, it could be argued that this combined approach is more powerful than either program is alone, especially now that the resulting energy savings can be strictly measured and verified.

Finally, other innovations proposed in the Energy Action Plan are as follows:

- allowing utilities the same return-on-investment for energy efficiency, demand response and new power plants;
- integrating energy efficiency programs with demand response programs so that there are no disincentives for doing both;
- transforming Research, Development & Demonstration (RD&D) projects into energy efficiency tools and standards;
- restructuring the IOU rate-making process to reduce the number of proceedings, create more transparency, adopt rates based on clear cost-causation principles and identify opportunities to reduce electricity costs;
- creating a sense of regulatory certainty and a long-term planning process capable of flexibility.

California should be honored for the orderly process it has used to advance its best ideas into the Energy Action Plan II, which offers one of the most comprehensive roadmap for energy policy in the U.S. As importantly, California has become the leader in developing energy efficiency and demand response programs that will be a formidable tool for the demand-side of the energy market in the future.

Combining economic development and environmental stewardship, California has done its best work with collegiality and consensus. While each state has its own requirements and constraints, California deserves to be studied for its process, planning and innovation.

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deployed using live-line methods on voltages up to 765 kV.

The primary sensor is based on a split core, active CT design, thereby providing highly accurate measurement capabilities. Fig. 1 illustrates a typical system installation in an HV substation. Traceable to NIST and NRC standards, three primary sensors are installed using live-line methods on the high side bus in an HV substation in series with the circuit breaker containing the existing relay-class CTs under test. While mounted on the bus, the primary sensors each wirelessly stream data to a computer workstation in the nearby substation control building.

The software on the computer communicates over the wireless link with each primary sensor. The software simultaneously communicates to an advanced 3-phase meter, the secondary sensor, which is connected to the secondary wiring of the existing relay-class CT under test. The software system collects global positioning system (GPS) time-synchronized data from each of the 3 current sensors on the bus, while also collecting corresponding GPS time-synchronized data from the meter connected to the secondary side of the CT under test.

Following data collection, the software compares the time-synchronized data from three primary sensors to the respective 3-phase data collected from the meter. The data is analyzed and the software calculates the appropriate ratio correction factors (RCF) and phase angle correction factors (PACF) for each test point over the dynamic operating range of the relay class CT under test. These correction parameters are then programmed into the advanced revenue meter which, in turn, provides dynamic correction for the ratio and phase angle errors of the relay-class CT over its operational range. This effectively reclassifies the CT to be of revenue metering accuracy.

The primary sensors are then removed and the system is left with only the advanced revenue meter, connected to the secondary wiring of the existing relay-class CTs. The revenue meter, using the correction parameters, measures highly accurate energy data and reports this back to the utility data collection and billing system.

### A. PRIMARY SENSOR

The primary sensor is based on the following feature set:

- Split core, active CT
- Self-powered
- Live-line installation
- Onboard GPS time synchronization
- Bluetooth wireless communications
- Electronics module for measuring RMS current magnitude and phase angle
- High voltage rating up to 765 kV

The primary sensor, as shown in Fig. 2, is a highly accurate device used as the reference standard against which the accuracy of the CT under test is compared.

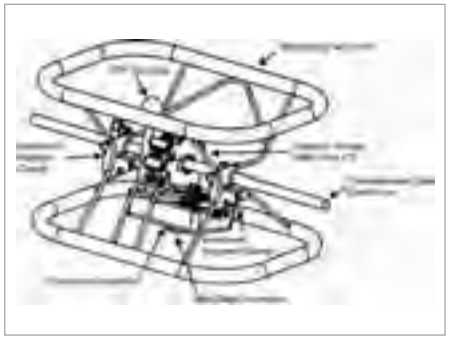

Fig. 2. Primary sensor.

The onboard GPS is required to achieve high accuracy time stamping of the data so that the software system can accurately compare data points from the primary sensor and the advanced revenue meter, which also utilizes the same high accuracy onboard GPS. The GPS is accurate to 100ns. This high accuracy GPS is also necessary to maintain highly accurate phase angle measurements on both the primary sensor and advanced revenue meter. Testing has shown the angular accuracy corresponds to +/- 5 minutes, or +/- 0.083 degrees.

The primary sensor uses an industrial version of Bluetooth wireless technology for its communication port. Bluetooth is based on a 2.5GHz spread spectrum radio frequency. It has low power consumption and provides the necessary range for wireless communications within a HV substation environment.

Bluetooth is an encrypted, highly directional, wireless media ideal for short range communications up to 300m line of sight.

The following sections describe in detail the split-core active CT, the self powering mechanism and the live-line installation methodology.

### B. ACTIVE CT

The primary sensor employs a unique split-core (clamp-on), actively compensated zero flux current transformer[1]. This active CT accurately transforms the high primary transmission line current to a lower level signal suitable for GPS synchronized high-resolution analog-to-digital conversion and subsequent digital signal processing.

Conventional split-core CTs, while providing the convenience afforded through ease of installation, typically suffer from ratio and phase errors that would prevent their use in high accuracy, IEEE Std. C57.13 class 0.3 metering applications[2]. The act of “splitting” a conventional toroidal CT results in degraded accuracy through a reduction in effective permeability and increased leakage flux. The limited performance of a conventional split-core CT is highly dependent on the mechanical accuracy and repeatable alignment of the mating core surfaces. Active compensation effectively removes these sources of error and results in a split-core CT having a higher ultimate accuracy over a wider dynamic current range than conventional metering IEEE Std. C57.13 class 0.3 “non-split” toroidal core CTs.

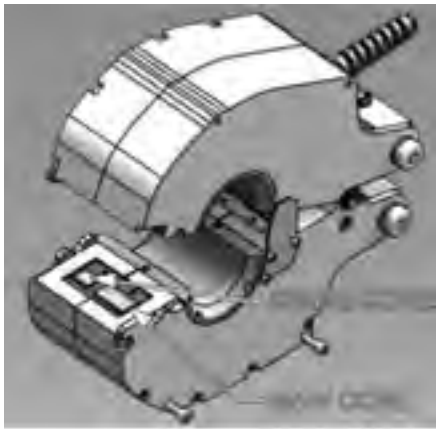

Fig. 3. Open primary sensor CT

The active CT of the primary sensor employs two magnetic cores: the main core and the sense core. Both cores are magnetically linked through a single turn to the transmission line conductor. Fig. 3 shows the active CT in an opened condition with the main and sense cores clearly visible. When closed, the two cores are

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# Reclassification

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precisely mated and form two independent toroidal magnetic circuits.

The main CT secondary winding is wound with N turns positioned over both the main and sense cores. The sense winding, also having N turns, is wound over and magnetically linked to only the sense core. The number of turns N is set to provide the desired current transformer division ratio, with 200 being chosen for primary transmission line currents of 1000 Amps RMS. This establishes a 1000:5 A overall ratio. Fig. 4 represents the block diagram schematic of the operation of the active CT within the primary sensor.

AC current Ip flowing in the transmission line conductor induces a time varying magnetic flux in both the sense and main magnetic cores that, through transformer action, induces a secondary current flowing through burden resistor RB1.

Without active compensation, the actual secondary current would be displaced in both amplitude and phase from the ideal division ratio N due to the complex magnetization current Imag required by the main core. The effect of having a complex magnetization current results in current transformer ratio and phase errors. The reduction in complex magnetization current, to produce higher accuracy is typically achieved in conventional current transformers through the use of higher permeability and lower loss core materials.

The sense core secondary winding is differentially connected to the input of a sense amplifier such that the amplifier output is driven to produce a compensation current Icomp in order to maintain the AC output of the sense winding at zero volts. Maintaining a zero output voltage across the sense winding corresponds to having a zero AC flux condition in the sense core. Zero flux operation of the sense core results in essentially lossless transformer operation which, in turn, provides near perfect ampere-turn balance between the transmission line conductor single turn and the CT secondary winding of N turns. The sense amplifier output compensation current Icomp essentially works to reintroduce the missing complex magnetization current Imag to the CT secondary circuit. The entire primary

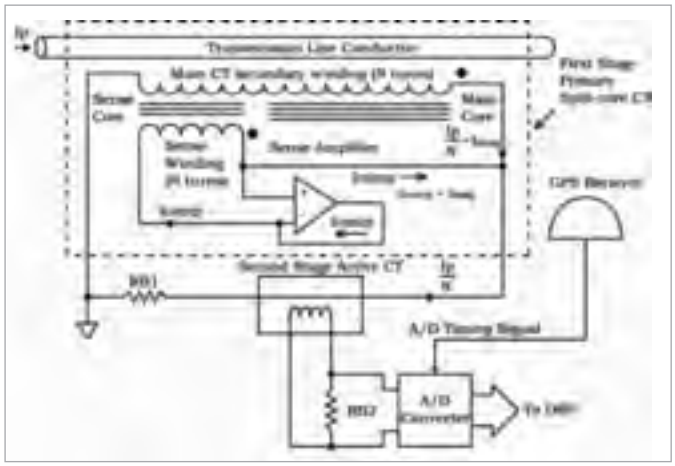

Fig. 4. Primary sensor block diagram schematic

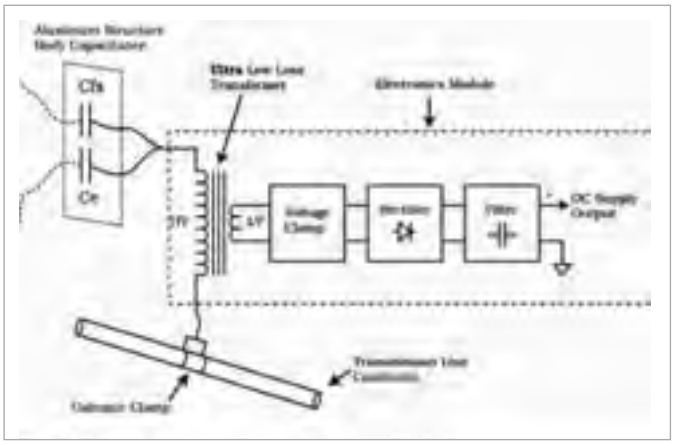

Fig. 5. Primary sensor self-powering circuit block diagram

Fig. 6. Live line installation of the primary sensor from a two-person bucket truck on a 138 kV line.

CT may be considered to operate in a primary to secondary ampere-turn balanced condition with energy losses of the main core replaced by the active sense amplifier electronics.

The main core operating flux level, as in the case of a conventional CT, is established by the transmission line current Ip and the value of burden resistor RB1. Burden resistor RB1 is a very low value due to the fact that the first stage primary CT is in close physical proximity with the second stage active CT.

Burden resistor RB1 is essentially determined by the short interconnecting wires and winding impedance and allows a smaller main core for a particular operating current range.

The secondary output of the primary CT is coupled to an electronically compensated second stage active CT of the continuous core variety which functions identically to the previously described primary CT operation in order to eliminate ratio and phase errors. The secondary stage active CT further ratio-metrically reduces the high transmission line conductor currents to a lower level signal that provides an accurate voltage representation across second stage precision burden resistor RB2. The voltage developed across RB2 is digitized in GPS synchronized real-time at 128 samples-per-cycle by the A/D converter, the output of which is processed by the internal digital signal processor in order to provide data for RMS current signal and phase.

### C. SELF-POWERING

The primary sensor employs a unique electric field-based powering system that draws energy from the high voltage transmission line potential. It provides continuous operation at all transmission line current levels (including

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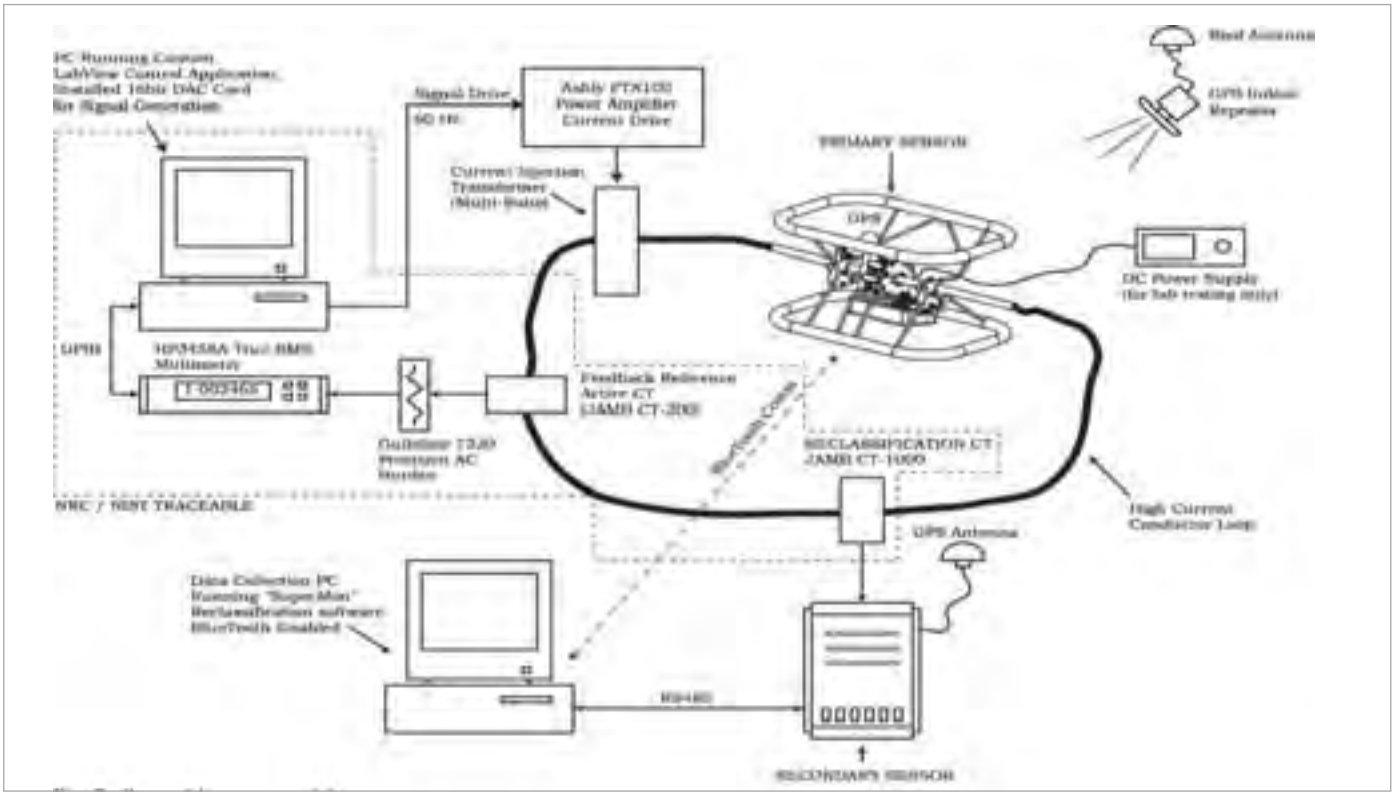


Fig. 7. Power Measurement laboratory test setup

# Reclassification

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zero), thus allowing the primary sensor to operate over a very wide dynamic range. Continuous operation is completely independent of transmission line current. Long term power supply reliability is ensured through the inherent simplicity of operation without the use of any energy storage devices such as batteries or solar panels.

The self-powering elements of the primary sensor are illustrated in Fig 2 in part II, section A of this paper. A tubular aluminum structure is positioned over and galvanically insulated from the transmission line through two insulated support clamps. The aluminum structure functions to provide corona protection while additionally providing a finite body capacitance through which a small AC current can flow.

Fig. 5 illustrates a block diagram representation of the self-powering circuit. The aluminum structure body capacitance is composed of a free space capacitance Cfs and an environmental capacitance Ce. The environmental capacitance Ce is a complex function of line-to-earth and line-to-line capacitances having net effect of adding to the total body capacitance. A typical value of total body capacitance would be 30 pF.

A galvanic clamp provides connection between the transmission line conductor and one side of the high voltage primary winding of an ultra low-loss high ratio transformer. The other side of the high voltage primary winding is bonded to the aluminum structure frame. A small 60 Hz AC current flows through the primary winding with ultimate high voltage build-up limited by the secondary side voltage clamp arrangement.

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# Reclassification

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The low voltage secondary output is rectified and filtered to provide a DC supply output voltage. Output power is a function of the aluminum structure body capacitance, transformer characteristics, transmission line potential, and electric field effects due to a particular installation position.

At 138 kV transmission line potential, the power supply provides a minimum of 2.5 W of power which is more than sufficient to operate the internal DSP, Bluetooth communication radio frequency link, GPS receiver, and primary sensor active CT compensation circuitry.



### D. LIVE LINE DEPLOYMENT

The primary sensor is designed to be installed and removed from an HV transmission line or bus using live-line techniques. Fig. 6 shows crew in a two-person bucket truck installing the primary sensor on a live 138 kV bus. The primary sensor weighs approximately 17 kg and is deployed using two shotgun hot sticks. Each hot stick is locked onto the eye ring of one of the two bus clamps on the primary sensor. The primary sensor is then lifted vertically toward the bus, maintaining proper clearances at all times. With the split-core CT open, the physical design of the primary sensor allows it to be guided easily into place, mounting it on the bus. Using the hot sticks, the two bus clamps are then screwed closed by turning the eye rings, securing the primary sensor to the bus. Once the primary sensor is secure on the bus, one hot stick holds the primary sensor steady while the other hot stick is used to screw the split-core CT mechanism closed. The unit can be installed in less than 10 minutes. Line crews performing the installation must be properly trained in live-line work and understand the necessary safety issues when operating equipment in a live, HV substation environment.

## III. TESTING AND DATA ANALYSIS

At the Power Measurement facility in Victoria, BC, Canada, the CT reclassification system has been thoroughly tested. Results are provided from the accuracy testing of the primary sensor and the overall system performance. Further system testing and analysis is also being performed at the utility laboratory of National Grid, USA Service Company in Syracuse, NY.

### A. LABORATORY TESTING

Laboratory accuracy testing of the CT reclassification system involved quantifying the overall end-to-end accuracy performance through in-circuit live current injection operation.

Establishing the limits of performance was made by attempting the reclassification of a precision JAMB Industries CT1000 electronically compensated reference current transformer.

The CT1000 current transformer offers ratio and phase error performance far exceeding the primary sensor and

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Areva T&D is investing in environmental friendly solutions for its medium- and high-voltage circuit breaker equipment.

# AREVA T&D RESEARCH AND DEVELOPMENT EXPLORES NEW TERRITORY FOR HIGH-VOLTAGE PRODUCTS

*Editor's Note:* In our July/August issue, we inadvertently ran an incorrect version of our Interview with Christian Lindner, VP, R&D, high-voltage products for Areva T&D. There were many textual and factual errors in the version that was published and we deeply regret this embarrassment to Areva T&D in general and Mr. Lindner in particular. With that said, we are printing here the correct version of the interview.

Following recent changes in the transmission and distribution industry, product development trends have emerged which better consider environmental aspects including the reduction of SF6 losses to the atmosphere, the elimination of dangerous substances and noise and visual impact.

Through an Eco-Design initiative, Areva T&D is investing its research and development these days in the area of more environmentally friendly solutions for high-voltage circuit breaker equipment, according to Christian Lindner, VP R&D high-voltage products for Areva T&D.

Mr. Lindner was frank about Areva T&D's "environmentally friendly" approach to high-voltage circuit breaker product development.

At the last CIGRE conference "Areva introduced a new switching principle to reduce the quantity of SF6 gas in high-voltage circuit breakers where we separate the interruption of current from the interruption of voltage. We have separated these two functions within the same device and by doing this, we suspect that we can reduce SF6 gas by a factor of 2," he explained.

"SF6 gas has excellent properties which enable us to build very compact designs. Although the T&D industry has not yet found economically feasible alternatives to the use of SF6 gas in

**Continued on Page 28**

# Reclassification

**Continued from Page 20**

secondary sensor accuracy capability. Any error measured may therefore be considered due to the combined performance of the primary and secondary sensors with the exclusion of the CT under test, the CT1000.

Fig. 7 illustrates the laboratory test set up at the Power Measurement facility. A custom PC-based control PID algorithm, developed using Labview™ software provides stable and precise control of a closed high-current, single-conductor loop that is routed through the primary sensor and the CT under test. This effectively duplicates the actual live field scenario; however, without the presence of an actual energized HV transmission line conductor, the primary sensor must therefore be powered through an umbilical connection made to a mains-operated DC power supply.

The current loop and ancillary equipment was optimized for high accuracy within a defined current range, in this case below 150 A RMS. Previous high-current accuracy sweeps have shown that system accuracy only improves at higher levels of primary current. This is consistent with theory and the behavior of conventional current transformers.

The industry-standard requirements for instrument transformers, under IEEE Std C57.13-1993, were used to benchmark system performance. Accuracy class 0.3 defines limiting values of ratio correction factor (RCF) and phase angle for current transformers used in metering applications. Two test points are called out at 10% and 100% of rated current with the requirement that RCF and phase angle errors fall within the respective parallelogram limits, as shown in Fig. 8. Operating points below 10% are not defined.

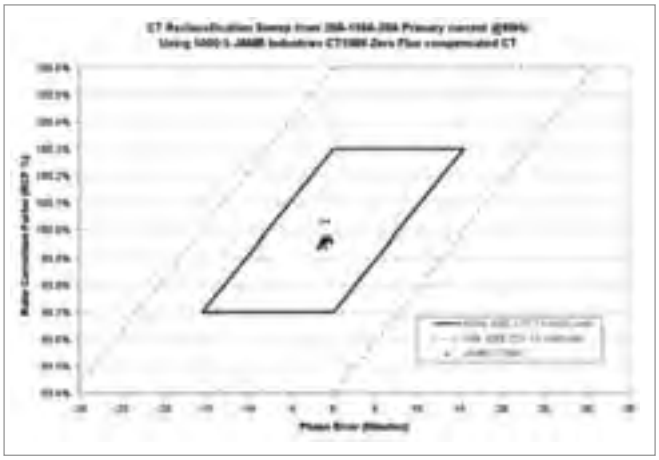

Fig. 8. Primary sensor accuracy performance test data

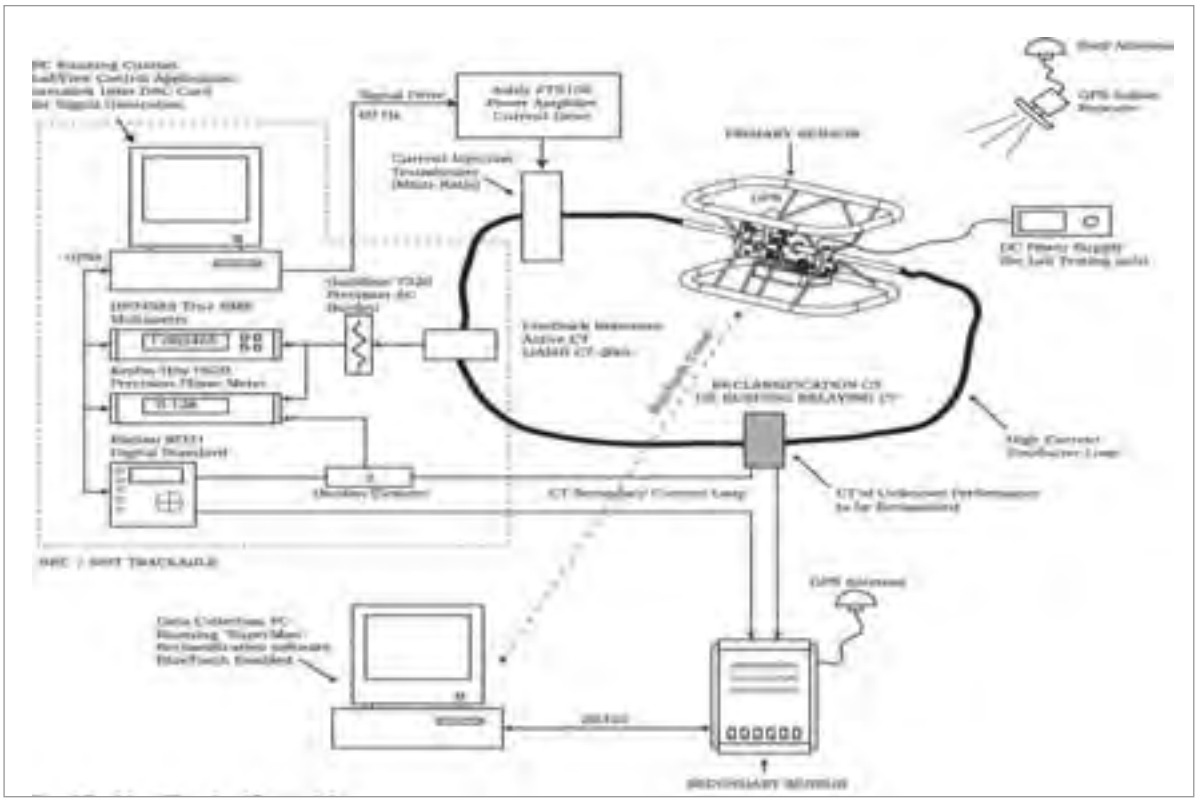

Fig. 9 Bushing CT reclassification laboratory test setup

A current sweep from 20-150-20 A RMS was chosen to test the end-to-end performance using the CT1000 5000:5 A reference CT. It should be noted that the 20 A RMS point represents 0.4% of full scale (5000 A) or a substantial 25 times lower than the IEEE Std. C57.13-1993 10% full scale test point.

A review of the actual test data shown in Fig. 8 clearly shows the overall high end-to-end performance of the combined primary and secondary sensor system. All RCF and phase angle error data points fall within a small area enclosed within the 100% IEEE Std. C57.13-1993 parallelogram limits.

The next step in the system evaluation involved the reclassification of a conventional, large core 1000:5 bushing CT removed from an oil-filled circuit breaker. The laboratory test setup was modified to allow two methods of reclas-

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# WATER, ELECTRICITY AND URGENCY DON'T MIX

By Jim Pauley, P.E., Vice-President, Industry and Government Relations
Square D/Schneider Electric North America

Nobody likes to be without electricity and the events with Hurricanes Katrina and Rita have only reinforced that point.

However, it is also equally true that people expect to have a safe system to distribute and control electricity. We know that electricity is dangerous, but we take for granted the wiring, protection, outlets and similar parts of the system used to get power from one point to another. We just expect it all to work.


Jim Pauley

With the flooding events brought on by the recent hurricanes, we tend to focus on the things we can see - the mud and muck in the streets, the mold and water marks on walls and furniture and the debris left in and on homes and buildings.

For the electrical part, our focus is on whether or not the utility company has been able to rebuild their system to restore power. They are working 24 hours a day to get the infrastructure back into shape to be able to supply the power we need to have lights, heat water and cook.

The question is whether we are neglecting what may need to be done within the home or building to make sure that electricity can be safely used.

During events such as a hurricane, the wiring within the walls as well as the electrical equipment itself has often been under water. Because of the equipment design and construction, you cannot just dry it out. In most cases, individual components or the entire electrical distribution system need to be replaced.

When restoring electrical power to a home or building, most states and cities have specific ordinances that restrict electrical power from being reconnected until an electrical inspection has been completed.

This inspection is aimed at ensuring that the installation is safe and that equipment and wiring meets the proper codes.

Of significant concern in the hurricane-ravaged areas is that power will be reconnected to homes and buildings in which the electrical wiring and equipment may have been damaged but the building itself may appear to be intact.

Electrical system damage may reveal itself immediately after turning on the power or it may sit silently and develop into a fire or shock hazard over time.

Everyone wants to get their power back, but doing so in a manner that creates a potential electrical hazard is not a good approach and may be highly dangerous.

Flood waters are especially damaging to electrical equipment. Dirt, chemicals, sewage and similar materials create an environment that attacks electrical parts, reduces needed clearances and corrodes critical elements of the system.

Typical problems include circuit breakers and fuses that no longer provide protection due to water damage, degraded insulating materials due to water absorption and damage to critical electronic devices such as ground-fault circuit interrupters.

Electrical wiring and equipment must be inspected before power is restored to individual structures. It is realized that there may not be enough electrical inspectors to get inspections done in a timely manner. To aid in this situation, the International Association of Electrical Inspectors based in Richardson, Texas has compiled a database of inspectors from around the country who are willing to take their time to travel to flood-ravaged areas and assist in the inspection process. More information can be found at www.iaei.org.

More information on how to handle flood-damaged electrical equipment can be obtained from the National Electrical Manufacturers Association at www.nema.org as well as from individual electrical equipment manufacturers.

Restoring power is an important part of getting an area back to "normal"; however electrical safety must be the driving force, not the speed of reconnection.

*Jim Pauley is an electrical engineer and a registered professional engineer.*

# SCADA SYSTEMS FOR VIRTUAL UTILITIES

By Yauheni Veryha, Department of Industrial IT Software and Applications, ABB Corporate Research

New trends of energy market facilitate formation of so-called "virtual utility", which is a group of united microgrids and similar entities. Virtual utilities aggregate distributed resources (i.e. microgrids, wind farms, fuel cells, etc) together to operate as a single, centralized energy system. In this paper, we present our vision of the future development, challenges and solutions for SCADA systems used to control virtual utilities. The upcoming changes in the energy market will create a demand for developing new network control technologies and improving existing ones for future use in virtual utility networks. SCADA systems for virtual utilities will have to manage and coordinate using advanced intelligence, communication and control means to maximize business value to network owners.

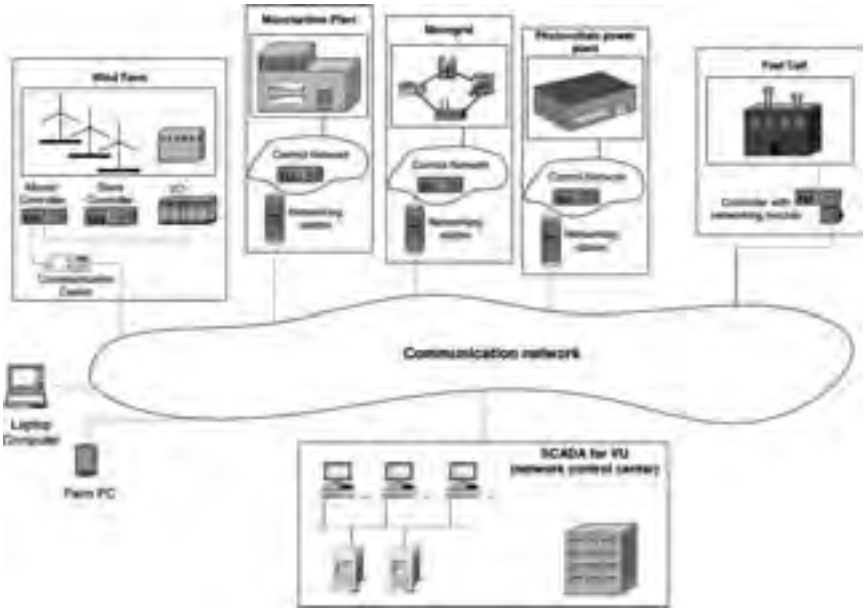


Fig. 1. An example of SCADA system for VU

## 1. INTRODUCTION

The structure of the world energy markets (power generation, transmission and distribution) is expected to change in the next decades. Some of the main impacts causing these changes are the following:

• Governments around the world have committed to cut greenhouse gas emissions (reduce CO2 emissions from future power generation) in line with the 1997 Kyoto Protocol on global warming.

• The European Union enforces the liberalization and deregulation of the European energy markets. The US market has been already liberalized.

• The energy mix in Europe and USA is changing:

- Renewable energies like wind, biomass, geothermal energy, solar energy, etc are gaining more and more market share;
- Emission trading will have a strong impact on future power generation, as the trend will be towards gas-fired power plants and renewable energy.

• The centralized, large plant power generation will continue to be the basis of power generation but decentralized, small to medium-size power generation will play a more and more important role.

• Electrical power consumers will also become producers, as excessive electrical energy will be fed in the power network. So-called "microgrids" will be formed. Microgrids are an "interconnection of small, modular generation to low voltage distribution systems" forming a new type of power system (Van Holde and Gregerson, 2002). Microgrids can be connected to the main power network or be operated autonomously, similar to power systems of physical islands. Microgrids are created by connecting a local group of small power generation units using technologies such as advanced sensoring, communications and control systems.

New trends facilitate the formation of so-called "virtual utilities" (VU). The VU is a group of aggregated microgrids and similar entities (Van Holde and Gregerson, 2002). The VU is the glue that holds the distributed resources together to operate as a single and centralized energy system. A network control systems, i.e. SCADA (Supervisory Control And Data Acquisition) systems, for VU should manage and coordinate all groups of microgrids and other similar entities united in the given VU. The main features of the SCADA system for VU include the intelligence, communication and control means which are able to maximize value to VU owners. An example of SCADA system for VU is shown in Fig. 1.

Hence, future energy market situation will create a demand for developing new network control technologies for VU networks that make wind power and other renewable energies economically attractive for both small-scale and large-scale solutions (Van Holde and Gregerson, 2002). It is of high importance that advanced software technologies for distributed systems, software standards and high-performance secure communication channels are built into SCADA systems for VU, making them easier to operate, maintain and make much more cost-effective and secure than conventional SCADA systems (Byres,

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2000; Coulouris, Dollimore and Kindberg, 1996; Jacobsen, 2005).

## 2. SCADA SYSTEMS FOR VIRTUAL UTILITIES

The hardware and software of SCADA systems for VU may not differ significantly from those of the conventional SCADA systems. The hardware architecture and software layers of SCADA systems for VU are shown accordingly in Fig. 2 and 3 (OS is the Operating System, COM is the Component Object Model of Microsoft and GUI is the Graphical User Interface). The integration platform in Fig. 3 is used to integrate all possible internal SCADA applications and external third-party SCADA applications for VU. A typical SCADA system for VU will also be able to analyze process data from I/Os (Inputs/Outputs) to identify if it matches pre-set alarm conditions, log the information into the history files used to produce management reports, send information to multiple remote sites to activate specific control functions, etc. In addition, a number of special SCADA applications designed for VU will have to be integrated into SCADA systems for VU:

· Advanced information management for VU (energy markets, emission trades, certificates, etc);

· Advanced modeling for VU (prediction, simulation and optimization);

· Advanced power management and monitoring for VU;

· Advanced power production technologies for VU (logistics, environmental issues, etc);

· Advanced power distribution technologies for VU (power quality management, energy storage, etc).

Using distributed control architecture in the SCADA system for VU, any remote site can be configured to perform a broad range of digital and analog monitoring and control operations.

Depending on its complexity, a computer network of the SCADA system for VU will consist of one or more computer systems with appropriate SCADA application software connected by a data communication medium to a number of distant process controllers placed at various locations to collect the data. The amount of information transmitted over a SCADA network may require higher bandwidth to communicate with remote nodes, thus, possibly requiring a data communication medium such as an Ethernet or wireless network, a public switched telephone network or the Internet to fulfill SCADA data transmission requirements.

The key requirements to SCADA systems for VU that differentiate them from conventional SCADA systems and, thus, should be appropriately handled are:

• Performance (Secure Intranet communication networks may be used to establish communication channels for control and data management. This may produce additional delays in data transfers.);

• Compatibility (Various control equipment and industrial communication protocols used in local microgrids and similar entities will have to support

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# SCADA

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some level of interoperability and compatible in order to be easily united in one VU network.);

• Security (The usage of Intranet, telemetry or other wide-area communication means may create a high vulnerability of SCADA systems for VU to external attacks from hackers (Bace, 2000; Steffen, 2005).);

• Robustness (In comparison to conventional SCADA systems, SCADA systems for VU will most likely extensively use wide-area communication networks. The probability of various errors in communication channels is quite high and should be appropriately handled.).

Typical user operations in SCADA systems for VU are shown in the use case diagram in Fig. 4. As one can see from use cases in Fig. 4, major user operations in SCADA system for VU do not differ significantly from those in conventional SCADA systems.

## 3. ARCHITECTURE AND SOFTWARE TECHNOLOGIES IN SCADA SYSTEMS FOR VU

Most likely, the software architecture of SCADA system for VU will be based on the concept of federated systems (concept of distributed system architecture in which process and application data from two or more separate control servers can be accessed from one client or server machine) or one of its modifications. Federated system concept has a goal to provide access to multiple, distributed remote nodes in an integrated environment, where data from different systems can be managed in a seamless, integrated manner (Benn, Chen and Gringer, 1996). On the first level of integration in federated system concept, system links will have to be established between remote nodes in the VU network. HMI (Human Machine Interface) components of SCADA system for VU will have to resolve these system links, get the corresponding data from the federated server or directly from remote nodes and visualize it appropriately. An example of such federated system software architecture of SCADA system for VU is shown in Fig. 5.

Key modules in the software archi-

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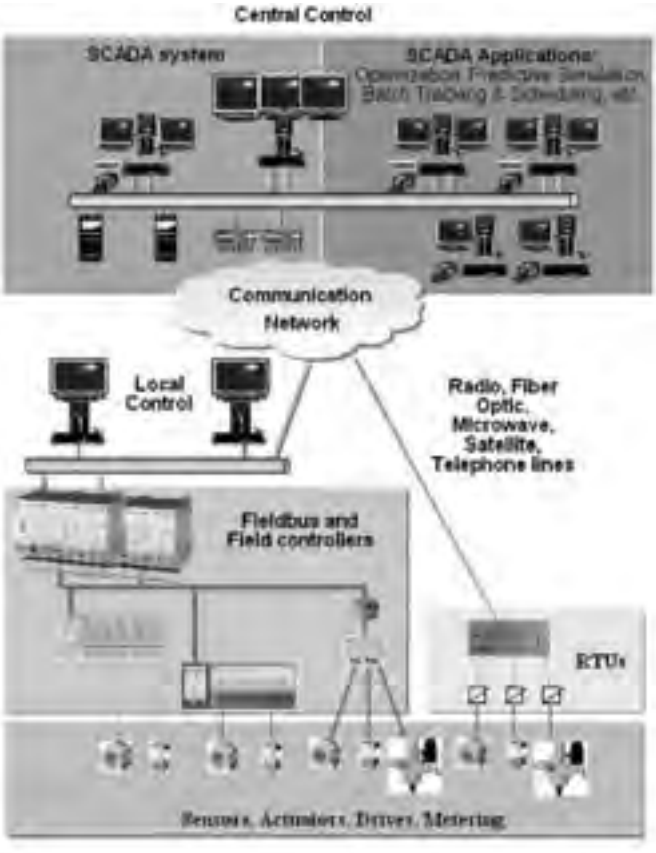


Fig. 2. Typical hardware architecture of the SCADA system for VU

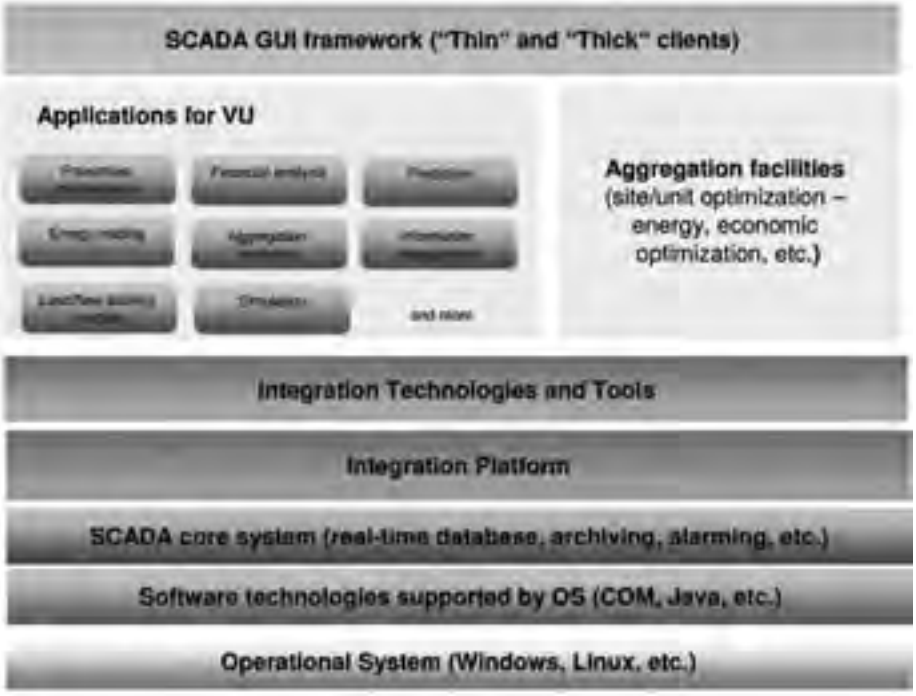


Fig. 3. Software layers of SCADA system for VU

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tecture of SCADA system for VU are those related to connectivities between master (federated server) and remote nodes. Remote node handlers (see Fig. 5), which are used to aggregate process data from various remote nodes for further processing on the federated SCADA server, will be most likely implemented using Web service technologies with the use of Microsoft .NET, Java or any other available frameworks for Web services.

A good candidate to standardize public interfaces for data exchange using Web Services is one of the newest OPC (OLE for Process Control, www.opcfoundation.org) standards - OPC XML DA (Data Access). It is expected that OPC XML DA will be widely supported by control applications in the future; at least as much as OPC DA is supported today (Iwanitz and Lange, 2002). Since Web services are widely accepted nowadays, it is not surprising that the newest OPC XML DA (Data Access) was designed to be easily implemented using Web Services (Iwanitz and Lange, 2002; OPC XML DA Specification, 2003).

To support Web Services, devices will have to support HTTP (HyperText Transfer Protocol) and XML (eXtended Markup Language). This means that OPC XML DA can be implemented on any device supporting HTTP and XML. Additionally, HTTP is firewall-friendly (from one side it is a benefit, but from the other side it means that one may require additional efforts to prevent intrusions) (Von Hoff and Crevatin, 2005). Firewall-friendliness of HTTP allows OPC XML DA to run over the Internet. The OPC XML DA interfaces (designed both for Intranet and Internet) can be used to provide standard data connectivity between remote nodes, master server and workstations.

If OPC XML DA will be used in SCADA systems for VU, then remote node data servers (see Fig. 5) can be simply implemented as OPC XML DA servers.

Web service can be defined as a collection of methods packaged as a single entity and published to the network for use by other software components and applications (Eckert, 2005; Hu and Kruse, 2005). The software market, including its main players, like Microsoft, IBM, Sun Microsystems, etc, strongly supports the development of Web services. At the moment there are no other alternative software technologies for interoperability on the market as mature and as widely acceptable as Web services (Barnaby, 2002; Kleines et al., 2002; Lowy, 2001; Peschke and Lueder, 2005). The externally accessible functionality of a Web service is described by a file written in a specific language WSDL (Web Service Description Language). WSDL defines only external behaviour of an application and is based on XML. Web services are platform independent and, thus, the internal implementation code of Web services can run on Windows, Linux, UNIX or any other operating system. Applications implementing or using Web services interact with each other by using the SOAP (Simple Object Access Protocol). SOAP combines XML so as to encapsulate messages in a format suitable for transmission using HTTP Internet protocol (Goeschka, 2005).

Web services, widely used to implement OPC XML DA, have their two main limitations, namely, performance and security (Anderson, 2001; Kruegel, 2005; Naedele, 2005;

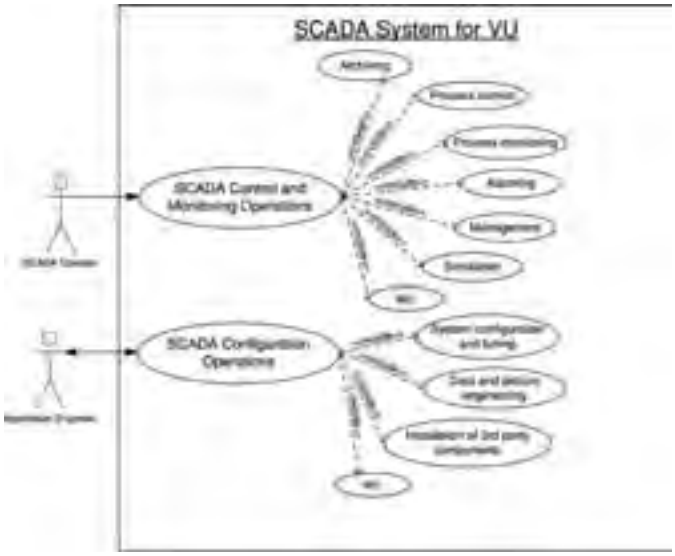


Fig. 4. Major use cases in the SCADA system for VU

Schwaiger and Sauter, 2001; Tanenbaum, 2002; Peschke and Lueder, 2005). We think that performance and security aspects of Web services will be crucial for wide acceptance of OPC XML DA in SCADA systems for Virtual Utilities. To provide high performance of Web services, one may use advanced caching mechanisms (client and server data caching). To pro-

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# Areva

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switchgear equipment, at AREVA T&D we are doing our best to minimize its emissions both through R&D efforts and organizational procedures. We also actively support a number of collective industry efforts to reduce the impact of SF6 gas on the environment," he said.

He suggested that while SF6 gas release is a big issue in the United States, it can easily be handled by incorporating new equipment or a new gasket.

Areva T&D signed voluntary agreements with national authorities to reduce the release of SF6 gas into the atmosphere.

Since Alstom sold its T&D division to Areva a couple of years ago, the Areva T&D R&D division has been focused on the continued development of the former Alstom products they inherited that will allow for the integration of new innovative technologies, especially communication-enabling technologies.

"Areva T&D is concentrating on 10 areas of high-voltage product innovation involving the integration of new ideas and new materials to make products lighter, less costly and with an increased life expectancy, and we believe that some of these innovations have the potential for transforming the T&D market," Mr. Lindner said.

Instrument transformers are a good example of this. Areva T&D now has the opportunity to make digital communications between different IEDs (intelligent electronic devices) from different suppliers. The idea is to allow Siemens equipment to talk with ABB equipment and Areva equipment as well as with the equipment of other manufacturers.

"For the customer, it is much easier to buy equipment from either manufacturer because of the ability for them to interact via this digital communication," he said.

"The implementation of guidelines for the new standard for communication in substations (IEC 61 850) that have been proposed by Areva, Siemens and ABB and presented at the last CIGRE conference in Paris is a demonstration between the three main competitors for the benefit of T&D customers," Mr. Lindner added.

## COMPOSITE OR PORCELAIN?

The issue of composite vs porcelain insulators has been a long-standing question around the world T&D marketplace for years. The use of composite insulators to replace porcelain insulators is another innovation that Areva T&D is currently working on. Composite insulators are already widely used in surge arresters and some medium-voltage equipment. In the case of high-voltage breakers, however, the adoption of composite materials has been less successful.

"Composite materials came to the high-voltage breaker market about 10 years ago but then there was strong competition from the porcelain manufacturers. They responded with much lower prices and, therefore, composite insulator material was less attractive. However, it appears today that composite material manufacturers are taking a "now or never" approach, making very economical proposals in terms of cost to replace porcelain," he suggested.

"I think there is a strong effort on the part of composite insulator suppliers to match the price of porcelain and there are some attractive benefits which you can exploit, like weight, the issue of cleaning and a lower degree of damage during transport," he said.

In the case of transformer bushings, 50 per cent of the market is porcelain and 50 per cent composite material because of the benefit of weight, cleaning and cost and the same thing can be applied to breakers.

"It's just been the cost that has disqualified composite materials in the last eight years. The benefits of weight and cleaning have not been as powerful as the benefit that porcelain has in terms of cost. In terms of innovation, there are more possibilities with composite materials (chemistry) than there are with porcelain and Areva T&D is exploring these innovative possibilities," Mr. Lindner said.

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## Areva

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One final area of discussion in our interview focused on the subject of product design.

Christian Lindner, VP, Research and Development, High-Voltage Products for AREVA T&D.

Areva T&D has been working on a way to simulate arc and thermal and dielectric recovery through scientific calculations. If this can be accomplished, it would lead to the replacement of costly power testing with scientific calculations.

"This would help us to reduce the number of tests that are necessary for the development of products through the use of computer simulation. It would make the design of products more accurate. This is a strong benefit to AREVA T&D in the development process by reducing the number of tests that are required during product design and development. The potential impact is fantastic but this is more long term. The CIGRE Study Committee A3 has recently created a working group to address this question. Areva T&D, together with the other main players in the T&D business will actively participate in this work with the aim to reduce developmental testing," Mr. Lindner concluded.

**Continued from page 27**

vide high security, one may use a combination of SSL (Socket Secure Layer) protocol as a transport-level security scheme and one of the following message-level security schemes:

- XML digital signature (http://www.w3.org/Signature);
- XML Encryption (http://www.w3.org/Encryption);
- XKMS (XML Key Management Specification) (http://www.w3.org/TR/xkms/);
- XACML (Extensible Access Control Markup Language) (http://www.oasisopen. org/committees/xacml/);
- SAML (Secure Assertion Markup Language) (http://oasis-open.org/committees/security);
- WS-Security (Web Services Security) (http://www.oasis-open.org/committees/wss/);
- Liberty Alliance Project (http://www.projectliberty.org).

## 4. SECURITY ISSUES IN SCADA SYSTEM FOR VU

The amount of information transmitted over a SCADA network may require high bandwidth data communication lines, such as an Ethernet, wireless network, a public switched telephone network or the Internet to fulfill the SCADA requirements. Traditional security assurances in such communication channels do not adequately protect against cyber attacks on SCADA systems in all cases. The following security guidelines should be taken into account during the design of SCADA systems for VU to provide high system security:

1. SCADA products should be evaluated based on the Common Criteria standards ISO/IEC 15408 to ensure the implementation of SCADA products does not compromise the security or safety of the critical infrastructure.

2. Isolate SCADA networks to a closed-loop network with limited and highly restrictive access from physical and electronic external sources.

3. Use segmented network topologies to increase the level of restrictive access and survivability.

4. Utilize authentication mechanisms such as passwords, tokens and biometrics to guard against unauthorized access. Enable encryption for all data communications. Perform vulnerabilities threat assessments on current and newly implemented system and network connectivity. It is essential that risk assessments be conducted on each interconnection between the SCADA system and corporate enterprise network.

3. Implement firewalls and intrusion detection systems to not only prevent entries but also monitor unintentional security breaches on the SCADA system and corporate enterprise network.

Another important aspect in SCADA systems for VU is the availability of high speed Wide Area Secure Network (WASN). It is important to have high-speed secure wide area network to enable high performance and security of SCADA system for VU.

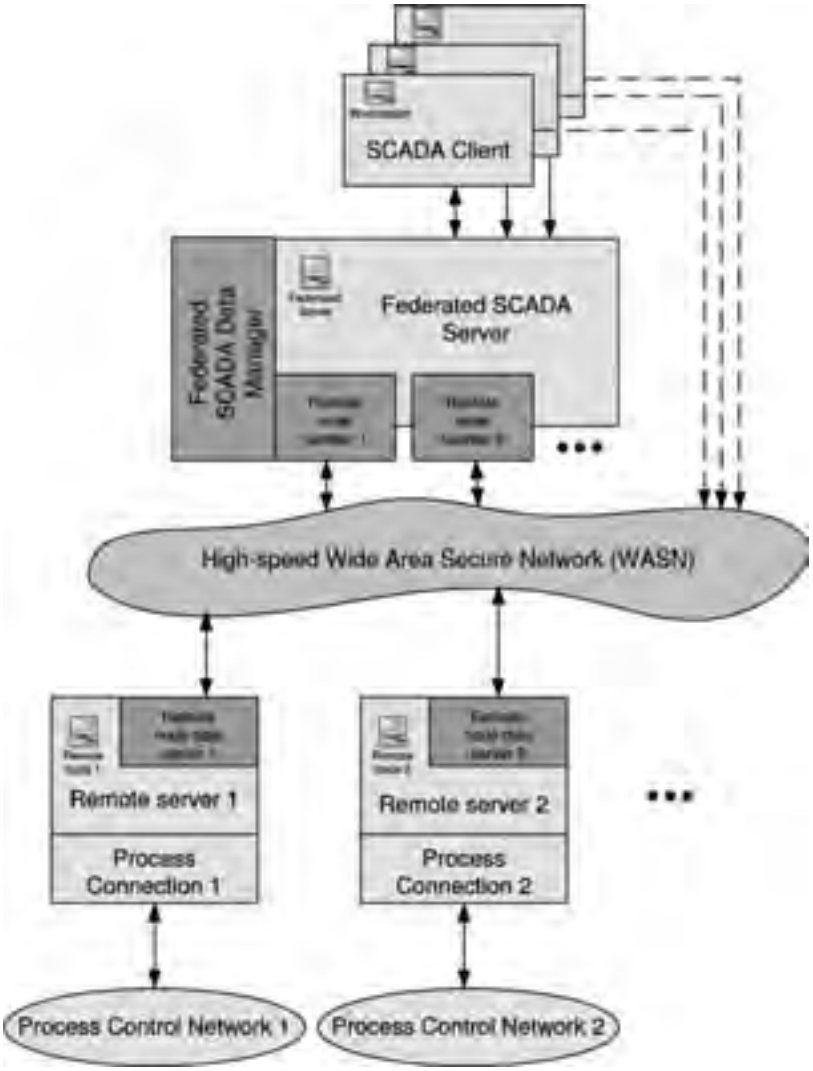


Fig. 5. An example of federated system software architecture of SCADA system for VU

## 5. CONCLUSION

Future energy market situation will create a demand for developing SCADA systems for VU networks that include wind power and other renewable, alternative energies becoming more and more economically attractive on the energy market. We showed that the successful integration and use of advanced software technologies for distributed control systems (secure Web services and federated systems), software standards (OPC XML DA) and secure communication channels (high-performance wide area secure networks) in SCADA systems for VU will play an important role in next years. The realization of security and performance aspects will make SCADA systems for VU much more cost-effective, stable and secure.

ClearSCADA Correction:
The second last paragraph in the article on ClearScada in Issue 6 of Electricity Today should read DNP3, not PNP3.

# EPRI'S NUCLEAR FUEL CLEANING TECHNOLOGY RECEIVES R&D 100 AWARD

The Electric Power Research Institute (EPRI), three member companies, AmerenUE, Exelon Corp., and South Texas Project Nuclear Operating Co., have earned a prestigious 2005 R&D 100 Award for ultrasonic cleaning of nuclear fuel, a promising new technology that safely removes deposits from irradiated fuel assemblies in nuclear power plants.

Dominion Engineering, Inc. (DEI) also earned an award.

The annual awards are given by R&D Magazine for the most outstanding technology developments with commercial potential.

"The future of the energy industry relies on pursuing innovative technologies that advance efficient, reliable and environmentally sensitive power generation and transmission," said EPRI CEO Steven R. Specker. "I applaud our team and member companies for their contribution towards this end."

The technology awarded delivers a patented process for removing corrosion products deposited on irradiated nuclear fuel pins using a unique form of ultrasonic technology. The technology was first applied at their nuclear power plants by the three EPRI member companies noted above, using equipment supplied by DEI.

"We were pleased to hear that our technology received an R&D Award," said Christopher J. Wood, a technical manager in EPRI's Nuclear Sector. "This breakthrough technology allows the full potential of current nuclear fuel designs to be achieved while maintaining excellent fuel reliability. Availability of a safe, reliable cleaning technology will also now allow utilities to further optimize fuel performance, core design, and reduce radiation fields and electricity generating costs."

This unique technology, developed in EPRI's Fuel Reliability Program, solves a significant emerging problem by removing deposits from nuclear fuel assemblies in nuclear power plants. Enhancing the performance of nuclear fuel is crucial to continue the improvement in electricity production from nuclear units. Over the past decade, nuclear power production has increased by over 20 percent, but this has placed additional demands on the fuel, as fuel temperatures have increased.

> **"We were pleased to hear that our technology received an R&D Award."**
>
> *- Christopher J. Wood, a technical manager in EPRI's Nuclear Sector*

Some of the potential problems with fuel reliability result from the buildup of deposits on the surfaces of the fuel elements, which produces an insulating layer that could result in corrosion of the fuel cladding material at increased fuel pin temperatures. Until EPRI's developed technology, there was no effective way of removing these deposits during the working life of the fuel. Including early development demonstrations, this ultrasonic fuel cleaning technology has been used successfully eight times at nuclear power plants in the USA through 2004, and has been licensed worldwide.

Seven additional commercial applications have taken place in 2005, including one in Spain. The technology used cleans all the fuel elements in every fuel assembly without any adverse effects. The cleaning process does not extend the schedule of routine refueling outages, and is very cost-effective in pressurized water reactors. It is expected to result in a major reduction in radiation fields in boiling water reactors.

The Electric Power Research Institute (EPRI), with major locations in Palo Alto, California, and Charlotte, North Carolina, was established in 1973 as an independent, nonprofit center for public interest energy and environmental research.

# RECORD NUMBERS TURN OUT FOR DEMO EXPO

The 2005 International Construction and Utility Equipment Exposition (ICUEE) attracted more than 16,400 industry professionals - its highest recorded attendance in show history. ICUEE 2005 was held September 27-29, 2005 at the Kentucky Fair and Exposition Center in Louisville, Kentucky.


Known as the Demo Expo, the show featured more than 800 exhibitors and more than 1.113 million net square feet of exhibit space, where attendees could operate equipment in demonstrations simulating real-life working conditions. An extensive education program complemented displays of the latest equipment technology and product innovations.

"Attendees came to see what's new and to test, compare and buy the equipment, products and services they need to enhance worksite performance and productivity," stated ICUEE Show Manager Nicole Hallada.

The 2005 ICUEE attendance topped the previous record reached in 1999 of 14,841 attendees, and was almost 20 percent higher than attendance at the last ICUEE, held in 2003 (13,698 attendees).

ICUEE 2005 attendees came from all industry segments, and more than 5 percent were international visitors, representing more than 40 countries. ICUEE targets electric, sewer/water, phone/cable, gas, general construction, government and landscaping industry professionals.

ICUEE 2005 provided attendees with more than triple the amount of education offered at the last show, and included the co-location of a special Underground Construction Technology (UCT) educational program. Industry experts examined the latest technological trends and operational issues affecting the utility and construction industry.

"We received very positive feedback from attendees on the value of these sessions, which they said was definitely worth their time," noted Hallada.

## ONTARIO POWER AUTHORITY BEGINS PROCUREMENT PROCESSES FOR FUTURE POWER RESOURCES

Ontario Power Authority (OPA) will begin processes for procuring additional electricity resources for the province.

OPA's first initiative will be a Request for Proposals (RFP) for 20 MW of innovative and aggressive demand response projects in the northern York Region. This procurement process relates to preliminary recommendations of the OPA, announced on September 9, which addressed the need for conservation and electric generation in the northern York Region. This RFP will be the first phase of a province-wide 250 MW demand side management and/or demand response initiative. Additional RFPs for conservation, demand management and/or demand response programs elsewhere in Ontario, will be rolled out over the next few months.

OPA also announced the commencement of two additional electricity procurement initiatives:

• Procurement of up to 1,000 MW of high efficiency Combined Heat and Power projects, also known as "Cogeneration" projects. A workshop was held on September 28 for project proponents and other stakeholders interested in the development of cogeneration, district energy and Combined Heat and Power Projects.

• A Request for Qualifications (RFQ) for 1000MW of electricity generation in the Greater Toronto Area, west of Toronto. This RFQ will be launched after consulting with the affected municipalities.

"We will be energizing the procurement processes fairly quickly," stated Paul Bradley, Vice-President of Generation Development at the OPA. "In July, we asked our stakeholders for their views on how to streamline the process. It was a very useful consultation and one that has given us momentum into what will be a very busy fall.

"We certainly learned that communication is key," said Bradley. To kick-off its procurement initiatives, the OPA had a public conference call for all interested parties on September 23. "This is only the first of many open calls to discuss issues and questions about initiatives the OPA has been directed to execute."

Stakeholders interested in these procurement initiatives can find information and documents posted on www.ontario-electricityrfp.ca.

## SEL GIVES DISASTER DISCOUNT TO CUSTOMERS WITH HURRICANE KATRINA DAMAGE AND MAKES $100,000 DONATION TO AMERICAN RED CROSS

After witnessing the devastation to much of the Southeast United States following Hurricane Katrina, Schweitzer Engineering Laboratories Inc. (SEL) is increasing its existing disaster discount, offering 30-50 percent off list price, depending on product type.

On a day-to-day basis, it's easy to take for granted the convenience of electric power, but during a disaster like Hurricane Katrina, electric power is not just convenient - it is critical. Hospitals, fire stations, and medical clinics need electric power to care for the sick and injured. Fresh water and food supplies depend on the availability of electric power. SEL recognizes the extraordinary challenges created by a natural disaster, and wants to assist in the quick and safe restoration of electric power.

SEL is also providing a $100,000 donation to the American Red Cross to help in the relief effort, and many of SEL's more than 1000 employees are personally donating to these efforts.

# Reclassification

**Continued from Page 22**

sification in order to compare the accuracy of the complete reclassification method. Fig. 9 details the modified test setup. A Krohn-Hite 6620 precision phase meter and a Radian RD21 digital standard were added to the bushing CT secondary current loop in order to provide highly accurate RCF and phase angle error measurement data independent of the CT reclassification system.

An accurate burden impedance, Z = 3 ohms, was inserted in series with the bushing CT secondary in order to approximate a typical field value in a relaying circuit.

The performance characteristics of the 1000:5 bushing CT over the 20-150-20 A RMS current range is illustrated in Fig. 10. It is readily apparent that the bushing CT is not ANSI class 0.3 compliant at the 10% (100 Arms) test point with performance rapidly degrading in accuracy at the lower current levels down to 20 A RMS. The data points generated by the two measurement methods agree closely in trend and are, in fact, shifted by only 0.05% RCF. Fig. 11 and Fig. 12, respectively, show another representation of the same data, representing RCF versus current and phase angle error versus current. This RCF and phase angle error data is then averaged and used to program the ION 8500 advanced revenue meter. The error correction parameters are programmed into the instrument transformer correction (ITC) module of the ION 8500 in order to compensate for the inherent error from the bushing CT and effectively provide improved overall metering system accuracy.

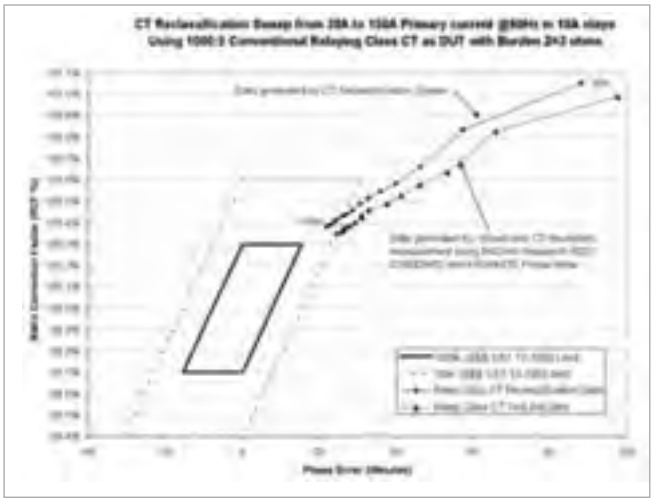

Fig. 10 Reclassification of a relay-class bushing CT

### B. SYSTEM TESTING RESULTS

The bushing CT RCF and phase angle error parameters, as determined

**Continued on Page 35**

"High-resistance grounding for low voltage power distribution systems enhances reliability and uptime of power distribution equipment and is proven effective in significantly reducing the frequency and severity of arc flash accidents"

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IPC

Continued from Page 33

through the laboratory testing, were programmed into ITC module of an ION 8500 advanced revenue meter.

The laboratory test setup was modified to include a stable voltage source generated from a second 16-bit DAC channel and amplified to a 60 Hz, 120 VAC RMS level. A Krohn-Hite 6620 phase meter was used to establish a precise 0.6 lagging power factor between the reference current loop and voltage signals. An accurate Radian Research RD21 was connected in series (current) and parallel (voltage) with the ION 8500 meter. Timed energy tests were performed with and without ITC applied. The Radian RD21 digital standard was used to compare timed watt-hour energy results with those recorded by the ION 8500 meter. The results are summarized in Table I.

The results show that with the ITC parameters applied in the ION 8500, the overall system accuracy for the CT under test improves dramatically and meets the IEEE Std. C57.13 class 0.3 requirements for revenue metering applications.

TABLE I
COMPARISON OF ACCURACY RESULTS FOR MEASURED ENERGY BETWEEN AN ION 8500 AND A RADIAN RD 21 WITH AND WITHOUT INSTRUMENT TRANSFORMER CORRECTION (ITC) APPLIED.

| Voltage V RMS | Current A RMS | Power Factor | Error(%) Without ITC | Error(%) With ITC |
|---|---|---|---|---|
| 120 | 20 | unity | -0.92% | -0.017 |
| 120 | 20 | 0.6 lagging | 1.63 | -0.10 |
| 120 | 50 | 0.6 lagging | 0.89 | -0.003 |
| 120 | 100 | 0.6 lagging | 0.65 | 0.056 |
| 120 | 150 | 0.6 lagging | 0.55 | 0.067 |

## C. OPERATIONAL BOUNDARY CONDITIONS

Extensive testing at the National Grid, USA Service Company engineering laboratories, in Syracuse, NY, USA was performed on instrument transformer correction, specifically Fig. 12. Phase angle error versus current for a relay-class bushing CT researching the variables affecting ratio and phase angle error correction factors. Historically, the RCF and phase angle error equations have been used by choosing constant compensation factors to correct for magnitude errors and phase angle errors.

These errors are typically provided by the CT transfer function when processing its primary input current, or the measure and to secondary output current, or its representative measurement. However, this work recognizes that, theoretically, these RCF and phase angle error equations can be mathematically modeled as functions of operational variables, to whatever degree of accuracy is required by the application. When these equations are coupled with well planned and proven operating boundary conditions, the resulting error correction capabilities are significant, as illustrated in the testing results in this paper.

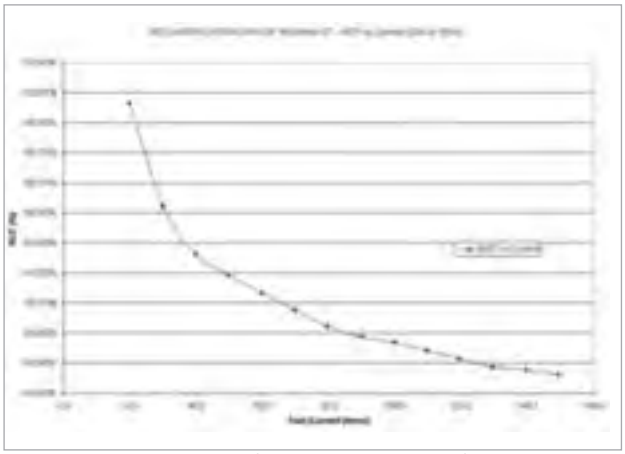

Fig. 11. Ratio correction factor versus current for a relay-class bushing CT.

Testing performed at National Grid, USA Service Company showed that there are two key operational variables that have the most significant effect on RCF and phase angle error: percent primary current and the amount of the secondary burden on the CT under test. However, any additional, potentially significant, variables need to be monitored and bounded. For example, the operational temperature and humidity must be maintained to comply with the CT manufacturers specifications.

In addition the percent harmonic distortion of the primary voltage variable must be maintained to meet IEEE 519-1992, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems limits[3]. While the temperature and humidity boundary conditions are easily monitored, the harmonic distortion is based on the CT's transfer function frequency response performance. Furthermore, harmonic distortion is indirectly linked to the overall measurement system's ability to accurately measure power in the presence of harmonic distortion.

Theoretically, the RCF and phase angle errors correction factors could model and compensate for the variance of temperature, humidity and harmonic distortion, however, the practical complexity of these compensation equations increases substantially and is believed to be unnecessary as long as the operational boundary conditions are well understood and enforced. That is, RCF and phase angle error correction algorithms can be applied successfully when operating within the specified boundary conditions and automatically disabled if the conditions are exceeded. The advanced revenue meter programmed with the RCF and phase angle errors must have the ability to dynamically apply the correction factors knowing the set boundaries and the live operating conditions in real-time.

For example, once the RCF and phase angle error equations are derived for a specific secondary CT burden, this burden must be quarantined. The burden must be effectively monitored and, if changed, the RCF and phase angle error equations must be re-calculated in order to re-tune the circuit.

Therefore, if the operational boundary condition ranges are well defined, monitored and maintained, the complexity of the RCF and phase angle error correction algorithms can be minimized, effectively maximizing the accuracy and reliability of the reclassified CT and metering system.

## IV. EVALUATION SITES

Along with extensive laboratory testing to prove the technical capabilities of CT reclassification, field testing was performed to further test the accuracy and performance of the CT reclassification system. BC Hydro and BC Transmission Company, located in Vancouver, British Columbia, Canada provided the first evaluation site. Live line, high voltage testing was performed at BC Hydro's Goward 138 kV substation in Victoria, British Columbia, Canada. This evaluation system provided a live HV environment to test the reclassification concept. Field testing started February 2005.

Continued on Page 37

# NEW HEADQUARTERS STRESSES ENERGY EFFICIENCY

Manitoba Hydro today unveiled the final design for the corporation's new, $188 million world-class energy efficient headquarters to meet Hydro's current and future business needs while serving as a model for highly energy-efficient building design and operation.

"Along with being a model for energy efficiency and a source of pride for Manitobans, Manitoba Hydro's new office building will be the next pillar in the revitalization of Winnipeg's downtown, bringing approximately 2,000 people to the city's downtown," said Premier Gary Doer. "Along with Red River College's Princess Avenue campus and the MTS Centre, this new building is a continuation of the positive momentum and growth that is underway in our city."

The 22-storey building will encompass approximately 690,000 square feet, including public, retail, commercial and Manitoba Hydro office space. It will include the areas required to achieve the building's energy reduction target of 60 per cent – which would make it one of the most energy efficient buildings in the world.

The design incorporates a splayed twin office tower resting on a podium that varies from two to three storeys, effectively marrying a large building mass with street level scale.

Energy efficiencies include:

- a geothermal heat pump system (extracting heat from the ground in the winter, returning it to the ground in warmer temperatures),
- a living "green" roof with mosses, grasses and lichens,
- atriums to provide conditioned fresh air,
- a solar chimney to enhance fresh air ventilation,
- windows designed to maximize daylight and reduce artificial lighting,
- energy efficient lighting, pumps and drives, and
- a double external wall to reduce heating and cooling requirements in extreme temperatures.


Progress of construction at the site can be seen on Manitoba Hydro's website

The building's form and orientation optimizes passive systems for ventilation, heating and cooling, contributing to the building's world class energy efficiency and a healthy, productive workplace. The building will be connected to the downtown elevated walkway system and provides street level retail activity, as well as offering a landscaped public courtyard on its southern exposure along Graham Avenue.

"The design successfully meets our objectives," stated Bob Brennan, Manitoba Hydro President and CEO. "It provides a healthy, productive and creative workplace for our employees and the building will be a world class model of energy efficiency and sustainability, while enhancing the urban environment and economy of downtown Winnipeg."

The new, state-of-the-art office building is being constructed in downtown Winnipeg on a site that fills an entire city block on the south side of Portage Avenue between Edmonton and Carlton streets and extending south to Graham Avenue. The new building, which was part of Manitoba Hydro's agreement to purchase Winnipeg Hydro, will cost $188 million to construct. The development of the project will total $258 million, which also includes such costs as modernizing Hydro's information technology and security systems, pedestrian bridge linkage, insurance, design work and capital interest.

The new headquarters will also save the corporation $15 million in annual operating costs. Included in this total is approximately $7 million in annual lease costs the corporation will save by amalgamating 12 leased Hydro offices into one location. The remainder of the savings will be realized through enhanced energy efficiencies, productivity improvements, co-location of employees and other design features.

"Manitoba Hydro will contribute greatly to the skyline of our emerging downtown," said Mayor Sam Katz. "The heart of our city is undergoing a renaissance and I applaud the commitment that Manitoba Hydro has made in keeping our momentum moving forward."

Completion is scheduled for 2007.

**ET**

# Reclassification

**Continued from Page 35**

Within this BC Hydro substation, the evaluation point was a 3-phase circuit breaker on a 138 kV line. The circuit breaker contains relay-class current transformers rated for a nominal current input of 800 A. The secondary wiring of the relay class CTs are connected to a variety of protective relaying devices located in the substation building.

The 138 kV line where the CTs under test are located experiences current flow in both directions. This line is connected to generation stations downstream. The generation operates part time and, as a result, the current flow direction changes to accommodate the load change.

The evaluation site has a complete CT reclassification system installed. The ION 8500 advanced revenue meter was located in the substation building in a switchboard case that was connected to the secondary wiring of the three relay-class CTs under test in series with existing protective relaying equipment.

The data collection computer was also located in the substation building. This computer runs software that continuously collects measurement data from the secondary sensor and three primary sensors.

Three primary sensors were installed on the 138 kV high voltage line in close proximity to the breaker and in series with the relay-class CTs within the breaker.

As the first evaluation site, this location provided proof of end-to-end system operation. The validation of the complete system operation includes several key points. The wireless Bluetooth communications between the primary sensor and data collection software is reliable in the HV substation environment. Test results show that even with large equipment such as power transformers, in the line of sight of the wireless communications, Bluetooth is reliable and signal levels are strong. The self-powering mechanism of the device provided substantial power, ranging from 2.8 W on phase A bus to 3.6 W on phase C bus depending on the proximity of other conductors which affects the electric field strength.

Live line installation methods used to install the primary sensors on the high voltage lines were tested several times. The device was designed for easy installation and line crews from BC Hydro confirmed that a set of three primary sensors could be installed in less than 30 minutes. Further evaluation sites are scheduled for the second quarter of 2005 with National Grid, USA Service Company in Syracuse, New York, USA and Georgia Power in Columbus, Georgia, USA.

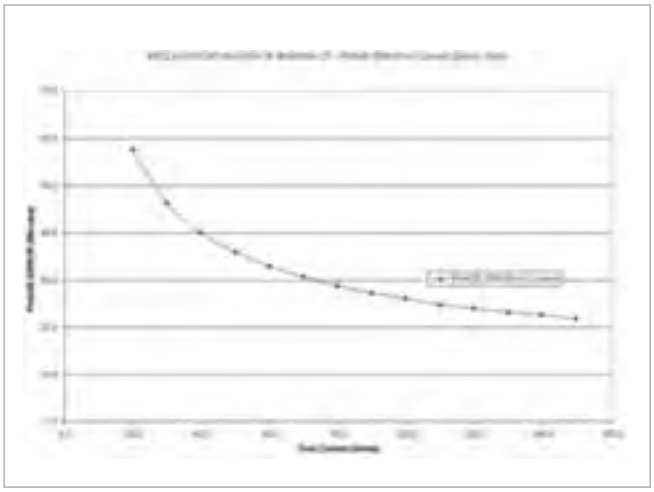

Fig. 12. Phase angle error versus current for a relay-class bushing CT

## V. CONCLUSION

The results from the testing and evaluation sites provide compelling data that the reclassification of existing relay-class CTs can be performed live, in-situ, during full operation of the CT. The resulting reclassification of the CT ensures improved accuracy to meet the necessary IEEE Std. C57.13 class 0.3 requirements for revenue metering CTs.

## VI. BIOGRAPHIES

Paul Doig graduated from University of British Columbia in Vancouver, BC, Canada and received his Bachelor of Applied Science Electrical Engineering in May 1997. Since 1998, Doig has worked at Power Measurement in Victoria, BC, Canada and is currently the Utility Marketing Manager focusing on revenue metering, power quality and high voltage sensing applications.

Colin Gunn received his Bachelor of Electrical Engineering from the University of Victoria in 1989 with specialization in communications technology. He joined Power Measurement in 1997 where his research interests have focused on AC energy metrology with emphasis on current comparator technology and high voltage field analysis. He holds six US patents.

Larry Durante graduated from Syracuse University where he earned his Bachelor of Science Electrical Engineering, BSEE, and MSEE. His employment experience includes power quality, laboratory research. He is currently the Revenue Metering Manager for National Grid, USA Service Company in Syracuse, NY, USA. Durante's current research interests include wide range high accuracy instruments transformers and dynamic error correction algorithms.

Clayton Burns graduated from Lehigh University where he earned his Bachelor and Masters of Science Electrical Engineering degrees in 1977 and 1982, respectively. His professional experience includes industrial electrical systems, electric generation, electric utility research, and his current assignment as a Principal Engineer in the Meter Engineering Department at National Grid, USA Service Company in Syracuse, NY. Mr. Burns is a registered Professional Engineer in the State of New York.

Marcie Cochrane graduated from University of Victoria in Victoria, BC, Canada and received her Bachelor of Electrical Engineering in 2002. Since 2002, Cochrane has worked at Power Measurement as a Systems Engineer, Hardware Development Project Manager, and currently as Product Manager for high voltage sensing applications and revenue metering products.

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# SUPERVAR DYNAMIC SYNCHRONOUS CONDENSER RECEIVES ACCOLADE

American Superconductor Corporation and the Tennessee Valley Authority announced that the SuperVAR dynamic synchronous condenser has been selected by R&D Magazine as one of the most technologically significant products introduced over the past year.

The condenser, which has been recognized for this achievement with the prestigious R&D 100 Award, is a product that stabilizes grid voltages, increases service reliability and can help maximize transmission capacity.

Developed by American Superconductor in collaboration with TVA, SuperVAR machines are dynamic synchronous condensers, which are rotating machines, much like motors and generators. They utilize superconductor technology and serve as "shock absorbers" for the grid, dynamically generating or absorbing reactive power (measured in volt-amperes-reactive or VARs).

"In today's digital economy, keeping voltage levels constant and stable is vital," said TVA Executive Vice President of Transmission/Power Supply Terry Boston. "That's what our customers expect, and we believe that's what this new technology will help us deliver. These machines will help protect the transmission system from voltage fluctuations and help ensure TVA's continued delivery of affordable, reliable power to the people of the Tennessee Valley."


The R&D 100 Awards, now in its 43rd year, names the most innovative new products introduced into the market over the past year as selected by a panel of independent judges and editors of R&D Magazine with superior expertise and long experience in the areas they are judging. The Chicago Tribune has described these prestigious awards as "the Oscars of Invention."

TVA installed the advanced prototype SuperVAR synchronous condenser at an electrical substation serving a steel mill operated by the Hoeganaes Corporation in Gallatin, Tennessee in August 2004. The machine helps stabilize voltage on TVA's grid by injecting or absorbing reactive power to minimize the sudden and large voltage fluctuations caused by the steel mill during operation of its arc furnace.

TVA is the nation's largest public power provider and is completely self-financed. TVA provides power to large industries and 158 power distributors that serve approximately 8.6 million consumers in seven southeastern states.

"We are delighted to accept this award that recognizes the importance of high temperature superconductor technology in increasing the reliability of electric power transmission," said Greg Yurek, president and CEO of American Superconductor. "This is particularly timely since the Energy Policy Act of 2005, recently signed by President Bush, highlights the need for increased investment in the reliability and modernization of the nation's transmission grid, including mandatory reliability standards. We expect SuperVAR machines to play a substantial role in meeting the new and enforceable reliability standards."

**ET**

# BIO-BASED TRANSFORMER MINIMIZES POTENTIALLY DAMAGING IMPACT OF HAZARDOUS MATERIALS IN HURRICANE-VULNERABLE AREAS

To facilitate the rebuilding of electrical infrastructure in areas impacted by the recent hurricane damage in the southern United States, Cooper Power Systems has increased production of all transformers, in particular Envirotra EF transformers, to meet anticipated high demand.

Envirotran EF transformers are filled with a bio-based transformer oil made from soybeans that can minimize the potentially damaging impact of hazardous material in hurricane-vulnerable areas.

Priority is being given to the new orders associated with the Katrina rebuild effort.

> "This is a time when we all need to take steps to assist in the recovery of the Gulf region."
>
> - Henry Hecker, Director, Transformer Products Cooper Power Systems

"This is a time when we all need to take steps to assist in the recovery of the Gulf region," said Henry Hecker, Director, Transformer Products, Cooper Power Systems. "Cooper Power Systems is reserving production and product planning space to specifically meet the needs of those utilities involved in rebuilding the affected areas. By supplying transformers filled with FR3 fluid, we can assist the utilities to rebuild their system in a manner that is friendlier to the environment."

Envirotemp FR3 fluid would not detrimentally contribute to the mix of chemicals spilled during natural catastrophes such as Hurricane Katrina. In addition, the high fire point of FR3 fluid greatly reduces the likelihood of a fire occurring in association with a failed transformer. There have been no recorded fires from Envirotemp FR3 fluid, the fluid used in Envirotran EF transformers.

Petroleum is the base fluid for traditional mineral oil-based transformers, which represent the majority of transformers damaged or destroyed in the states affected by Hurricane Katrina. Reports indicate that Hurricane Katrina knocked out 90% of the petroleum production in the Gulf region and a significant portion of the nation's refining capacity. Even a partial conversion by utilities to the use of bio-based oil in transformers will reduce demand for petroleum, not only at times when supply is tight, but also on an ongoing basis.

Bio-based fluid is a renewable energy source that's grown domestically and lessens the country's dependence on foreign oil. Manufactured from edible seed oils, FR3 fluid meets the Environmental Protection Agency's "Ultimate Biodegradability" classification, permitting alternative spill response procedures such as natural bio-remediation. Both Factory Mutual approved and an Underwriters Laboratories classified less-flammable fluid, it has the highest flash/fire points in the industry.

As an additional benefit, FR3 fluid extends transformer paper insulation life five to eight times. The increased insulation life translates to extended and enhanced transformer life, and the ability to carry higher loads during peak demand periods without leading to premature insulation failure. The enhanced performance allows utilities to manage their assets more profitably and forestall costly capital expenditures. **ET**

# FOR SCADA/EMS, EVERGREEN MAINTENANCE MAKES MORE SENSE THAN EVER

By Bob Fesmire, ABB

The Energy Policy Act of 2005 recently signed into law by President Bush empowers FERC to establish mandatory reliability standards and impose penalties for non-compliance. What exactly this will mean for the utilities and other organizations that operate the bulk transmission system is not entirely clear. However, one area that is likely to feel the impact of the new standards is the IT infrastructure that monitors and controls transmission operations, specifically supervisory control and data acquisition and energy management systems (SCADA/EMS).

If the physical transmission system is akin to a body, then SCADA/EMS is its brain and central nervous system. If a problem occurs here, it can affect the entire grid. Fortunately, new computer technologies have done much to prevent such problems from occurring and to mitigate their effects when they do. However, this is a double-edged sword: As programs grow more complex, they also become increasingly susceptible to the vagaries of software. Not surprisingly, service agreements for SCADA/EMS are often viewed as an integral part of the hardware and software they support.

Traditionally, many SCADA/EMS service contracts have focused primarily on supporting the user with technical support and bug fixes. This is an important and necessary function, but neglects the ongoing maintenance and development of the product itself. While the service agreement might cover a 24-hour help line and similar user-support functions, the program itself remains largely unchanged over the course of its life, save for bug fixes or other minor code changes required to keep it running according to the original specifications. If the user wants to add new functionality, he would most likely have to pay for it through costly change orders. In practice, this approach has led to a situation in which the gap between the needs of the utility and the capabilities of the system grows wider over time until it reaches a point where it becomes necessary to replace the system entirely.

A broader concept of maintenance includes keeping pace with available technologies and matching system capabilities to meet customer needs on a continuing basis. This is the essence of what is known as an "evergreen" service model. Under this approach, the utility pays a regular and predictable amount, and in exchange is supported by a continuous upgrade regimen. The vendor adds new functionality, streamlines processes and makes other enhancements to the installed software as they become available.

**Smaller investments in maintenance over the life of the system will not only extend the life expectancy of that system, but also prevent larger, unplanned expenditures along the way.**

Evergreen service programs offer a few key advantages over traditional contracts. In addition to benefits like bug fixes, access to system experts and guaranteed response time, the owner can also realize significant long-term cost savings by extending the life of the SCADA/EMS. Smaller investments in maintenance over the life of the system will not only extend the life expectancy of that system, but also prevent larger, unplanned expenditures along the way. Such an approach also keeps the installed system competitive with new alternatives, thus preserving the value of the original investment.

These benefits, particularly life extension, speak to the utility's ability to realize the greatest "bang for the buck" in its expenditures, and to reduce the risk associated with maintaining highly complex systems. But the nature of the evergreen approach makes it particularly well suited to preserving reliability as well. This takes on a new level of importance in light of the soon-to-be imposed FERC standards.

If, for example, some new functionality is required to meet the standard, bringing a system that has not had the benefit of an evergreen contract into compliance will clearly involve greater cost (in both money and time) than updating an evergreen-serviced system. Indeed, the required functionality may well have already been implemented via the evergreen process itself.

Finally, there are less tangible benefits that accrue to the utility that develops an ongoing relationship with a SCADA/EMS vendor with an evergreen service plan. Through user groups and interactions with the vendor's staff, they can provide useful input as the next release of the system is developed. They can also gain valuable insights by sharing their experiences with fellow users. Most vendors seek to foster these relationships because they work to the advantage of software developers and users alike.

It remains to be seen exactly how the forthcoming reliability standards will affect utility operations and spending patterns, but the inherent advantages of the evergreen model are hard to refute. In the context of a new reliability regime, this approach to maintaining what is arguably the single most critical utility system seems like a natural fit.

*The views and opinions expressed in this article are not necessarily those of ABB.*

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# VERIDIAN EMPLOYEES ACHIEVE ONE MILLION HOURS WORKED WITH NO LOST TIME INJURIES

Veridian employees achieved an important safety milestone recently, as they surpassed one million hours worked with no lost time injuries. The Ajax, Ontario company's 150 member staff has worked almost four full years without a lost time accident.

"We are very appreciative of our employees' commitment to safety," says Michael Angemeer, Veridian's President and CEO. "Our staff often works in less than optimal conditions. Just (recently) many of our linespersons worked in high winds and driving rain to repair power-lines downed by falling tree limbs. Following safe work practices during these types of emergency conditions requires discipline. I congratulate all of Veridian's staff for their professional approach to the work that they do."

Veridian will formally recognize its employees' safety at the end of October. A celebratory luncheon will be held for all staff. Representatives from the Electrical & Utilities Safety Association (E&USA) will be on hand to present the association's prestigious President's Award for safety.

Rick Oliver, Veridian's Manager of Occupational Health and Safety, attributes the company's safety success to a corporate culture of cooperation and accountability. "Our Board of Directors and executive, management and front line staff at Veridian all share a common attitude to safety," he says. "Every employee plays an important role in maintaining a safe workplace, and all understand that working safely contributes not only to personal well-being, but to workplace efficiency as well."

Through its subsidiary Veridian Connections Inc., Veridian Corporation is responsible for distributing electricity to more than 97,000 customers in the cities of Pickering and Belleville, the towns of Ajax and Port Hope, and the communities of Uxbridge, Bowmanville, Newcastle, Orono, Port Perry, Beaverton, Sunderland and Cannington. **ET**

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