

ELECTRICITY TODAY
IS A PROUD
MEDIA SPONSOR OF



MARCH 9-11, BANFF, AB



MARCH 31 - APRIL 2
TORONTO, ON

January/February 2008
Volume 20, No. 1

ELECTRICITY

North American Policies and Technologies

Transmission & Distribution



TODAY

THE TRANSFORMER REPORT: PREVENTING EXPLOSIONS, IDENTIFYING RISK AND GAUGE MAINTENANCE

PAGE 14

Cyber security: Identifying the risk before harm can be done

PAGE 10

NFPA 70b Electrical Maintenance Training is coming to a city near you

February 4-5, 2008 Ottawa, ON

March 4-5, 2008 Winnipeg, MB

March 10-11, 2008 Fort McMurray, AB

February 6-7, 2008 Toronto, ON

March 6-7, 2008 Vancouver, BC

March 12-13, 2008 Edmonton, AB

www.electricityforum.com/forums/nfpa70b-electrical-maintenance.html

Electrical Buyer's Guides,
Forums, On-Line Magazines,
Industry News, Job Postings,
Electrical Store, Industry Links

www.electricityforum.com

PUBLICATION MAIL AGREEMENT # 40051146



Elster... always a step ahead with proven AMI solutions

Utilities worldwide are faced with the issues of rising fuel costs, deregulation, peak load, grid reliability and conservation. Elster Integrated Solutions (EIS) is playing a central role in addressing these issues by providing proven, reliable AMI solutions to IOUs and smaller utilities alike. A turnkey solution provider, EIS brings together an exceptional team, leading-edge technologies and strategic partners to deliver value added solutions that mitigate risks and accelerate ROI. Our AMI systems and solutions for gas, electricity and water help utilities improve operational efficiencies, reduce costs and support conservation efforts.

Elster's EnergyAxis® System is the largest, true two-way, RF mesh deployment in the world. Proven to work in multi-utility applications ranging from high-density metropolitan environments to lightly populated rural areas, the system supports residential and commercial and industrial applications. Its' standards-based, open architecture is flexible and adaptable to utility needs today and future-proofed to support rapidly changing infrastructure, applications and communications technologies. A proven foundation on which to build reliable demand response, distribution automation and smart grid solutions, Elster's EnergyAxis System is a step ahead of any AMI on the market.

Publisher/Executive Editor
Randolph W. Hurst
randy@electricityforum.com

Associate Publisher/Advertising Sales
Carol Gardner
carol@electricityforum.com

Editor
Don Horne
don@electricityforum.com

Web Site Advertising Sales
Barbara John
forum@capital.net

Circulation Manager
Colleen Flaherty
colleen@electricityforum.com

Production Manager
Alla Krutous
alla@electricityforum.com

Layout
Cara Perrier
mac@electricityforum.com

Visit our Web Site:
www.electricityforum.com
E-mail: hq@electricityforum.com

Subscribe on-line:
www.electricityforum.com/et/subscribe.htm

Phone:
905 686 1040

Electricity Today Magazine is published 9 times per year by The Electricity Forum [a division of The Hurst Communications Group Inc.], the conference management and publishing company for North America's electrical power and engineering industry.

Distribution: free of charge to North American electrical industry personnel who fall within our BPA request circulation parameters. Paid subscriptions are available to all others.

Subscription Enquiries: all requests for subscriptions or changes to free subscriptions (i.e. address changes) must be made in writing to:

Subscription Manager, Electricity Today
215-1885 Clements Road,
Pickering, Ontario, L1W 3V4

or on-line at www.electricityforum.com.

Canada Post - Canadian Publications Mail Product Sales Agreement 40051146

ISSN 0843-7343

Printed in Canada.

All rights reserved.

The contents of this publication may not be reproduced in whole or in part without prior permission from the publisher.

Member of:



Volume 20, No. 1 January/February 2008

in this issue

EDITORIAL

SHAKE HANDS WITH THE DEVIL

CYBER SECURITY

IDENTIFYING THE RISK BEFORE HARM CAN BE DONE

TRANSFORMERS

PREVENTING TRANSFORMER EXPLOSIONS: EXPERIMENTS, ANALYSIS AND SIMULATIONS

REDUCE RISK EXPOSURE FOR SUBSTATION TRANSFORMERS

GAUGES ARE AN IMPORTANT PART OF YOUR TRANSFORMER'S OPERATIONS

VOLTAGE SAG

VOLTAGE SAGS: AN EXPLANATION - CAUSES, EFFECTS AND CORRECTION - PART II

CONFERENCES

ENERCOM - BUILDING CANADA'S ENERGY VISION FOR THE 21ST CENTURY

IPPSA 14TH ANNUAL CONFERENCE AND TRADE SHOW - KEEPING COMPETITION CLEAN

NUCLEAR

NUCLEAR SELLS CLEAN AIR, ENHANCES SAFETY FOR NEW GENERATION REACTORS

MAINTENANCE

POWER AND UTILITY COMPANIES: GO ULTRASONIC TO STAY UP AND RUNNING

SUBSTATION

TESTING AND ANALYZING YOUR POWER SYSTEM APPARATUS

PROTECTION & CONTROL

B.C. HYDRO FUELS GROWTH WITH PLANT INTEGRATION

PRODUCTS AND SERVICES SHOWCASE

ADVERTISERS INDEX

6

10

14

23

28

25

27

41

29

36

38

42

53

54



BRUCE CAMPBELL



CHARLIE MACALUSO



DAVID O'BRIEN



SCOTT ROUSE



DAVID W. MONCUR

BRUCE CAMPBELL, LL.B., Independent Electricity System Operator (IESO)

Mr. Campbell holds the position of Vice-President, Corporate Relations & Market Development. In that capacity he is responsible for the evolution of the IESO-administered markets; regulatory affairs; external relations and communications; and stakeholder engagement. He has extensive background within the electricity industry, having acted as legal counsel in planning, facility approval and rate proceedings throughout his 26-year career in private practice. He joined the IESO in June 2000 and is a member of the Executive Committee of the Northeast Power Coordinating Council. He has contributed as a member of several Boards, and was Vice-Chair of the Interim Waste Authority Ltd. He is a graduate of the University of Waterloo and Osgoode Hall Law School.

DAVID O'BRIEN, President and Chief Executive Officer, Toronto Hydro

David O'Brien is the President and Chief Executive Officer of Toronto Hydro Corporation. In 2005, Mr. O'Brien was the recipient of the Ontario Energy Association (OEA) Leader of the Year Award, establishing him as one of the most influential leaders in the Ontario electricity industry. Mr. O'Brien is the Chair of the OEA, a Board Member of the EDA and a Board Member of OMERS.

CHARLIE MACALUSO, Electricity Distributor's Association

Mr. Macaluso has more than 20 years experience in the electricity industry. As the CEO of the EDA, Mr. Macaluso spearheaded the reform of the EDA to meet the emerging competitive electricity marketplace, and positioned the EDA as the voice of Ontario's local electricity distributors, the publicly and privately owned companies that safely and reliably deliver electricity to over four million Ontario homes, businesses, and public institutions.

SCOTT ROUSE, Managing Partner, Energy @ Work

Scott Rouse is a strong advocate for proactive energy solutions. He has achieved North American recognition for developing an energy efficiency program that won Canadian and US EPA Climate Protection Awards through practical and proven solutions. As a published author, Scott has been called to be a keynote speaker across the continent for numerous organizations including the ACEEE, IEEE, EPRI, and Combustion Canada. Scott is a founding chair of Canada's Energy Manager network and is a professional engineer, holds an M.B.A. and is also a Certified Energy Manager.

DAVID W. MONCUR, P.ENG., David Moncur Engineering

David W. Moncur has 29 years of electrical maintenance experience ranging from high voltage installations to CNC computer applications, and has conducted an analysis of more than 60,000 various electrical failures involving all types and manner of equipment. Mr. Moncur has chaired a Canadian Standards Association committee and the EASA Ontario Chapter CSA Liaison Committee, and is a Past President of the Windsor Construction Association.



**NOW AVAILABLE
TO 69/72 kV**

Reliable for Over 30 Years

Introducing 3M™ Cold Shrink Terminations for High Voltage

Invented 30 years ago, 3M™ Cold Shrink Terminations have been continually improved by 3M scientists and engineers alike. Testing in 3M Laboratories has demonstrated that the silicone material used in 3M™ Cold Shrink Terminations and Splices will retain its interface pressure for more than 50 years, based on accelerated life testing.

It's this hands on approach to technology that has allowed 3M to expand Cold Shrink Terminations into the 69/72 kV category.

For more information on 3M™ Cold Shrink Terminations please contact 1-800-3M-HELPS (1-800-364-3577).



3M is a trademark of 3M. Used under license in Canada.
© 3M 2006. 0603-CP-24814 BA-06-10919





By Don Horne

When Kansas legislators rejected an application for two proposed coal-fired power plants in that state, they did so in an effort to limit pollution, control global warming and reduce the potential health risk to residents from a projected 11 million tons of carbon dioxide emissions.

The trouble is, Sunflower Electric Power Corporation has told the residents of this relatively flat, very breezy state the wind turbines that would have accompanied those coal-fired plants are now out of the question.

No reliable power from coal means that the proposed transmission lines would not be economically feasible to build with only wind turbines contributing to the grid.

Assertions that the rejection of the coal plants has hurt any immediate wind power construction have been decried as a “total myth” by Lt. Gov. Mark Parkinson.

The President and CEO of Sunflower Electric Earl Watkins Jr. has stated that “Regional transmission development will suffer if our project dies;” adding that “No one, and I repeat no one will build new transmission to Colorado.”

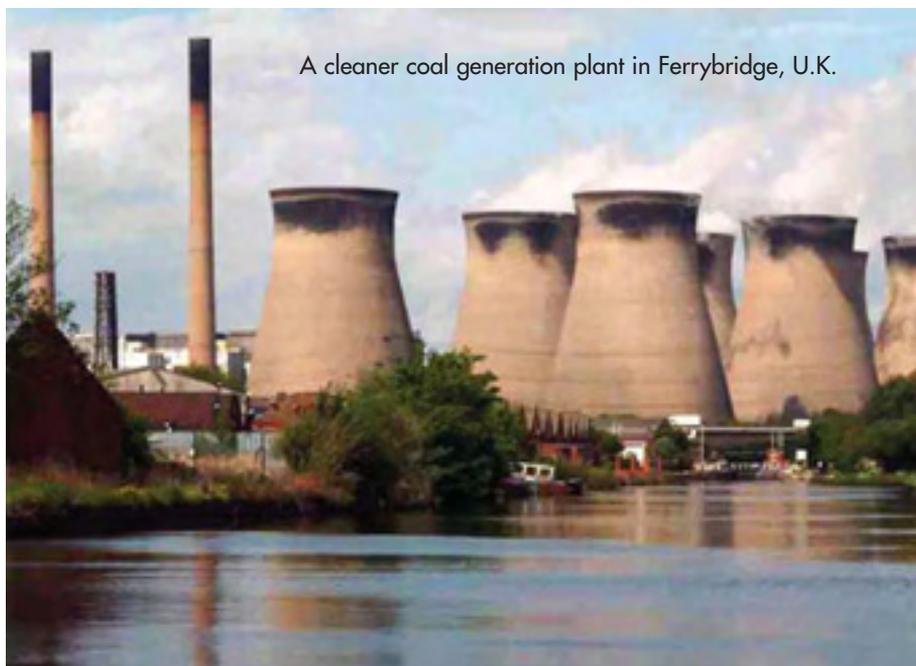
The coal plants were expected to deliver 85 per cent of their electricity to out-of-state customers.

All altruism aside for those embracing zero-emission wind generation, Watkins rightly states that those living in neighbouring states will choose their own wind power before buying Kansas power.

“And what right-minded utility in Colorado, Oklahoma or Texas would invest in or buy wind power from Kansas after being told to take their projects back home,” Watkins says.

Despite Watkins’ cautionary tale, two transmission lines have been approved since the rejection of the two plants. One is a line proposed by Lawrence-based ITC Great Plains. The 180-mile high voltage line would run from Spearville, near Dodge City, south-

SHAKE HANDS WITH THE DEVIL



A cleaner coal generation plant in Ferrybridge, U.K.

east to Comanche County, and then northeast to Wichita.

A potentially large market for wind power lays to the southeast of Kansas, where there is virtually no wind generation available. Ironically, there is also virtually no local interest in wind power in that region.

The real wind market for Kansas is west, in California. And for that market to be exploited, anchor generation like nuclear, natural gas or – you guessed it – coal, needs to be in place to make the transmission line economically viable.

As an intermittent resource, wind can only be a component of an energy portfolio.

Roughly 3 per cent of Kansas electricity comes from wind (mostly large scale wind farms). Because of the high winds and flat topography of the state, Kansas could be a nation leader in wind generation.

Some experts put the wind percentage of potential total electric use for Kansas as high as 10 per cent by 2010, and 20 per cent by 2020.

A 20 per cent wind component for

the grid? Many an operator would laugh you out of the room.

But with new storage technologies for renewable generation being explored every day, a higher percentage of wind turbines reliably turning the breeze into electricity is inevitable.

Throughout the end of 2007, the Republican-controlled senate refused to pass the Energy Bill put forward by the Democratic-heavy House of Representatives. The Republicans’ primary objections were the “twin millstones of utility rate hikes and massive tax increases”. Democratic senators were willing to drop the requirement for utilities to produce 15 per cent of their electricity from renewable energy sources.

So it appears that in the here and now, many in the renewable generation camp will have to shake hands with the devil and accept that clean coal technologies (or nuclear, or natural gas) will have to be partnered with new wind and solar projects so that these environmentally friendly sources of generation can be exploited.

don@electricityforum.com



EasyPower®

Power made easy.

Arc Flash Safety, Device Coordination, and Design Made Easy!

EasyPower®, the most automated, user-friendly power system software on the market, delivers a full lineup of Windows®-based tools for designing, analyzing, and monitoring electrical power systems. EasyPower helps you get up to speed rapidly, finish complex tasks quickly, and increase your overall productivity. Consultants, plant/facility engineers, maintenance personnel, and safety managers will all realize increased job throughput and profitability without extensive training! Watch our 3 minute EasyPower® video; just go to: www.easypower.com/video.html.

Arc Flash Safety Compliance Made Easy! Studies, Work Permits, Boundary Calculations, and More

EasyPower ArcFlash™ lets you:

- Rapidly create and implement a comprehensive arc flash program
- Comply with OSHA, NFPA, NEC®, and ANSI regulations
- Prevent expensive fines and litigation
- Reduce risks and improve plant safety
- Identify all critical PPE levels and clothing needs
- Prepare efficiently for emergencies
- Save valuable time and money

One-Touch PDC and Design Tools Now Available in EasyPower 8.0!

What used to take hours or even weeks can now be accomplished in seconds. Finally, truly automated design and device coordination is here. With EasyPower's one-touch automation, you don't need to make manual calculations or memorize electrical codes. For the first time, even those without design experience can complete comprehensive design and analysis tasks.

SmartDesign™ | Automated Design for Low-Voltage Systems

EasyPower SmartDesign™ completely automates equipment sizing in the design process, saving countless hours of manually rerunning calculations to verify code compliance. It also generates comprehensive reports to alert you to possible problem areas, giving valuable insight. There's no need to reinvent the wheel with SmartDesign™; just set up your design sheets ONCE, and SmartDesign™ does all the rest for you.

SmartPDC™ | Protective Device Coordination Made Easy

EasyPower SmartPDC™ fully automates the tedious, labor-intensive work of setting protective devices – just highlight an area to coordinate, and one click completes the task for you. Intelligent reporting automatically provides a list of devices and setting options, with a detailed description explaining each setting. It's like having the industry's brightest engineers right inside your PC.

About ESA, Developers of EasyPower

Since 1984, ESA has redefined the way companies manage, design, and analyze electrical power distribution. Our innovative technologies make power system design and management simpler, smarter, and safer than ever. We invite you to visit www.EasyPower.com for a complete overview of all the powerful options available within EasyPower 8.0!

Power made easy
intelligent | intuitive | instantaneous
power system software

WHY EASYPower?

- Easiest to use
- Fastest algorithms and results
- Intuitive graphical user interface
- Shortest learning curve
- Most accurate, lowering liability/risk
- Follows Windows® standards
- Complete integration of all functions

CLICK ONCE TO...

- Size equipment per National Electric Code
- View/modify integrated one-line data
- Perform complex arc flash calculations
- Verify duty ratings and compliance
- Analyze switching conditions instantly
- Study countless operating scenarios
- Generate detailed reports
- Access critical documentation
- Print compliant work permits and labels

"EasyPower 8.0 really knocked my socks off. I don't know of any other program that comes close to its speed and automation – that auto-coordinates and eliminates all the guesswork.

Typically, setting devices takes up to 15 minutes – sometimes longer – per circuit, depending on the complexity. But with EasyPower SmartPDC, it literally takes only 5 to 15 seconds. Just amazing!

Tie this all in with new automated design features, the ability to conduct studies, and having a fully integrated database - and watch productivity skyrocket."

– Jim Phillips, P.E. T2G Technical Training Group

TRY BEFORE YOU BUY

Download a Free Demo!

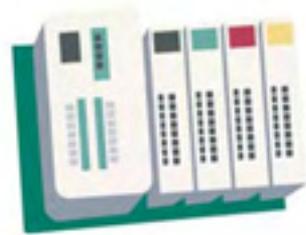
ONLINE PRESENTATION

Witness the speed and automation of EasyPower and ask engineers specific questions during a live online product presentation.

Sign up today. It's free!

Tap into the power of EasyPower! Download a FREE demo or sign up for a free live, online presentation:

www.EasyPower.com | 503-655-5059 x35



RTU



Alarm Annunciator



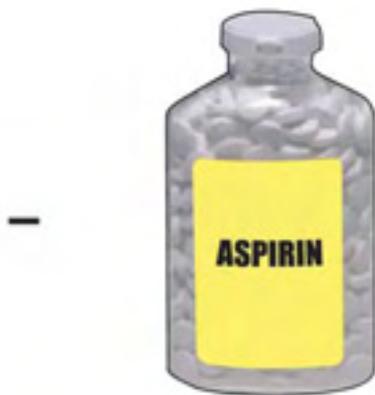
Substation HMI



Protective Relay Integration

Visit novatechweb.com/orion.html for complete information detailing the use of Orion in the following applications:

- Smart RTU
- Distribution Automation
- Alarm Annunciation
- Sequence of Events Recording
- Protective Relay Integration
- WEBServer™ HMI



=



Orion5r 19-Inch Rack Mount

Multiple functions,
minimal headaches.



IDENTIFYING THE RISK BEFORE HARM CAN BE DONE

By Don Horne

When Wurldtech is doing their job perfectly, you never hear about it.

Such is the life of infrastructure cyber security, identifying potential threats so clients can mitigate or manage them before they cause catastrophic harm.

For utilities, the spread of the internet and interconnective control and monitoring systems means that unseen attackers can disrupt or disable the power grid with the simple click of a mouse.

“I don’t want to seem like I am spreading fear, but there have been over 300 incidents (of identified threats to utilities), and most have been kept quiet,” says Bryan Singer, Vice President of Professional Services with Wurldtech. “And most of those incidents have been through modem lines.”

The electric power industry is one of the most crucial global Critical Infrastructure (CI) sectors. It encompasses sensitive potential targets and underlies the smooth operation of all other infrastructures. Despite widespread backup and continuity of operations resources and procedures, if the electric power sector were to suffer sustained outages, communications could be seriously disrupted, trains could stop running, planes could be grounded, and the economy could grind to a halt. Unlike other energy sources, electricity cannot be stockpiled, so power disruptions would have almost immediate effects.

Wurldtech Security Technologies, based out of Vancouver, British Columbia, offers products and services designed to specifically protect the systems and networks that operate the world’s critical infrastructure – like electricity grids.

“We look at how the system is at risk. There are inherent weaknesses in current systems,” points out Bryan. “Utilities existed in a disconnected network for years, and (at that time) they could exist without risk.

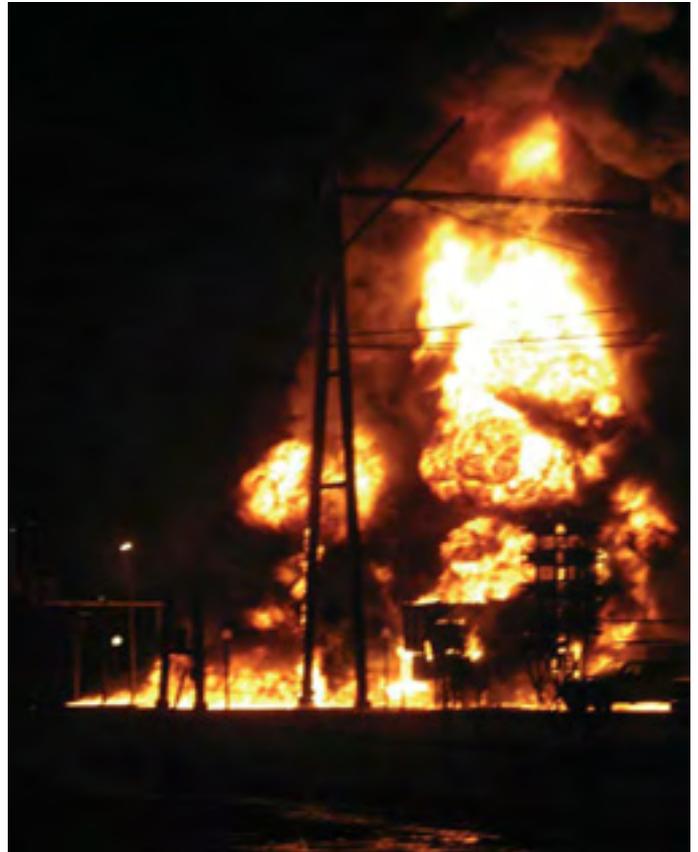
“Sure there always has been a risk – an ‘insider risk’ (people working within the utility who cause harm either intentionally or unintentionally) – but now that we’ve had to connect the grids, and managers need to see across the entire system (SCADA, monitoring software), this has created the threat exposure.

“There is still the insider risk, but it has opened the door to access by modem, radio telemetry and open internet,” says Bryan.

“Every point of connectivity is a point of failure.”

R. Tyler Williams, President and CEO of Wurldtech, says that threats to industry usually are a result of unintentional mistakes due to a lack of understanding of the complex risks and potential vulnerabilities inherent in a mission-critical industrial environment.

“Yes, there are nefarious threats that exist; but more frequently we see disruptions occur as a result of seemingly benign and standard maintenance or configuration changes,” says Tyler. “But in the end, a disruption is a disruption – and



Utilities are familiar with the conventional threats to their infrastructure (such as this substation fire). But the growing threats from cyberspace are just as real as this transformer explosion, and potentially more destructive.

what is often underestimated is the sheer size and breadth of the resulting economic, social and legal impact, especially for a utility.”

In order to identify potential threats, Wurldtech had to start by putting themselves in the shoes of the people who could cause the problems.

“We began in uncharted territory and needed to solve an undefined problem for a nascent market. This meant creating a testing platform that would incorporate the most sophisticated hacking techniques available and designed specifically for a complex real-time environment with the ability to stay ahead of the ever-evolving threats,” says Tyler.

That search for the solution gave birth to Achilles.

The Achilles Security Analysis Platform combines the

Continued on Page 12

CANDURA instruments

Ideal Portable Power Monitoring & Analysis Tools

Used by **Utilities** and **Industry**
to Easily Resolve Power Quality & Energy Issues



PowerPro Power Quality Analyzer

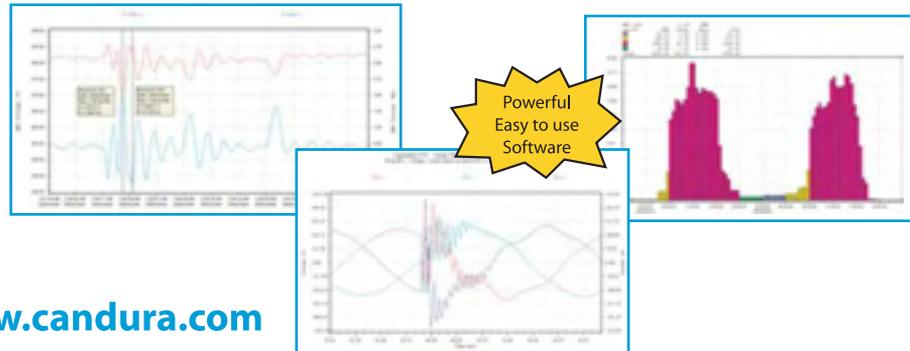
- Measures all critical parameters, including Harmonics, Waveforms, Transients and Current Inrush
- Full Energy Analysis Capability
- Rugged, Portable, Weatherproof and Easy to Setup
- Unbeatable Product Support

PowerView Data Analysis Software

- Instant graphics and reports
- Export data & graphs for reports and analysis

Try PowerView Now!!

Visit www.candura.com



Data Logging • Energy Audits • Cost Analysis EnergyPro Energy Analyzer

- True RMS V, I, KW, KVA, and KWHR trending
- Daily, weekly or monthly costing reports
- THD, Harmonics and unbalance trending

most advanced network security testing tool with a new delivery mechanism revolutionizing the field of embedded systems testing. The Achilles Platform allows asset-owners and operators to validate system resiliency and maintain the integrity and availability of critical operations.

Worldtech also collaborated with industry to create the Achilles Certification Program which provides a benchmark for the certification of secure industrial control systems. The program is designed to assist asset-owners and product vendors assess the overall security of industrial controllers and certify that they meet a comprehensive set of requirements and conformance.

Through Achilles, we are trying to drive vendors to a certain minimum level of standards," says Bryan. "We are trying to raise the bar for infrastructure security."

This commitment to raising the bar is demonstrated by Bryan Singer being the founding chair (now co-chair) of ISA SP-99, the Industrial Automation and Control Systems Security Standards Committee, a standards body focusing on the security issues of the control systems environment.

Although the spectre of a terrorist attack must be acknowledged, Bryan says that a more likely scenario in the next few years would come from disgruntled retirees.

"We have seen this already. You have people retiring from a company, and radical environmentalists – or eco terrorists

in extreme cases – plying these employees with drinks, loosening their tongues and gaining access to restricted information.

"Now they have gained access to, say, smokestack monitoring, and use that information against the company in a smear campaign," says Bryan.

"One company had to spend \$150,000 in a public awareness campaign to fight just such an action."

This sort of assault, although it may seem harmless to some, can have far-reaching effects.

THE THREATS ARE REAL

With 85 percent of the United States' critical infrastructure in private hands, the federal government must make sure that the 17 infrastructure sectors include cyber security in their plans to protect themselves against cyber attacks and disaster, an official of the Government Accountability Office has told two House panels. However, none of the sectors included in their sector plans all 30 cyber security criteria, such as key vulnerabilities and measures to reduce them, the official also testified.

Internet attacks on the 100 electric utility clients protected by SecureWorks, an Atlanta-based cyber security firm, leaped 90 percent this year - from 43 attacks per utility per day at the beginning of the year to 93 since May, company officials reported recently. That's about double the rate for other industries SecureWorks protects.

A year ago, Ira Winkler, a security expert taking part in an exercise to test the cyber defenses of a nuclear-power plant, used his computer to hack into the plant's control system. After a few hours, the whole thing was called off because the "simulation" was too successful. Winkler had wrested control of key systems from plant engineers and could do what he wanted with the plant.

The U.S. has been "in a race against time" since early 2005, when the attention of "black hat" hackers shifted to focus more on probing and exploiting SCADA control-system weaknesses of electric utilities.

In a bid to plug gaps, the National Electric Reliability Corp. (NERC) in June was put in charge of grid reliability. It has proposed eight new cyber security requirements that are already being adopted by the electric-power industry. Those standards were criticized as being inadequate by experts during an October 17 congressional hearing.

Lawmakers on a House Homeland Security subcommittee have anointed a blue-ribbon commission charged with developing a new national cyber security strategy.

A blue-ribbon panel of three dozen security experts hopes to craft a strategy to improve the United States' cyber security by the time the next president takes office, the Center for Strategic and International Studies (CSIS), and the task force's Congressional sponsors.

The bipartisan Commission on Cyber Security for the 44th Presidency will be tasked with creating a plan to secure the nation's computers and critical infrastructure and presenting that plan to the next president. The task force is headed by Representatives Jim Langevin (D-RI) and Michael McCaul (R-TX), Microsoft's vice president for Trustworthy Computing Scott Charney and retired Navy admiral Bobby Inman.

The commission aims to be nonpartisan and brings together 32 security experts, apart from the four people heading the panel. Among the experts are Idaho National Laboratories' infrastructure protection strategist Michael Assante, Oracle's chief technology officer Mary Ann Davidson, Princeton University professor of computer science Edward Felten, IBM Internet Security System's CEO Tom Noonan, and Verizon's executive director for national security policy Marcus Sachs.

"This sort of eco-terrorism is a genuine threat, as it can disable the economy of an area if the public decides to demand the closure of a plant because of the data that has been made public. It is a battle for the hearts and minds of people."

The Achilles platform is currently being used by at least one Canadian utility (BC Hydro) and numerous in the U.S.

"What began as an identification and tracking tool has now become a type of insurance coverage for these utilities," says Tyler. "BC Hydro is one of the most advanced utilities in the world when it comes to security, and we are glad to play a part in their proactive safety and security strategy."

For instance, the upcoming Olympic Games in Vancouver in 2010 will require a reliable supply of electricity from BC Hydro, and naturally that power must be protected from worldwide attack.

"Nothing is more high profile than power (electricity)," says Tyler. "We are seen as a trusted advisor for this industry, and we work for and with some of the largest industrial companies in the world." In fact, we are proud to include Bell Canada among our partners. Our relationship with Bell combines bench strength and in-

depth industry knowledge providing a complete security framework (physical, logical/cyber, application, etc.) for Critical Infrastructure (CI) organizations.

Study online, at your own pace and earn your certificate as an...

Electronics Technician

**Programmable Logic
Controllers Technician**

**Electromechanical
Technician**



Interactive CD-ROM Based Learning Programs

Develop your knowledge and technical skills in design, programming, installation, operation and troubleshooting of industrial electronics and PLC equipment.

Our Programs feature

- Industry recognition
- Full accreditation
- Open enrolment
- Pay-as-you go registration
- Hands on lab experience through software simulation
- Free 1-800 number technical and tutorial support

Contact one of our Program Advisors today to learn how our program can work for you!

Student Feedback

"I am an electrician at Ford Motor Company and took the Electronics and PLC Technician courses to upgrade in 2005. I found them very good. The flexibility to take it at your own pace is great for shift workers and people with small kids. I would highly recommend them."

Kelly Green

"First, I would like to say this course was excellent. It was well laid out and the sequence of modules certainly made sure that the concepts could be built upon so there is no information overload. I would definitely recommend this to others. A challenging yet rewarding experience."

Carla Maret



Call now!
(416)-415-4726 or
Toll-free 1-888-553-5333

www.gbctechtraining.com



We Bring The Classroom To You.

PREVENTING TRANSFORMER EXPLOSIONS: EXPERIMENTS, ANALYSIS AND SIMULATIONS

1. INTRODUCTION

Transformer explosions are caused by low impedance faults that result in arcing once the oil loses its dielectric properties. Oil is then vaporized, and the generated gas is pressurized because the liquid inertia prevents its expansion. The pressure gap between the generated gas bubbles and the surrounding liquid oil generates pressure waves, which propagate and interact with the tank structure. They cause the pressure rise that leads to the tank explosion. These explosions result most of the time in very expensive damages for electricity facilities.

Realizing that the transformer explosion prevention is the sole effective solution to avoid such financial losses, SERGI designed and patented worldwide the Transformer Protector (TP).

2. TRANSFORMER PROTECTOR (TP) DESCRIPTION

The TP is a passive mechanical system that can only be activated by the level of transformer internal pressure reached during short-circuits. The TP has therefore a very high reliability, making false activation impossible. The TP is designed to protect the main transformer tank, the On Load Tap Changers (OLTC) and the Oil Cable Boxes (OCB).

In Figure 1, the CTP Model protects the transformer tank and the OLTC; this arrangement consists of 6 main components:

1. Transformer tank Depressurization Set (DS), item 1;
2. OLTC Depressurization Set, item 2;
3. Transformer Conservator, which is used here to separate the oil from the explosive gas produced during the short-circuit, item 3;
4. Gas Evacuation Pipe, which channels the flammable gases to a remote and safe area; item 4;
5. Nitrogen injection system, which injects Nitrogen for security purposes to avoid the bazooka effect provoked by the explosive gas when in contact with air (oxygen) and to confine the oil capacities

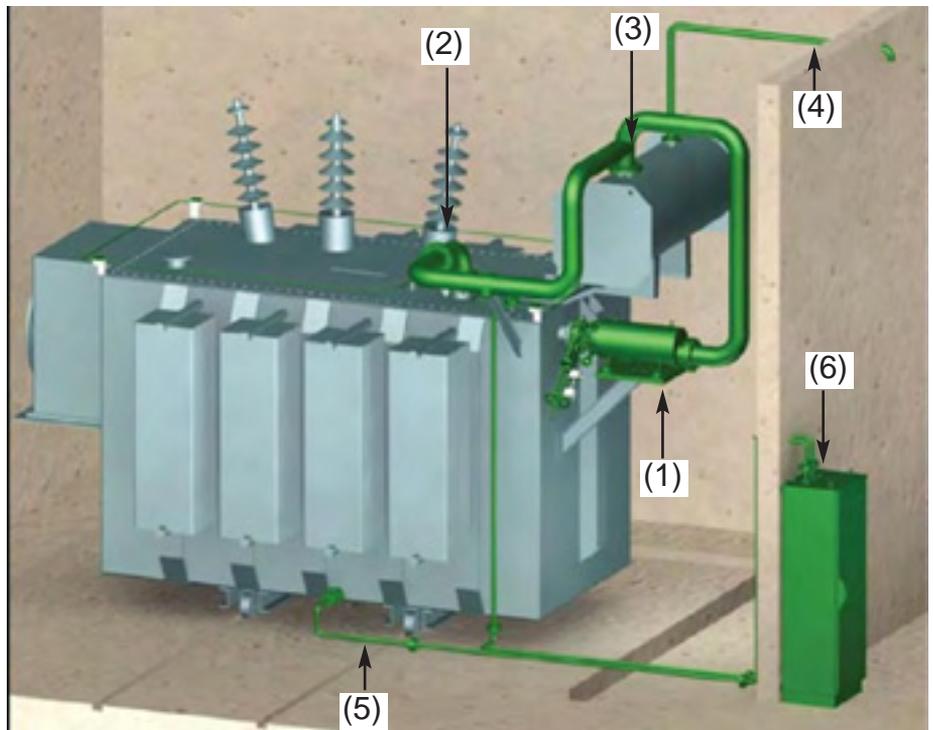


Figure 1: Transformer equipped with a TP comprised of two decompression sets.

under a safe atmosphere so that maintenance can be executed safely, item 5;

6. The TP Cabinet, where all cables are connected and the Nitrogen Cylinder is stored, item 6.

When an electrical fault has occurred, at the exact time of the electrical arc creation, an enormous amount of explosive gas is created. The first Mega Joule produces 2.3 m³ (80 feet³) of explosive gas, while 100 Mega Joule produces only 4,3 m³ (150 feet³). This huge amount of gas created during the first millisecond provokes a dynamic pressure peak which travels at the speed of the sound inside the transformer oil, 1,200 meters per second (4,000 feet per second). This first dynamic pressure peak of the shock wave, generated by the electrical fault, will activate the TP before static pressure is built up. Then the TP depressurizes the transformer within milliseconds before inner tank pressure reaches its designed limit pressure. It

thus prevents the tank from exploding.

As soon as the TP activates, the mechanical energy is evacuated and the transformer protected even if the electrical arc is fed for one or two seconds. Oil and gas are then quickly expelled from the transformer tank through the Decompression Chamber (DC) to the Conservator. In the Conservator, gases will be separated from the oil and channeled away to a remote and safe area. Then, nitrogen will be injected to have the whole transformer safe, cool and ready for repairs.

3. THE EXPERIMENTAL CAMPAIGNS

Up to now, two TP test campaigns have been performed, both under the worst conditions by creating low impedance faults leading to electrical arcs inside the transformer tank dielectric oil. In 2002, Electricité de France performed 28 TP tests. Then, in 2004, a second campaign of 34 TP tests was carried out by

Continued on Page 16

Test CT's and PT's

INSTRUMENT TRANSFORMER TEST SYSTEMS

FEATURES:

- Test CT's and PT's at High Accuracy for all IEC and ANSI classes
- Easy to Use, High Speed Fully Automatic
- Prints RCF and Phase Data
- Stores Test Programs for Easy Recall
- All Solid State
- Low Cost

*"The world's best
test systems"*

Model CT-4000 for Current Transformers

Model PT-3000 for Potential Transformers

Model CTPT for CT's and PT's

CALL FOR LITERATURE
OR DEMONSTRATION



OPTIMIZED DEVICES, INC.

220 Marble Ave. Pleasantville, New York 10570
Phone: 914-769-6100 Fax: 914-769-5102 Email: sales@optdev.com

Transformer Explosions

Continued from Page 14

CEPEL, the Brazilian independent High Voltage Laboratory. For the 62 tests, each transformer was equipped with the TP, which reacts directly to the moving dynamic pressure peak, shock wave, caused by the low impedance fault. This part presents the main conclusions of the last test campaign.

3.1. Experimental settings

34 live tests were performed by CEPEL on three standard transformers (T1, T2, T3). Their large sizes enabled the detailed study of the pressure wave propagation. In these configurations the maximum distance between an electrical arc and the TP ranged up to 8.5 meters (28 ft). These tests were carried out to study the pressure wave propagation and to demonstrate the TP efficiency during a low impedance fault by measuring physical parameters such as pressure, gas temperature, applied current, arc voltage and tank acceleration.

3.1.1. Experimental Set

Each transformer was equipped with a standard TRANSFORMER PROTECTOR in which, contrary to what is shown on Figure 1, an Oil and Gas Separation Tank (OGST) was used instead of the conservator to collect the oil and flammable gases expelled out of the transformer after the TP operation (see Figure 2).

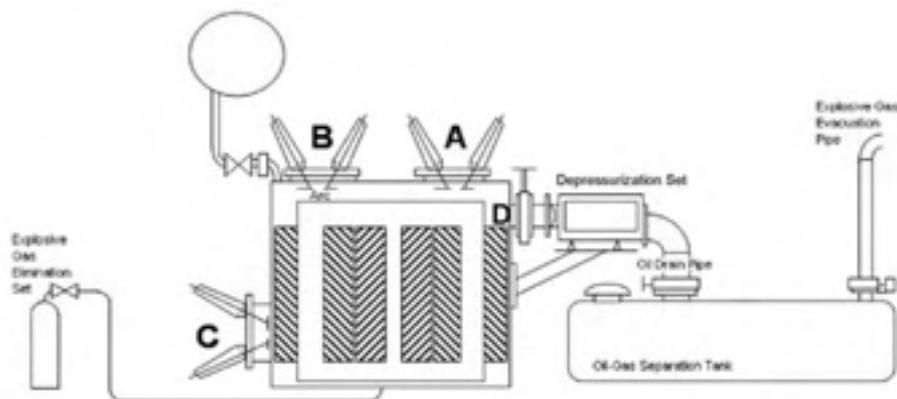


Figure 2: Life Tests Transformer Principle Drawings

3.1.2. Experiments

To study in detail the pressure wave propagation influence, and to show that the TP reliability does not depend on the arc location inside the transformer tank, the electrical arcs were ignited at three different locations, as shown in Figure 2: on the top cover close to the Decompression Set location (position A), on the top cover opposite the Decompression Set location (position B), and in the lower part of the tank opposite the Decompression Set location (position C). Position C was the harshest position to test because it was far from the TP and near the windings, which prevented the pressure waves from easily propagating. Note that position D is shown in Figure 2, and is the location where the TP was installed.

Most of the tests were carried out with electrical arcs with currents ranging from 5 to 15 kA, and fed during 83 milliseconds. This duration corresponds to the average response time of an old circuit breaker and was chosen to maximize the generated gas volume.

3.2. Analysis: Generated gas

During the CEPEL test campaign, the electrical arc produced from 1 to 2.3 m³ (35 to 88 ft³) of gas. This volume is plotted as a function of the arc energy in Figure 3. The global trend (dotted curve) is drawn by the following equation:

$$V = 0.44 \ln(E + 5474.3) - 3.8$$

where E is the arc energy and V the generated volume.

The gas volume generated during an electrical arc is thus a logarithmic function of the arc energy, which seems in accordance with the vaporization process and especially with the

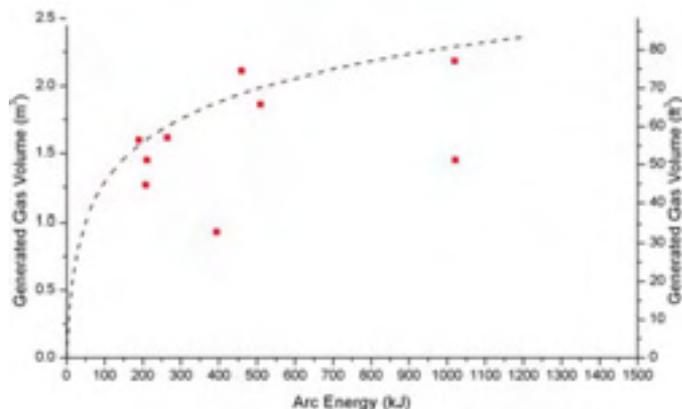


Figure 3: Generated gas volume v. arc energy

THE COLT GROUP

EXPERTS IN
TRANSFORMER LEAK REPAIR

<ul style="list-style-type: none"> Flapper Valve Packing Flapper Valve Flanges Tap Changers Pumps Drain Plugs Cover Plugs Bushings Weld Leaks 	<ul style="list-style-type: none"> Two Year Guarantee No Draining Oil Sealant Compatibility Analysis Dialectrically Tested Sealant Experienced Technicians Lump-Sum Quotes Reduced Down Time
---	--

866-572-5325

OIL LEAK REPAIR SERVICES

www.coltonline.com

saturation of the vaporization for high energy arcs. Indeed, this saturation is due to the fact that, after the arc has vaporized, almost instantaneously an important gas volume, it stays in that volume using its energy to crack the oil vapor rather than continuing to directly vaporize the oil: this results in a smoother vaporization process. The first stage of the vaporization process is almost instantaneous and because of the oil inertia, the gas is very quickly pressurized, generating one important pressure peak that propagates in the oil. The tests showed that the arc energy does not have any clear influence on the pressure maxima detected in the bubble.

3.3. Analysis: Wave Propagation and Fluid/Structure Interaction

At the beginning of the process, when the arc occurs, the tank is sealed and the vaporization causes the bubble growth which generates a shock wave in the transformer.

3.3.1. Pressure

• Pressure Profile Evolution at a Single Location

The pressure in the transformer after an electrical arc has occurred is transient as shown in Figure 4, where an experimental curve is displayed.

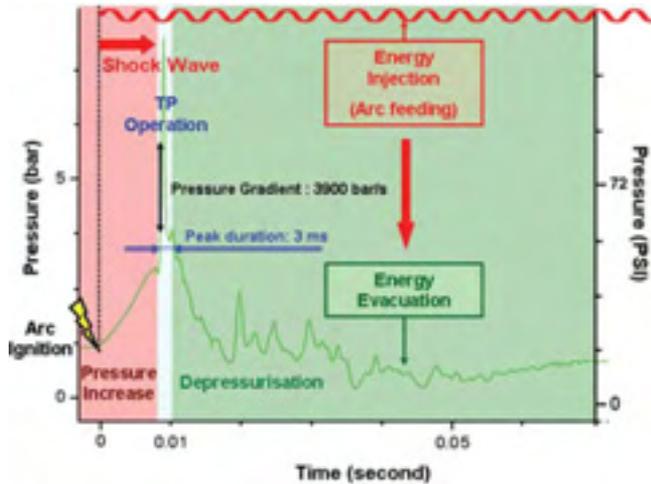


Figure 4: Pressure Evolution Close to the Arc Location after the Arc Ignition

The different phases are also detailed on this figure: after the arc ignition, the pressure locally rises and reaches a maximum level; the waves, generated by the arc, propagate at a finite speed through the transformer and interact with the TP with a pressure gradient of 3900 bar/s (56000 psi/s). Three milliseconds after the TP has activated, the pressure is back to the activation level. Some secondary peaks, much lower than the first pressure maximum, can be observed. They are due to wave reflections off the tank walls and reflected wave interactions.

As soon as the TP has activated, it can be noted that the arc can be fed for a period much longer than the standard opening time of a circuit breaker. Even in this severe condition, the pressure would remain at harmless levels for the transformer tanks.

• Local Pressure and Wave Propagation

The shock wave caused by the electrical arcing propagates in the tank. In Figure 5, experimental pressure profiles are displayed on the right and a simplified associated principle diagram on the left. Each curve shows what happens near each sensor located in positions A, B and C.

The displacement of the shock wave in the tank can thus be followed. The arc ignition located in C causes a high-pressure peak. The pressure waves propagate leading to a second delayed lower peak in B, ending in A. For each sensor, the other pressure peaks (smaller than the main peak) are due to wave reflections off the walls.

It has thus been experimentally proven that pressure is not spatially uniform in the tank, and that the pressure waves propagate at a finite speed.

3.3.2. Pressure Peaks and Tank Withstand

• Pressure Peaks

Only one main pressure peak has been noticed for each test. The pressure profiles show variations after that main peak but their magnitude remains low compared to the first pressure peak level.

Indeed, the initial energy transfer is almost instantaneous, and so is the phase change. The created gas has no time to expand and reach the pressure and temperature equilibrium with the surrounding oil. Because of the oil inertia, the gas gets very quickly under pressure, which generates the first very strong pressure waves.

As it is more difficult to vaporize a liquid than to crack oil

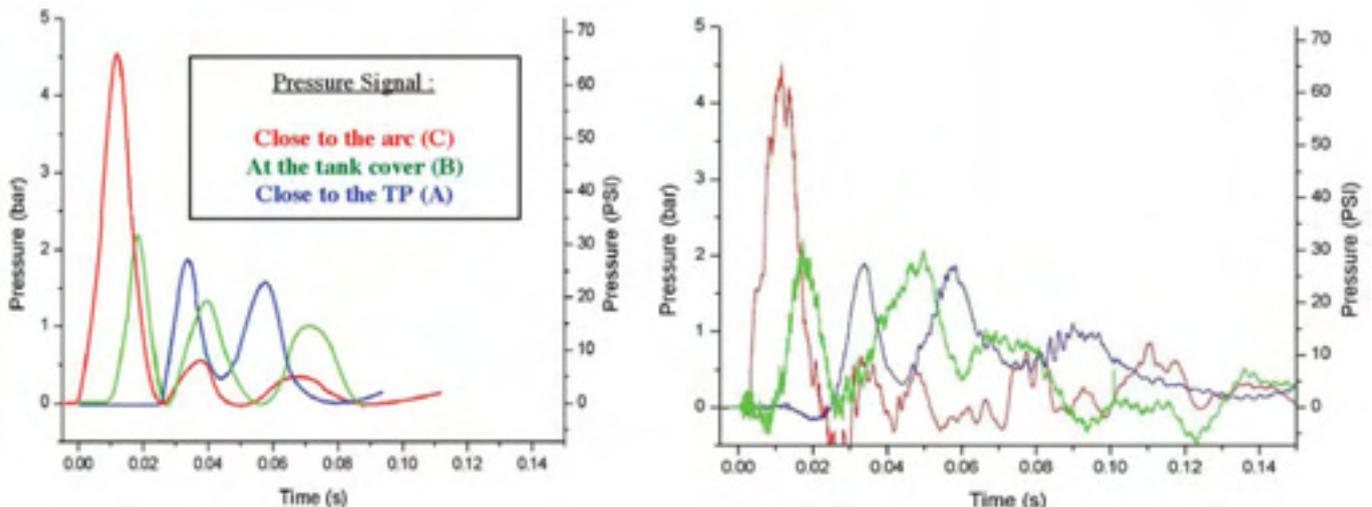


Figure 5: Pressure measurements model

vapor, the arc location would mainly remain in the gaseous phase after its ignition. The vaporization which happens after the gas bubble appearance is smoother and does not really generate physical conditions such as the ones in the very first instance of arc. The secondary pressure variations are thus the result of the overlapping waves and structure influence combined with the smooth gas generation influence on pressure.

Figure 6 shows that even if most of the pressure peaks are higher than the commonly admitted transformer withstand static overpressure limit of +1.2 bar (+17.4 psi), there was no tank rupture.

The pressure peaks' amplitude is determined by the created arc. The peaks range from +1.5 to +13 bar (+21.75 to +188.55 psi) for arc energies from 0.01 MJ to more than 2.4 MJ as shown in Figure 6. The maximum pressure seems to strongly increase with the arc energy while the energy remains in the low range. This dependence tends to weaken as the energy increases. The pressure rise is indeed the result of the strong oil vaporization that takes place in the arc very first moments, the energy transferred afterwards having less impact on the pressure build-up. As an illustration, Figure 6 shows that when comparing tests for which pressure peaks respectively equal +8 bar (+116 psi) and +8.8 bar (127 psi), the maximum pressure only varies in 0.8 bar (11.6 psi) while the corresponding arc energies vary within an order of magnitude (0.1 MJ and 1 MJ respectively). This is a very important statement when trying to extrapolate the pressure maximum for high energy arcs: according to the above data, the local pressure should remain in the pressure range experienced during the CEPTEL tests.

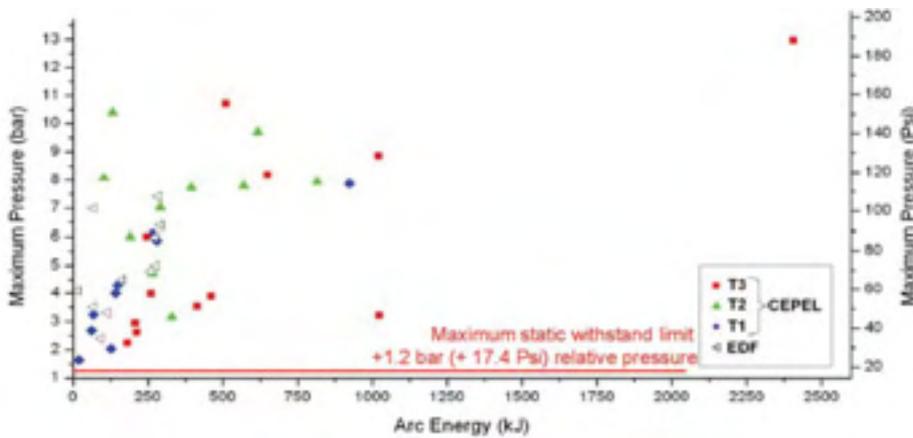


Figure 6 : Maximum relative Pressure close to the Arc v. Arc energy (reference pressure: atmospheric)

• Tank Withstand

To static pressure: To check the mechanical properties of the transformers, static tests were performed before applying any low impedance fault. The withstand limit was found to be +0.7 bar (+10.15 psi) for the biggest CEPTEL test transformer, T3. Therefore, this limit (+0.7bar-+10.15 psi) has been used in this analysis as a threshold for the tank depressurization during the dynamic tests. As long as the average static pressure inside the transformer remains under this limit, the transformer is safe.

To dynamic pressure: Despite the fact that the local pressure measured during the dynamic tests is, on average, 6 or 10 times higher than the static withstand limit (Figure 6), no tank damage and no tank permanent deformation occurs because the

pressure peaks are very short. In fact, the structure can locally withstand high dynamic pressure increases due to the elasticity of its walls and the TP small inertia to operate. If the pressure had remained above the static overpressure limit, the tank would have exploded.

3.4. TP Influence on the Pressure Evolution

3.4.1. Activation Time

The “activation time” is the addition of the following times:

- The “pressure wave transit time” is the time required from the arc ignition, for the shock waves to propagate and reach the TP;
- The inertia of the TP to operate;
- And the TP burst indicator signal delay.

On average, the TP has activated after about 20 milliseconds (minimum: 4.64ms, maximum: 45.7 ms) after the arc was ignited. Because the pressure wave propagation speed is finite, the maximum distance between the arc location and the TP is the parameter that matters the most for the TP to activate. In the worst situation, the arc occurs in the transformer’s lower part opposite the Depressurization Set (location C, figure 9).

3.4.2. Depressurization Time

The depressurization time is the time between the TP Opening and when the pressure is definitely under the level of +0.7 bar (+10.15 psi). It is important to remember that the level of +0.7 bar corresponds to the static pressure limit where leaks appeared on the T3 transformer during the static pressure tests. On average, the TP depressurizes the tank in 116ms, with a minimum value of 19.7ms, and a maximum of 347ms. This experimentally proves the TP’s ability to depressurize the transformer tanks within milliseconds and prevent the explosion. The previous experimental data and their analysis are very important in the numerical tool validation, which is the subject of the following sections.

4. NUMERICAL SIMULATIONS

4.1. Mathematical, Physical, and numerical Modeling

The set of equations used to theoretically and numerically describe the phenomena is a model for compressible two-phase flows that is based on a set of Partial Differential Equations (PDE), which governs the hydrodynamic behavior of mixtures. One of the major and most interesting model’s charac-

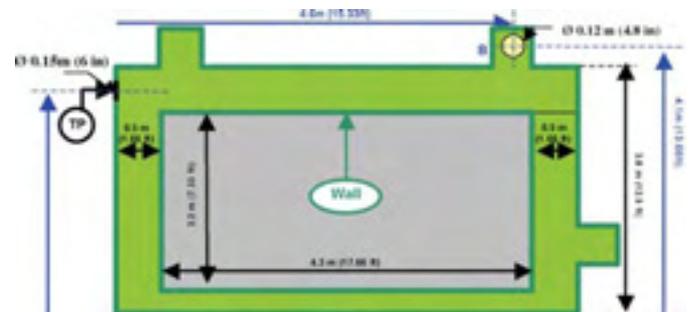


Figure 7: Boundary and Initial Conditions – T3 Transformer

teristics is its ability to accurately depict the pressure wave propagation inside liquids and gases. Physical effects such as gravity, viscosity, and heat transfers are added in the modeling in order to be as close as possible to reality. For the model to be complete and consistent, each phase is described by an equation of state that leads to theoretical sound speeds in agreement with the experimental ones.

A Finite Volume Method is thus adopted to numerically solve the PDE's system. It allows describing precisely complex geometries such as transformer tanks.

4.2. Validation against Experiments

In order to validate the presented mathematical method, numerical tests have been performed and compared to the experimental results. For this comparison, we focus on the most severe tests performed on the T3 transformer, which dimensions are similar to those of a 100 MVA transformer manufactured currently.

4.2.1. Experimental Tests for Comparison

Two experimental CEPEL tests (number 31 and 33) are analyzed here to compare numerical and experimental results. For both tests, the transformer is subjected to an 83ms arc occurring in position B, figure 8 with a maximal current peak of 30kA (nominal value 14kA) and a maximum voltage of 1kV. Test 31 considers a TP with a calibrated relative burst pressure of +1.5 bar (+21.75 psi) and with an outer reference absolute pressure of 0.1 bar (1.45 psi) while test 33 is performed using a TP with a calibrated relative burst pressure of +0.8 bar (+11.6 psi) and with an outer reference absolute pressure of 1 bar (14.5 psi).

4.2.2. Geometry, Initial and Boundary Conditions

The outer tank as well as the magnetic core dimensions are detailed in Figure 7.

The TP is numerically modeled and the calibrated burst pressure is set depending on the simulated test.

Experimentally, the arc vaporizes the oil and creates gas bubbles under pressure. In the initial state of the simulations we assume the gas bubble has already been created by the arc and the gas is already under pressure.

Thus, the gas bubble generated by the arc is located in the initial state in position B, figure 8. Pressure inside the gas bubble (4.3bar, 62.4psi) and the corresponding density (4.3 kg/m³, 0.27 lb/ft³) are determined according to the arc energy for each test. The arc characteristics are those of the corresponding experimental test.

Moreover, virtual pressure sensors are located in the simulation domain in order to compare the experimental pressure profiles to simulated ones. The results of this comparison are shown in Figure 8.

4.2.3. Experiment/Simulation Qualitative Comparison

Experimental and numerical results regarding the pressure time evolution are similar. In both cases, the three same

Nearly 800 shipped to over 54 countries

VLF IT!

Our VLF products have finally brought a portable and affordable method of AC testing for cables, generators, and other high capacitance loads. Cables and generators are designed for and operate under AC stress. They should be tested with AC voltage.

Control your outages while improving power delivery reliability.

NEW! Automatic Data Logger with VLF Units – Available NOW!

● Power Cables

- Hipot after installation or repair
- Test critical feeders
- Test cables of critical customers
- Tan Delta & Partial Discharge compatible
- Best means of burning faults

● Generators

- Interim and final factory testing
- On-site maintenance testing

Meets IEEE-400.2, IEEE-433,
DIN VDE 0276/620,
(Cenelec HD620),
IEEE 400-2001

VLF Patent #US 6,169,406

For more information on VLF, download our VLF FAQ paper from our website.

VLF 1Hz testing offers the surest way to expose defects in power cables, splices, generators and other high capacitance loads that require AC testing.
Fast, easy and inexpensive.



Ideal for commissioning and HV AC withstand testing of Windfarm Power Cable Circuits



IMPROVE SYSTEM RELIABILITY



HIGH VOLTAGE
VLF HIPOT INSTRUMENTS INC.

31 County Rt. 7A • Copake, NY 12516 • (518) 329-3275 • Fax: (518) 329-3271
E-mail: sales@hvinc.com • www.hvinc.com

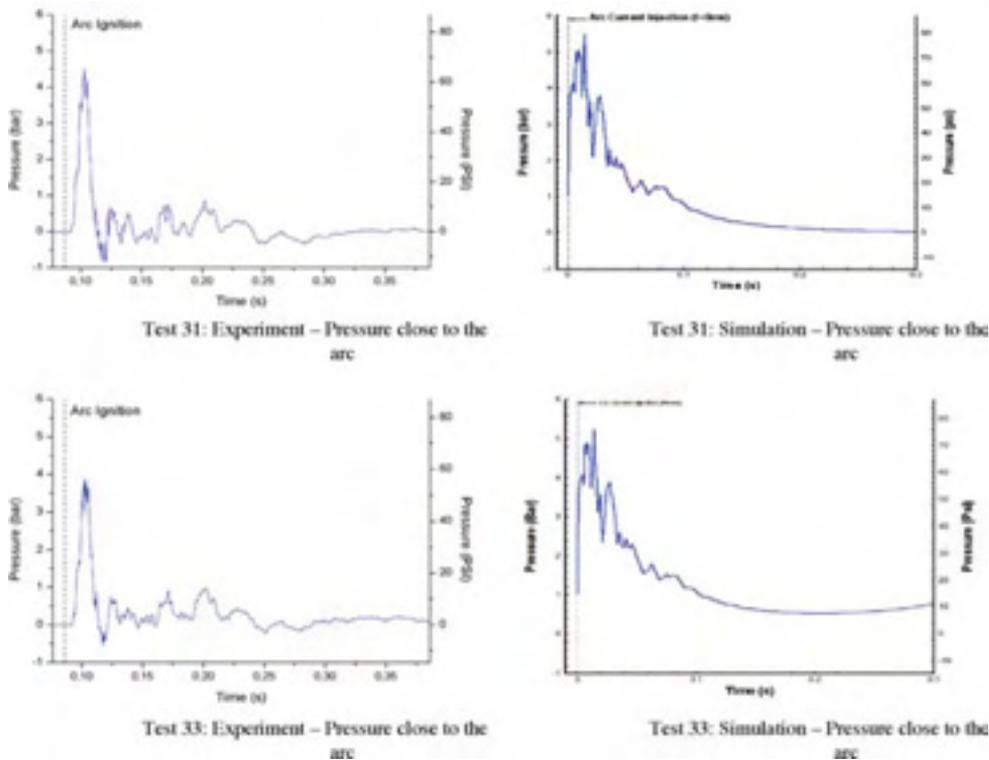


Figure 8: Geometry influence on pressure profiles

phases can be observed: a very sharp pressure rise following the arc ignition, a pressure drop because of the TP activation, and a phase where the pressure alternatively rises and decreases because of the complex wave dynamics due to the wave reflections off the transformer walls (cf. Figure 8). It can be seen that in both cases the pressure returns to the initial reference pressure.

In Figure 8 where numerical as well as experimental results are displayed, the experimental results are in accordance with the tendency exhibited in the previous sections. The simulated pressure profiles are very similar as well: even if the pressure maxima are not exactly the same, the chronology of

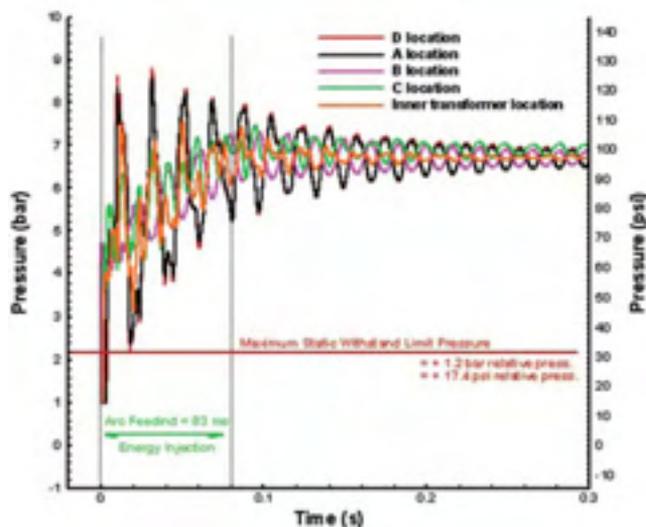


Figure 9: Pressure when the Tank is NOT equipped with the TP

the phenomena and the profile shapes are identical. These similarities between experiments and theory confirm the geometry influence on local pressure profiles. On each profile, we can also notice that the TP influence causes an inner tank average pressure decrease. The pressure oscillations are due to the pressure waves (rarefaction and compression waves) that propagate back and forth in the tank interacting with the tank structure.

4.3. Numerical simulation results

Simulations manage to give results in accordance with the experimental results, for a relatively low cost and without any danger. They were thus used here to compute the consequences of an electrical arc appearing in a tank not equipped with a TP and also to compute the TP operation on a very large transformer.

4.3.1. What would happen without TP?

Experimental testing would be dangerous if the transformer were not protected by a TP, so numerical simulations were performed instead. Figure 9 shows pressure evolutions computed for a geometry and for arcing conditions similar to those of the CEPTEL test 31 (Figure 8). It shows that, after the arc feeding, the average pressure remains close to an equilibrium state equal to 7 bar (100 psi), much higher than the static withstand limit pressure.

Thus, during test 31, if the transformer had not been equipped with the TP, the inner average pressure would have risen up to the static overpressure withstand limit. The transformer would have exploded as soon as the tank wall elasticity limits were over, i.e. as soon as the tank walls could not store any more mechanical energy due to the pressure increase.

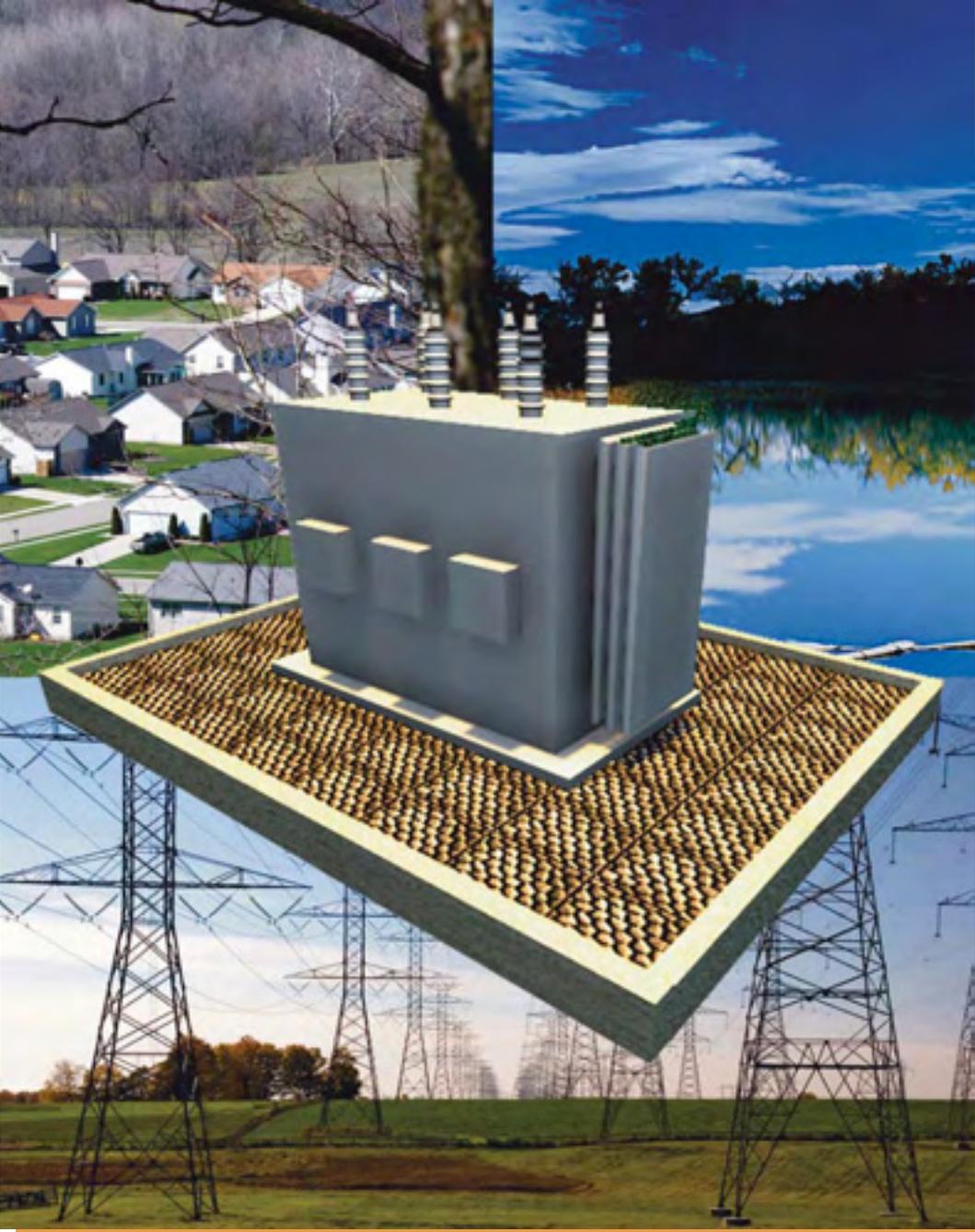
Geometry and Numerical Parameters:

The 750 MVA transformer dimensions are displayed in Figure 10. The studied configuration corresponds to the worst case where the electrical arcing is ignited in location C, figure 9, where the gas bubble appears. The maximum distance between the TP and the arc ignition is the key-parameter. In the case of the CEPTEL tests, for T3 transformer, the biggest of the three, this distance was 8.5 m (28 ft). In the case of this 750 MVA transformer geometry, this distance is about 15 m (49 ft), twice the distance considered in the case of T3 transformer. In conclusion, the extrapolation is only of an order of 2, instead of an order of 37. The RD calibrated static pressure is set at +1.2 bar (17.4 psi).

Continued on Page 22

The SorbWeb™ Plus

Secondary Oil Containment System Solution



- Proven system that effectively contains oil spills from equipment and transformers
- No pumps, no oil water/separator, no maintenance
- Engineered and designed around site requirements
- SPCC Compliant



CANADA
Tel: 705-737-0551
Toll Free: 1-866-269-8275

USA
Tel: 207-786-0424
Toll Free: 1-877-786-0424

www.sorbwebplus.com

Transformer Explosions

Continued from Page 20

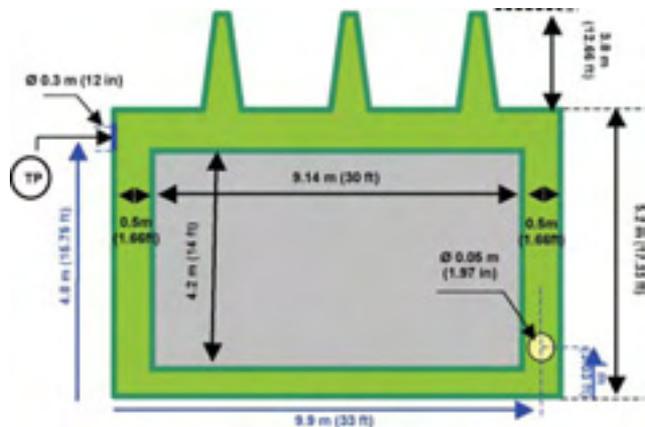


Figure 10: Initial and boundary conditions, pressure sensors locations

Results:

A 70 kA arc is applied to the system for 70 ms, which is illustrative of harsh fault conditions. The maximum pressure reached and recorded during this simulation is higher than 5.5 bar (80 psi) in one of the bushings and 4.2 bar (61 psi) close to the arc. The major value in the bushing is due to its geometry (wave-guide). The time for the wave to be propagated from the arc to the TP is 13.86 ms.

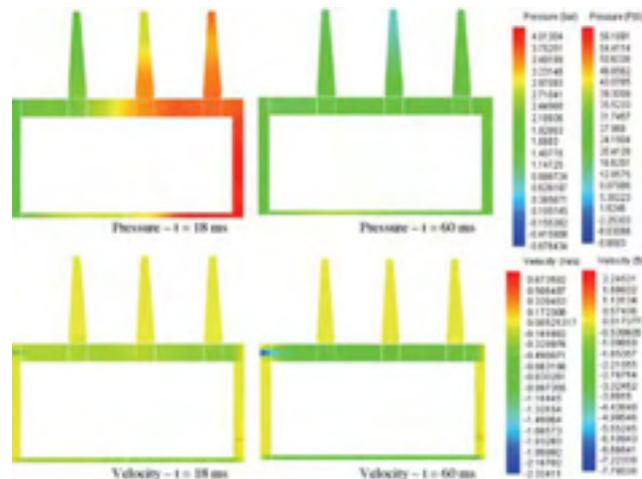


Figure 11: TP behavior – 750 MVA, 70 ms, 70 kA, C

The depressurization time is 60 ms, which is very acceptable for such a tank size. The pressure repartition informs us about the way the wave concentrated in any locations into the tank. The Figure 11 shows the interaction of the pressure wave with the TP after 14 ms. After 60 ms, the TP almost decreases the pressure under the 0.7bar (10.15 psi) level in the entire tank, even if the electrical arcing is still supplied (pressure rise close to the bubble location). Even with a higher current (70 kA instead of 15 kA for CEPTEL tests) applied for 70 ms, the TP succeeds in depressurizing the tank in a few milliseconds since the pressure remains under the average withstand limit of the structure.

5. CONCLUSION

An essential step for SERGI is to show the TRANSFORMER PROTECTOR efficiency for all transformers and all types of rupture of insulation. Its research program philosophy is thus to maintain a strong connection between experiments and the theoretical developments:

- 34 experimental tests under severe low-impedance faults were performed in the CEPTEL Laboratory. They showed that during a transformer short circuit, the TRANSFORMER PROTECTOR (TP) is activated within milliseconds by the first dynamic pressure peak of the shock wave, before static pressure increases, thus preventing the transformer tank rupture;

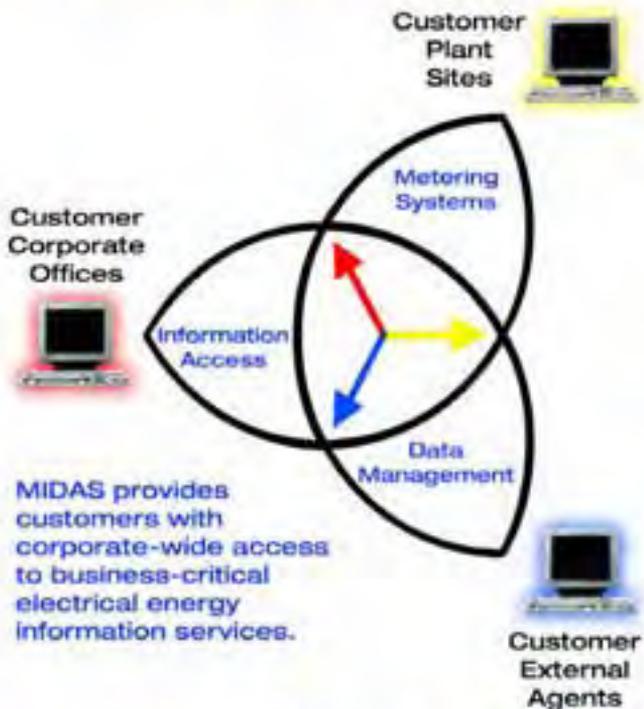
- In addition, a complete numerical tool was developed in order to describe compressible two-phase flows, the pressure wave propagation inside liquids and gases, and to simulate the TP depressurization process. This tool was validated using comparisons with the experimental data.

Furthermore, results from the simulations show that:

- if the same arcing conditions as during the CEPTEL tests had been applied to a transformer not equipped with a TP, the tank would have been subjected to static pressure up to 7 bars to which it would not have been able to resist;

- The TP is efficient to quickly depressurize large transformers (up to 10m / 33ft long) subjected to severe electrical fault conditions and to prevent the transformer tank explosion.

MIDAS Metering Services Ltd.



MIDAS provides customers with corporate-wide access to business-critical electrical energy information services.

"Putting the power of information in your hands."

710, 138 - 4th Avenue S.E., Calgary, AB Canada T2G 4Z6
 Telephone: (403) 301-3314 Facsimile: (403) 301-3316
www.midasmetering.com

REDUCE RISK EXPOSURE FOR SUBSTATION TRANSFORMERS

By Patrick McShane, Product Manager, Fluids and Transformer Components

The aging of the substation infrastructure in the United States is causing increasing concerns for risk management. The rate of installation of new units is currently very low. Compounding the problem, the load demand on existing units continues to grow, however slowly.

One report by a major insurance group predicts substation transformer failures to rise by 500% within ten years as many units installed in the heyday of the '50s and '60s are exceeding their expected operational life cycle. Another insurance group reported that in a recent study period, the operational life cycle appears to be decreasing. The failures, due to insulation deterioration, occurred in transformers with an average age of just 17.8 years vs. the average expected life of around 40 years.

Unfortunately, a small but significant percentage of substation transformer failures occur in an "eventful mode," resulting in ruptures and/or fires. In spite of established safeguards, such as deluge systems, separation distance requirements, and firewall barriers, significant fires have been reported. One insurance company reported 25 substation transformer failures costing over \$100,000 each in just one year. But often the real cost is not the damaged transformer, but rather consequential damages. For example, just this past January, two transformer substation fires were reported nationally, one at a nuclear power plant and one at a petrochemical plant. Production downtime, lasting weeks, was estimated to cost approximately one million dollars per day for each incident.

Other potential eventful failure costs include the potential for damage to adjacent equipment and property, casualties and resulting liabilities, potential environmental risk exposures, and unfavorable publicity that often accompany such eventful failures.

Fortunately, there is a practical and proven means to significantly reduce, if not eliminate the risk of substation fires: The replacement of mineral oil with fire-resistant, ester-based dielectric coolants for new and aged power transformers.

Factory Mutual Global has increased the amount of fluid volume by a factor of ten eligible for significant reduction in fire protection safeguarding for transformers containing the fire-resistant fluids.

The recent revision of the Factory Mutual Global Property Loss Prevention Data Sheets 5-4 for transformers, has two major changes:

Liquid	Approved Transformer or Equivalent	Liquid Volume, gal (m ³)	Horizontal Distance			Vertical Distance ft (m)
			Two Hour Fire Resistant Construction, ft (m)	Non-combustible Construction, ft (m)	Combustible Construction, ft (m)	
Less Flammable (Approved Fluid)	Yes	N/A	3 (0.9)			5 (1.5)
	No	≤10,000 (38) >10,000 (38)	5 (1.5) 15 (4.6)		25 (7.6) 50 (15.2)	25 (7.6) 50 (15.2)
Mineral Oil or (Unapproved Fluid)	N/A	<500 (1.9)	5 (1.5)	15 (4.6)	25 (7.6)	25 (7.6)
		500-5,000 (1.9-19)	15 (4.6)	25 (7.6)	50 (15.2)	50 (15.2)
		>5,000 (19)	25 (7.6)	50 (15.2)	100 (30.5)	100 (30.5)

Table 2a Separation Distance Between Outdoor Liquid Insulated Transformers and Buildings

Liquid	Approved Transformer or Equivalent	Fluid Volume, gal (m ³)	Distance ft (m)
Less Flammable (Approved Fluid)	Yes	N/A	3 (0.9)
	No	≤10,000 (38) >10,000 (38)	5 (1.5) 25 (7.6)
Mineral Oil or (Unapproved Fluid)	N/A	<500 (1.9)	5 (1.5)
		500-5,000 (1.9-19)	25 (7.6)
		>5,000 (19)	50 (15.2)

Table 2b Outdoor Fluid Insulated Transformers Equipment Separation Distance

Reduction in minimum separation distances for medium power transformers and increase in fluid volume threshold before containment is required for highly biodegradable fire-resistant fluids.

Need Help?
Need A Job?
Contact Lisa—



Call or send confidential resume to
LISA LINEAL: LINEAL Recruiting Services
OVER 25 YEARS EXPERIENCE

TOLL FREE 877-386-1091

Ph: 203-386-1091 Fax: 203-386-9788

lisalineal@lineal.com
www.lineal.com

Electromechanical • Electronic
Electrical Service & Systems Specialists

Se Habla Español



GridSense-Inc is a leading manufacturer of intelligent Line Monitoring, Power Quality and Condition Monitoring systems. We offer immediate and cost effective "smart grid" solutions to Electric Power Utilities providing critical information on the condition and operating performance of the Transmission and Distribution grid. GridSense providing the intelligence for the Smart Grid of the future.

LineTracker | Overhead Load, Fault & Event Monitoring



The LineTracker system is an effective wireless Smart Grid monitoring solution capturing critical line condition and performance parameters including load, fault current and protection operation information allowing utilities to optimize asset utilization and improve system reliability and quality of supply.

- For use up to 138kV
- Live Line Installation
- Self-Powered
- Wireless Communications

PowerMonic | Portable & Weatherproof Power Quality Analyzer

The rugged PowerMonic is an easy to use portable power quality and event recorder offering effective, reliable and versatile monitoring of low voltage circuits. It is a versatile workhorse instrument that can be relied upon for investigating a wide range of voltage investigations, equipment compliance studies and power flow analysis.

- Weatherproof
- Rugged Field Design
- Versatile
- Easy-to-Use



The reduction in minimum separation distance appears in both Tables 2a, Separation Distance Between Outdoor Liquid Insulated Transformers and Buildings and Table 2b, Outdoor Fluid Insulated Transformers and Equipment Separation Distance. In the previous version of the LPDS (Revision Jan. 2001), the minimal horizontal distance for FM Approved, fire-resistant, dielectric fluid-filled equipment was 5 feet to non-combustible construction, and was limited to transformers containing 1,000 gallons. The volume has been increased to allow transformers containing up to 10,000 gallons with this clearance. This compares to the limit of less than 500 gallons for conventional mineral oil transformers with a minimum of 15 feet to noncombustible construction. In addition, the distance is measured from the transformer for the FM Approved fluids, but for mineral oil units it typically must be measured from the outside edge of the required containment means.

For example, consider a 100 MVA unit with a total of 10,000 gallons in the main tank and LTC compartment. The minimum required horizontal distance between its tank and the next closest equipment or non-combustible construction wall is 5 feet if the dielectric coolant is FM Approved. For mineral oil filled transformers, the minimum separation is the distance from the tank to the edge of the containment area, plus 50 feet.

The bases of the above changes are primarily due to both the fire safety record of less-flammable fluid and recent "worst case" fire testing performed at the Thomas A. Edison Technical Center in Franksville, Wisconsin. Previous high fault primary and secondary testing has shown that it is essentially not possible to ignite liquid-less-flammable fluids by arcing as the ignition source. The more recent testing has shown that another ignition means, glowing hot metal, easily and quickly ignites conventional transformer mineral oil, but does not ignite fluids with fire points greater than 300°C under the same operational conditions.

There have been no reported fires involving any of Cooper Power Systems' fire-resistant fluids since the introduction of the first such dielectric coolant, R-Temp Fluid, in 1975.

The other major revision in the new FM LPDS for transformers involves changes in the threshold volumes requiring fluid containment for environmentally preferred dielectric fluids such as



Significant transformer fires have been reported despite established safeguards



Envirotemp FR3, the natural vegetable oil based fluid. Transformers filled with fluids certified as biodegradable by the EPA, containing less than 2640 gallons where the release of such a fluid does not expose navigable waterways, may be exempt from the FM Global containment requirement. The threshold for mineral oil is 500 gallons or less, depending on exposure to buildings.

The U.S. EPA has certified the biodegradability of Envirotemp FR3. When tested per the EPA Method OPPTS 835.3100, its biodegradation rate and completeness slightly exceeds that of a material the EPA classifies as "Ultimate Biodegradability." Because the U.S. EPA has published its verification of our published environmental claims of Envirotemp FR3 fluid, transformers with the fluid can bear the U.S. EPA ETV logo. ETV is the acronym for Environmental Technologies Verification. Envirotemp FR3 is the first transformer material to receive the U.S. EPA ETV status.

Both initial and maintenance cost sfor containment and fire protection at a substation can be very high. The new FM Global requirements offer high potential savings by substituting alternative fluids for mineral oil.

VOLTAGE SAGS: AN EXPLANATION - CAUSES, EFFECTS AND CORRECTION - PART II

By Ian K.P. Ross, MIEE, Omniverter Inc.

8.0 THE SOLUTION

8.1 First Identify the Problem

8.1.1 Equipment Identification

In order to provide an optimal and cost effective solution to voltage sag problems, it is necessary to determine which equipment is susceptible to unplanned stoppages. In most industries, there is still a significant amount of electrical equipment which is not sensitive to voltage variation or which can be restarted at little or no cost. Usually it is not necessary to protect an entire industrial facility, it is sufficient to protect the key sensitive equipment.

8.1.2 Identify the Voltage Sags

The next stage is to determine the frequency, depth and duration of the voltage sags.

These can vary widely even in apparently similar industrial facilities. Collection of this data is essential if the optimal solution is to be identified.

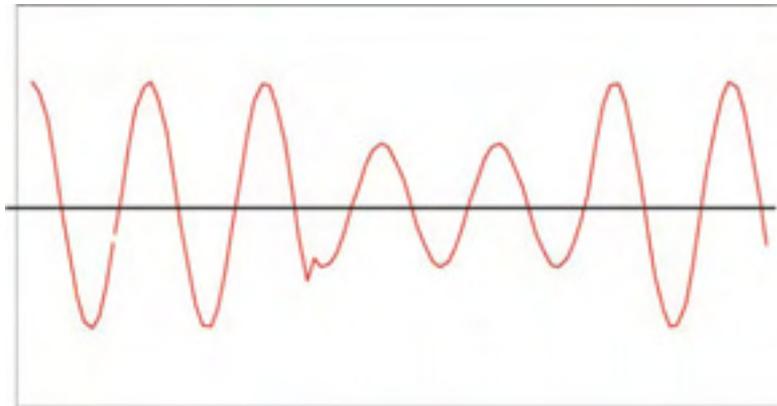
In North America, only a small proportion of manufacturing businesses have installed electrical metering which is capable of measuring and recording the voltage variations which are responsible for the majority of their very costly Unplanned Production Stoppages.

8.2 Measure the Problem

8.2.1 Install Metering

To identify the depth of the voltage sags and their duration, the sag events need to be measured and recorded for subsequent analysis. As typical voltage sag events last only a few cycles, the most cost effective way to measure these is by installation of an electronic meter with wave form capture capability.

As and when a voltage sag occurs, these devices capture the 3-phase voltage values throughout the sag event, the duration of the event in cycles, and can time stamp the start and or finish of the event. The data is captured automatically and is downloaded to a computer for later analysis.



Voltage Sag - A reduced voltage for a limited period
Figure 1

8.2.2 Record Unplanned Production Stoppages

It is extremely helpful to record precisely the time and date of unplanned production stoppages and then to compare these against voltage variations recorded by the meter, as not all voltage sags lead to stoppages. This analysis will show the value of the sag voltage which typically causes production problems and equally those events which have not caused problems.

Surprisingly, in many industries, people are so busy trying to restart the process, they fail to record the time of the stoppage with any formal system. Even in large companies, precise data on the number and duration of unplanned stoppage is often difficult to find.

8.2.3 Meter Cost vs. Cost of Unplanned Production Stoppage

The cost of an installation with a meter capable of wave form capture and its software is typically a few thousand dollars.

This is often only a small fraction of the cost of even one unplanned production stoppage. Unfortunately installation of such meters has not become commonplace in many industries as "there is no money in the budget for this".

8.3 Choose a Solution

Once the characteristics of a typical voltage sag have been determined by examining recorded data from the waveform capture meter over a period of time, it is possible to calculate the type of voltage sag correction required to cover the depth and duration of expected future voltage sag events.

If it is possible to correct the problem by changing some sensitive components, this may well be the least expensive solution. This approach has been widely adopted in the semi-conductor industry and it is notable that this industry has invested heavily in high quality meters to identify the problems. This is an industry where an unplanned stoppage may cost \$1 million per event or more.

If component substitution is not practical, it is necessary to identify the size of the load to be protected in kVA and its supply voltage. This may be an entire plant at medium voltage or a critical machine at low voltage or anything in between.

9.0 THERE ARE VOLTAGE SAG CORRECTION DEVICES AVAILABLE

9.1 Traditional Solutions

Traditional methods of Voltage Control included Transformer Tap Changers both mechanical and SCR switched units, Servo-Variac technology

and Ferro-Resonant Transformers (constant voltage transformers).

In some cases and for some applications these traditional technologies may still be applicable and work well, but in many cases they were designed to correct problems other than voltage sags.

9.2 UPS Solutions

Uninterruptible Power Supplies (UPS) technology has been available for over 20 years and is ideally suited for those applications such as high speed data processing where continuous protection against any power variation and more importantly against any power interruption is essential.

Industrial UPS units are widely used to protect electronic process control equipment and to allow for an orderly shutdown of the process but it is rarely economic to install large UPS systems with their attendant large battery banks for high power electrical equipment such as high horsepower drives, extruders etc.

9.3 Electronic Voltage Regulators

There are several manufacturers of devices designed specifically for voltage sag correction in industrial applications. These devices use a combination of an inverter plus short term electrical storage or an inverter with a specially designed injection transformer to provide voltage correction against voltage sags as they arise.

Typical response times from initiation of a voltage sag to its correction are

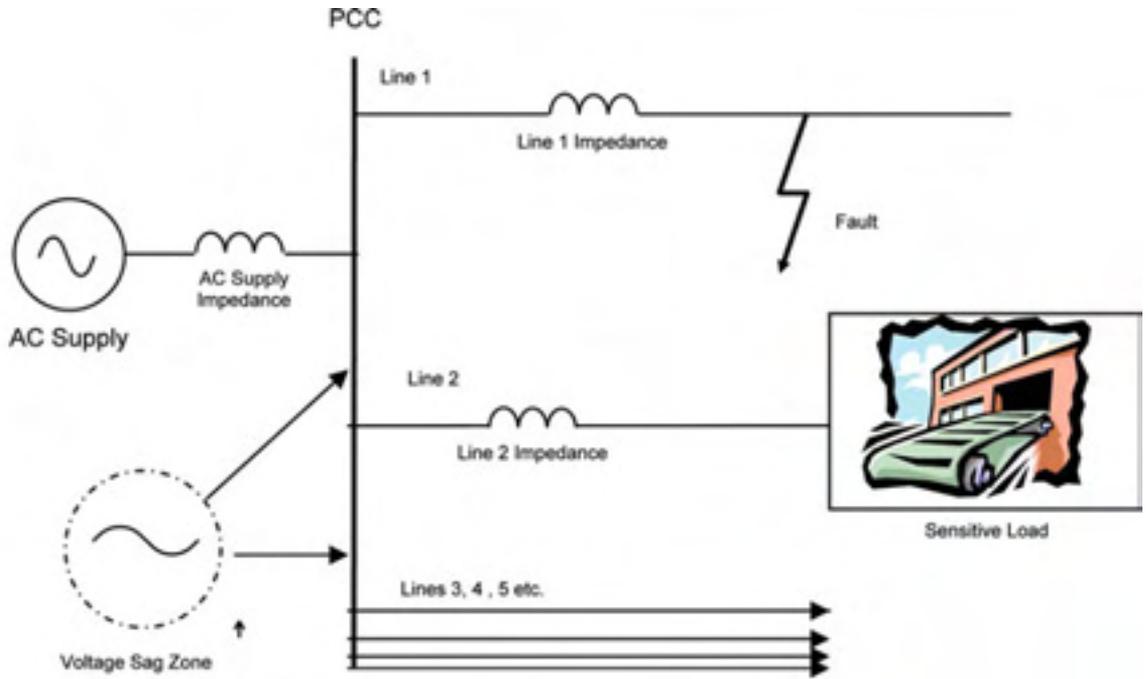


Figure 2

Electrical utilities are unable to eliminate the causes of voltage sags and this situation will not change in the foreseeable future.

of the order of one half cycle or less.

Some devices offer limited ride through a zero voltage event for a short time, others do not.

These devices provide excellent protection against both 3 phase and single phase voltage sags.

Some manufacturers offer small single-phase devices at low voltage 120V or 220V typically with small kVA ratings. Others provide only 3-phase devices at low voltage 208V – 600V and at medium voltage to 36kV.

The kVA ratings of 3 phase devices typically range from <20kVA -5 MVA at low voltage and from 1MVA to 50MVA for medium voltage applications.

A few manufacturers offer solutions in the 50MVA to 100+MVA range at medium voltage

but demand for these occurs infrequently.

9.4 Pay back on Sag Correction Investment

Typically, pay back periods for actual savings achieved by businesses who

have installed voltage sag correction equipment can be as little as few weeks, more commonly 12 months or less, but rarely exceed two years.

10. Summary

Voltage sags occur throughout North American utility networks. Some areas are more susceptible than others, as the frequency of events is related to weather and climate.

Electrical utilities are unable to eliminate the causes of voltage sags and this situation will not change in the foreseeable future.

Industry has invested heavily in high-speed and precision equipment, much of which is more sensitive to voltage variation than traditional machinery.

It is possible to establish a history of voltage sags in any given facility for a modest investment in one or more suitable meters and their associated software. The events from this history can be compared to the incidence of unplanned production stoppages, if adequate records are kept.

There a number of alternative solutions available for the correction of voltage sags, and typically the financial case for investment in these solutions will meet or exceed the investment criteria for many industries.

ENERCOM - BUILDING CANADA'S ENERGY VISION FOR THE 21ST CENTURY

TORONTO ONTARIO - MARCH 31 – APRIL 2, 2008

ENERCOM 2008 brings together the leading industry experts who will challenge you with views on topics critical to **“Building Canada’s Energy Vision for the 21st Century”**. Don’t miss this opportunity to participate and hear first hand about the issues impacting our industry and country.

We have an action packed 2008 conference, co-chaired by **David McFadden**, Senior Partner, Gowlings LLP, Chair, National Energy and Infrastructure Industry Group and Chair, Board of Directors for the Ontario Centres of Excellence, and **David Collie**, President & CEO, Burlington Hydro Inc. and Chair of the Electricity Distributors Association.

Speakers and panels of ENERCOM 2008 will share the following:

World challenges in meeting rising energy demands

Addressing challenges to electricity infrastructure development

Electricity outlook, future scenarios for North America’s energy market

How innovative technologies and new thinking are shaping Ontario’s energy future

Ontario’s energy economics

The regulation pendulum

Where will the money come from? – Ontario’s need for new infrastructure

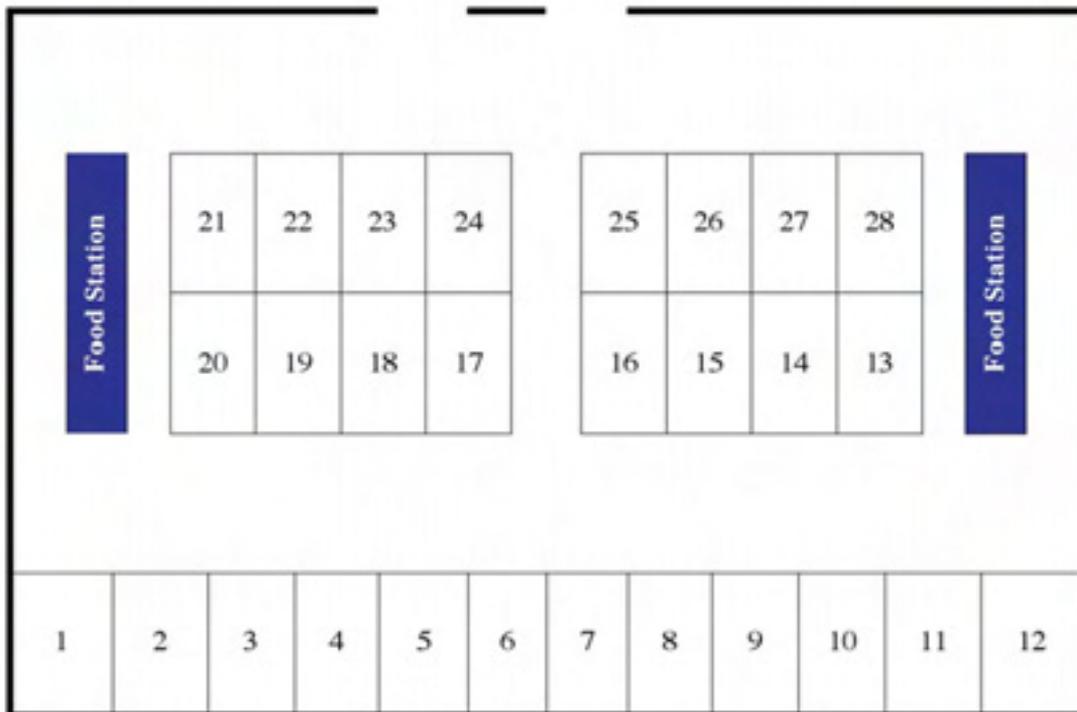
Hear also keynote addresses by **Jeffrey Simpson, The Globe & Mail’s National Affairs Columnist on ‘Hot Air: Fixing Canada’s Climate Change Catastrophe’** and **Peter C. Newman, Legendary Journalist & Best Selling Author on Why The 21st Century Will Belong to Canada.**

ENERCOM 2008 offers unique networking opportunities, including a gala opening reception and dinner on March 31st. Join key sector executives and policy makers for an exclusive evening.

Display your products/services directly to your target market, and take advantage of additional marketing opportunities. Exhibit and sponsorship opportunities are available: See www.enercom.to.

Reserve your spot now for Canada’s leading Energy Conference & Exposition at the Fairmont Royal York Hotel, Toronto, Ontario. For full program details and registration information, visit www.enercom.to.

ENTRANCE



GAUGES ARE AN IMPORTANT PART OF YOUR TRANSFORMER'S OPERATIONS

By Guy Agustin and Ben Caples, Field Service Technicians, Transformer Testing & Repairs, Inc.

TEMPERATURE GAUGES

A Temperature Gauge is a common safety device installed on transformers, regulators and other electrical equipment when filled with liquid insulating fluid(s) for dielectric insulation and cooling.

Normal equipment operation and the environmental temperature cause changes in the oil temperature. The warmer oil will usually rise to the top of the tank. A temperature gauge well is normally mounted slightly below the 25 degree centigrade oil level. This submerges the well in the top of the oil where the warm oil accumulates. A temperature gauge is installed in the well to measure the changes in the temperature of the liquid insulating fluid(s). Temperature gauges and wells provide a positive system to measure and indicate the insulating fluid(s) temperature in transformers, regulators and other electrical equipment.

Various ANSI, IEEE and industry standards specify temperature gauges and wells to measure and indicate the insulating fluid(s) temperature in transformers, regulators and other electrical equipment.

PRESSURE-VACUUM GAUGES

Pressure-Vacuum Gauges are commonly installed as safety devices on liquid insulating fluid(s) filled transformers, regulators and other electrical equipment that provides a gas space above the oil.

After the tank is filled with liquid insulating fluid(s) to the 25 degree centigrade level, the liquid insulating fluid(s) are blanketed with a positive inert gas (nitrogen) pressure. The positive inert gas blanket provides a moisture barrier and room for the liquid insulating fluid(s) to expand.

Normal equipment operation and changes in the environmental temperature cause changes in the liquid insulating fluid(s) and gas volume. The liquid insulating fluid(s) and gas expand when heated and contract when cooled. The expansion causes an increase in the gas

pressure and the contraction causes a decrease in the gas pressure. Pressure/vacuum gauges measure and indicate the gas space pressure or vacuum in transformers, regulators and other electrical equipment.

When transformers operate, they generate normal gases, but can also develop internal faults that will generate abnormal gassing rates. Most high voltage electrical equipment (especially transformers) are completely sealed, and if left unmonitored, these gases can build up and cause ruptures and possible equipment failures. Pressure-Vacuum Gauges are the front-line defense in monitoring possible problems.

Various ANSI, IEEE and other industry standards specify pressure/vacuum gauges to measure and indicate the gas pressure in liquid insulating fluid(s) filled transformers, regulators and other electrical equipment.

LIQUID LEVEL GAUGES

This type of gauge is a common safety device installed on transformers, regulators and other electrical equipment when filled with liquid insulating fluid(s) for dielectric insulation and cooling. The tank is normally filled with liquid insulating fluid(s) to the 25 degree centigrade level, which is marked on the tank wall. Normal equipment operation and changes in the environmental temperature cause changes in the liquid insulating fluid(s) volume. The liquid insulating fluid(s) expands when heated and contracts when cooled. The liquid insulating fluid(s) is usually colorless and difficult to see without the aid of a liquid level gauge.

Liquid level gauges provide a positive indication of the oil level in transformers, regulators and other electrical equipment. Low fluid levels can lead to overheating, premature loss of electrical equipment life, or even failure of the equipment.

PRESSURE RELIEF VALVES

A common safety device installed on

liquid insulating fluid(s) filled transformers, regulators and other electrical equipment provides a gas space above the oil. After the tank is filled with oil to the 25 degree centigrade level, the oil is blanketed with a positive inert gas pressure. The positive inert gas blanket provides a moisture barrier and room for the oil to expand. Normal equipment operation and increases in the environmental temperature cause increases in the gas pressure.

When transformers operate, they generate normal gases, but can also develop internal faults that will generate abnormal gassing rates. Most high voltage electrical equipment (especially transformers) is completely sealed and if there is no way to vent the buildup of these gasses, over pressure can cause ruptures and possible equipment failures. Pressure relief valves are the front-line defense in protecting your investment.

Electrical equipment tanks are usually designed to withstand the pressures created during rated operating and temperature conditions. The tanks are normally equipped with a pressure relief valve to relieve excess pressure. The valve opens and closes automatically with a provision for manual operation. Our pressure relief valves automatically and manually relieve excessive gas pressure in transformers, regulators and other electrical equipment. Various ANSI, IEEE, REA and industry standards specify pressure relief valves to relieve excessive gas pressure in electrical equipment.

PRESSURE RELIEF DEVICE

The pressure relief device (PRD) is designed to open and close automatically when the pressure reaches the operating pressure of the PRD.

The pressure relief device will open and remain open until the pressure falls to the reseal pressure. The pressure relief device reseals at a positive pressure. Pressure relief devices are available with an optional alarm switch and semaphore (indicating flag).

NUCLEAR SELLS CLEAN AIR, ENHANCES SAFETY FOR NEW GENERATION REACTORS

By Dr. Ken Petrunik, President, CANDU Reactor Division, Atomic Energy of Canada Limited

After several decades of slow global growth of nuclear power capacity, governments and the public are again thinking seriously about new nuclear power plants (NPPs) as a source of clean, safe, economic baseload electricity. During this period, Atomic Energy of Canada Limited (AECL) has continued to build CANDU plants around the world and recent new-build CANDU 6 projects have shown record delivery performance, allowing the industry to overcome public perception that nuclear projects often exceed their budget and schedule.

CANDU nuclear reactors currently produce about 16% of Canada's electric-

ity and more than 50% of the Province of Ontario's electricity generation mix. Canada has abundant supplies of uranium, a strong nuclear power industry and high-performing, homegrown reactor technology in the form of the successful CANDU power reactor and a new reactor product, the Advanced CANDU Reactor, ACR-1000, which can meet demands for safe, clean, economic electricity — in Canada and other countries — until at least the end of this century.

In Canada, recent public opinion surveys show support for nuclear energy reaching its highest level in two years, with a 15% increase in support — to 63%

— in Canada's major "nuclear energy" province, Ontario. Across Canada, Alberta has emerged third to Ontario and New Brunswick in terms of support.

CLEAN AIR BENEFITS

Canada has a wide mix of energy resources, including hydro, gas and nuclear, and renewable energy sources such as wind power, and efforts to conserve energy have been strengthened in recent decades. However, most easily-accessible hydro sites are already in use and coal is being phased out for environmental reasons. As well, natural gas is a finite resource, subject to price and sup-

Are you an expert in Arc Flash and Electrical Safety? Your talents are needed NOW!

ELECTRICAL TRAINERS

for a variety of subjects:

- Arc Flash Analysis
- Industrial Electrical Safety
- Air Conditioning & Refrigeration
- Short Circuit Study
- Coordination Study
- Arc Flash Study
- Circuit Breaker Testing and Maintenance
- Electrical Relay Protection
- 2006 Canadian Electrical Code
- Power Transformer Maintenance
- Programmable Logic Controllers
- Basic Electricity for the Non-Electrician
- Variable Frequency Drives
- Test and Measurement Equipment
- Boiler Operation, Maintenance & Safety
- Electrical Ladder Drawings, Schematics & Diagrams
- Generators & Emergency Power
- Motors, Controls and Starters

NEEDED If you have considerable working experience in any of these areas

AND If you have experience in instructing courses in these areas, then send your resume to:

Randolph Hurst, President.
rwh@rogers.com

The Electricity Forum is one of North America's largest Electrical Training organizations. Since 1986, The Electricity Forum has trained more than 25,000 electrical professionals across North America on a wide range of subjects. Our company is seeking experienced electrical training instructors for our public enrollment and on-site training courses. We offer a competitive and innovative package of training fees and expenses.

The Electricity Forum publishes Electricity Today Magazine, Electrical Source Magazine, and 12 Annual Technical Handbooks. Our website at www.electricityforum.com receives more than 10 million page views a year from 1 Million unique visitors.

ply volatility and better applied to uses other than electricity.

The growing recognition that nuclear power plants are the only new, large-scale, zero-carbon, economic source of electricity is causing governments and the public to reassess this reliable electricity source. CANDU NPPs emit virtually none of the air pollutants associated with fossil fuel combustion. Nuclear energy produces no greenhouse gases — carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydro fluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) — nor do they emit trace heavy metals, such as Arsenic and Mercury, which are associated with coal production.

By using nuclear energy to produce electricity, Canada avoids the emission of about 90 million tonnes of greenhouse gases per year, equivalent to the greenhouse gases produced by 18 million cars or trucks — about 12% of Canada's total greenhouse gas emissions. For the same reason, Canada also avoids the emission of an additional 10% of smog and acid-rain producing gases. Without CANDU plants, annual Canadian CO₂ emissions would increase by 20%.

Worldwide, CANDU plants avoid more than 300 million tonnes of CO₂ emissions annually. CANDU plants have avoided 1.6 billion tonnes of GHG emissions since 1972 — with each CANDU avoiding 5 megatonnes per year.



Figure 1: ACR-1000 twin-unit plant.

CANADIAN NUCLEAR INDUSTRY

AECL developed and designed the CANDU nuclear reactor and plays a leading role in the Canadian nuclear industry in terms of domestic and international sales of nuclear products and services. The Canadian Nuclear Safety Commission Nuclear (CNSC) provides regulation of the Canadian nuclear industry.

Four electrical utilities — in three Canadian provinces — operate CANDU 22 units (18 of which are currently in service). As well, Canada is the world's largest producer of natural uranium — providing more than a quarter of the total world production from its Saskatchewan mines. More energy is contained in Saskatchewan's uranium reserves than in all known Canadian conventional oil reserves (excluding the Athabasca oil sands).

Key activities currently taking place in Canada's nuclear industry include the refurbishing of older plants, to extend their life, and preparations for new-build CANDU projects. Two major refurbishment projects are underway in Canada — one at the Point Lepreau Generating Station (PLGS) in New Brunswick and another involving Units 1 and 2 at the Bruce A station in Ontario. AECL is General Contractor for the PLGS project and is providing retubing services for both projects.

As mentioned in the October 2007 issue of *Electricity Today*, Canadian new-build initiatives involving the ACR-1000 are underway in Alberta, New Brunswick and Ontario, and international initiatives are also being explored. In Ontario, both Bruce Power and Ontario Power Generation (OPG) have made application to the CNSC to prepare for the construction of new units at the existing Bruce and Darlington stations, respectively. Overseas, the ACR-1000 is one of four designs chosen in 2007 for generic design assessment, following a UK energy review in 2006. As well, AECL and Nucleoeléctrica Argentina have signed a Memorandum of Understanding (MOU) to enter into commercial negotiations for a new 740-MWe CANDU 6 at the Embalse CANDU station. In Romania, completing Units 3-4 at the Cernavoda (CANDU 6) Power

Lightweight Thermal Imager From Industry Heavyweight

NOW WITH FUSION!



240x320 thermal resolution

FLIR FUSION: pinpoint problems fast

1.3 mega pixel visible image



Forget struggling with bulky, hard-to-use infrared images. Invest in the new FLIR T400 infrared imaging camera and make your job easy.

This camera uses the latest technologies including optics that tilt at the flick of a wrist, an LCD that also serves as a touch screen, 4-hour rechargeable battery, and software that makes reporting and documentation a snap.

DETECT hot spots, avoid electrical failures, increase worker safety, and protect building assets now! For Electrical, Mechanical & Building Inspections!

To request your FREE demo or to obtain more information call:

1 800 613-0507 ext: 24 or go to www.goinfrared.com



Touch Screen Text/Sketch Functionality



Tiltable Optics Reduces Back and Arm Strain

Plant continues to be a priority. AECL is also in discussion with energy officials in many other countries, including Egypt, Lithuania, Morocco and Poland.

Canada's nuclear industry has recently strengthened its ability to deliver new nuclear power plants. In 2006, Canada's leading private sector companies in the nuclear and power plant field — Babcock and Wilcox Canada, GE-Hitachi Nuclear Energy Canada Inc., Hitachi Canada Ltd., and SNC-Lavalin Nuclear Inc. — joined together with AECL to create Team CANDU. The team has already developed a positive, long-standing relationship through the success of several previous new-build projects.

Team CANDU is also supported by associate members, including the Organization of CANDU Industries (OCI) and municipalities, labour groups, universities and clean air groups. The OCI represents almost 100 Canadian companies supplying goods and services for CANDU reactors in domestic and export markets. The Canadian nuclear industry is also supported by 3,000 sub-suppliers and provides approximately 30,000 high skilled jobs within Canada.

CANDU PERFORMANCE

Of the 34 CANDU NPPs around the world, eleven (11) are AECL-designed and -built 700-MWe-class CANDU 6 units—in Argentina (1), Canada (2), China (2), South Korea (4) and Romania (2). These continue to sustain high performance and have collectively surpassed the US and French LWR capacity factors with a combined average of 92.4% in 2006, and a lifetime capacity factor of 88.1%. Three CANDU 6 units—Wolsong Units 3, 2 and 4 in second, third and fourth positions respectively—were in the “Top Ten” worldwide for lifetime performance in 2006.

EVOLVING CANDU: THE ACR-1000

AECL takes an evolutionary approach to designing new nuclear power plants (NPPs). The current, successful 700-MWe-class CANDU 6 design evolved from earlier CANDU units at the Pickering A station in Ontario. The newer 740-MWe Enhanced CANDU 6 (EC6) evolves the CANDU concept further, retaining basic CANDU features and adding some advancements and simplification developed through experience and feedback gained in the design, construction and operation of CANDU plants around the world.

AECL's 1200-MWe Advanced CANDU Reactor, the ACR-1000, continues the evolution of the well-established CANDU line.

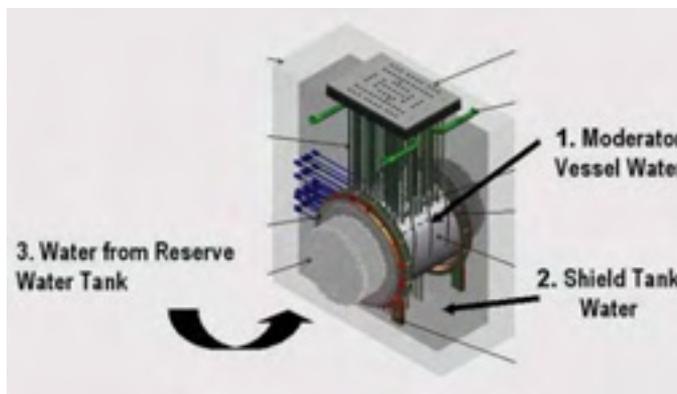


Figure 2; In the unlikely event of an accident, three major passive heat sinks keep damaged fuel in the core.

The basic design is completed and the ACR-1000 program is in full project mode under AECL's Commercial Operations group — to achieve an in-service date of 2016. Again, basic features — including a modular, horizontal core with fuel channels, simple fuel bundle design, separate low-temperature and low-pressure heavy water moderator and passive safety features — are retained and innovations and new technologies are introduced to further enhance safety, performance and economics. Major changes to the design include using light water (instead of heavy water) as the coolant and the introduction of low-enriched (instead of natural) uranium fuel, in advanced CANFLEX bundles. However, 80% of plant features, equipment and specifications are still based on the CANDU 6 reference plant, giving a high degree of confidence that the initial new-build project will be completed successfully.

ACR-1000: EVOLVING AND ENHANCING SAFETY

Enhancing safety is a major goal for every new CANDU design. In the ACR-1000, designers have increased safety and operating margins, enhanced accident-resistance and core damage prevention features, provided a thicker steel-lined containment and improved fire protection. The thicker containment is designed to withstand external events such as earthquakes, tornadoes, floods, aircraft crashes and malevolent acts. Each corner of the reactor auxiliary building houses redundant safety equipment in a four-quadrant design, with quadrants separated by three-hour fire barriers.

The ACR-1000 design combines CANDU's passive safety features with engineered safety technology. Central to the



Electrical Forensic Engineers

- Electrical Apparatus Failure
- Fire and Explosion Investigation
- Safety and Accident Prevention
- Electrical Power System Specialists
- Commissioning & Technical Service
- Product Liability
- Origin and Cause
- Expert Witnessing
- Personal Injury
- International Consultants

We are currently recruiting an Electrical Power Engineer

If you are detail oriented, committed to excellence and professionalism and would enjoy the benefits of a rich teamwork environment, then we would like to hear from you! Please visit our website for an outline of this position.

- SINCE 1970 -

www . brosz . net

1 - 877 - 472 - 7670

safety system are two fast-acting, fully capable, diverse and separate shutdown systems. These are physically and functionally independent of each other and also from the reactor regulating system, and are optimized for reliability.

Additional defence-in-depth is derived from the inherent passive-safety of the CANDU core, including heat sink redundancy for potential accident conditions. These passive features have been enhanced still further in the ACR-1000 design to mitigate, prevent or significantly delay severe accidents. As well, the ACR-1000 core is designed for a small negative void coefficient. This provides inherent protection against transients with any inadvertent increase in power.

Advanced digital control systems also play an important role in enhancing ACR-1000 safety. SMART CANDU systems improve the timeliness, the quality and the integration of the information made available to plant operators and engineers, thus reducing the time to diagnose and respond to events. As well, new technology allows computerized testing of major safety systems and automatic calibration of in-core detector control systems.

ACR-1000: MEETING GRID REQUIREMENTS

A focused effort was also made to ensure the ACR-1000 is flexible enough to meet grid requirements. The ACR-1000's enhanced power maneuvering capability simplifies reactor operation and makes the reactor inherently more responsive to the grid. Load following and daily load cycling capability are facilitated by enhanced control schemes — due to the use of solid control rods — and CANDU's ability to refuel on power. On-power refuelling minimizes excess reactivity in the core and provides an inherent ability to manage load changes and provide better reactor control. Load following the grid provides up to 2.5% power variation, while operating at 97.5%. Daily load-cycling capability includes rapid load reduction from steady state 100% power operation and to 75%, and periodic load reduction from 100% to 60% and as low as 50%, when required, for example, on weekends.

The ACR-1000 also features station blackout capability, ensuring a rapid return to full power on restoration of electrical grid. It can supply the unit's services from the grid or the turbine generator and also has two independent, on-site standby power generation facilities.

In Service	New-Build Project	Completion Performance
1997	Wolsong 2	On budget, on schedule
1998	Wolsong 3	On budget, on schedule
1999	Wolsong 4	On budget, on schedule
2002	Qinshan III 1	Under budget, 43 days ahead of schedule
2003	Qinshan III 2	Under budget, 119 days ahead of schedule

Table 1: Project performance of recent AECL new builds

RECENT CANDU NEW-BUILD PROJECTS

In the last 10 years, AECL has built more reactors than any other nuclear technology company. These were all CANDU 6 units, the latest of which, Cernavoda Unit 2 in Romania, was officially commissioned in October 2007. The last five new-build CANDU 6 projects were completed on or ahead of schedule, and either on or under budget, as depicted in Table 1.

For Wolsong Units 2-4—completed between 1997-99—



Figure 3: maximum use of modularization and “open-top”, parallel, construction—demonstrated at Qinshan Phase III — significantly reduce schedule and contribute to quality performance.

local manufacturing was a key consideration and reached 70% for the last two units. For these units, AECL was prime contractor to Korea Electric Power Company (KEPCO) for the Nuclear Steam Supply System (NSSS) and architect



Figure 4: AECL-designed MACSTOR dry storage units are in use in Canada, Korea and Romania.

engineer for the Balance of Plant (BOP). The project was completed on schedule and on budget. AECL was turnkey contractor for the Qinshan Phase III project, completed under budget and ahead of schedule in 2003.

Key factors leading to AECL's successful project performance include:

- effective, efficient and proven project management systems
- use of modern software, including CADDs for reactor design and 3-D modelling of complex construction sequences, Primavera P5 for project management scheduling, and proven materials and wiring management systems
- maximum use of modularization and “open-top”, parallel, construction — demonstrated at Qinshan Phase III — significantly reducing schedule and contributing to quality performance
- management style successful in dealing with diverse partners and customers

WASTE MANAGEMENT

In Canada, waste management (back-end and operational) is the responsibility of Canadian utility owners. Used CANDU reactor fuel is compact, solid, small in volume, and stable in a water environment. It is stored on-site at CANDU nuclear stations, where deep-water pools are used for initial cooling and shielding. There are about two million used fuel bundles (0.5 m long, weighing about 20 kg each) in Canada. After five to ten years, the used fuel is moved to on-site above-ground dry storage in concrete canisters, with passive cooling provided by air-flow.

Continued on Page 34

Every utility has different needs.
One size solution does not fit all.

CSWEEK
Expanding Excellence in Customer Service

San Antonio, TX
May 19-23
2008

Comprehensive Utility Customer Service education...

Meter-to-Cash

Our venues designed for IT and customer service professionals include:



Multiple one-day and day-and-a-half in-depth courses addressing crucial utility customer service issues including CIS selection, project management, field service and testing, call center management, AMI and MDM.



A forum for CIS application user groups and their application providers to discuss current and future developments and utility-specific enhancements.



CS Week Executive Summit takes a decidedly "green" turn with the reality-based and forward-thinking topics for 2008. Highly regarded by participants for the informative and spirited discussions, this invitation-only event is coordinated by senior utility executives for senior utility executives.



More than 60 workshops and 80-plus utility speakers and industry experts sharing first hand case studies, best practices, strategies, applications and technologies. Over 100 exhibitors will be on hand showcasing the latest products and services.



Honored Keynote Speaker

Henry Cisneros

Former Secretary, HUD

Friday, May 23, 2008

Register to Win a



2008 Jeep Wrangler

Online registration now available at www.csweek.org

THE POWER OF PHENIX:

The Power of Performance



High Current Test Sets



Liquid Dielectric Test Set



Aerial Lift Test Set



AC & DC Hipots



100A Digital Microhmmeter



Manufacturer & Global Supplier for:

- Electrical Utilities
- Manufacturers
- Transformer Repair
- Service Contractors
- Electrical Apparatus Repair
- Electrical Equipment
- Transformer Manufacturers
- Cable Manufacturers
- Quality Control Areas

Visit Us at NETA 2008 !
Booth #614



HIGH VOLTAGE HIGH CURRENT HIGH POWER

www.PhenixTech.com

+1 301.746.8118

75 Speicher Drive, Accident, MD 21520 USA

Nuclear Sells Clean Air

Continued from Page 32

AECL-designed MACSTOR dry storage units are in use in Canada, Korea and Romania. OPG has a similar concrete canister design. Dry storage is expected to be a secure form of interim storage for at least 60 to 80 years.

As with many countries with a significant nuclear power program, Canada has focused research and development efforts for the long-term management of high-level nuclear waste on the concept of Deep Geological Disposal (DGD). In 1977, a Task Force commissioned by Energy, Mines and Resources Canada (now Natural Resources Canada) concluded that interim storage was safe, and recommended the permanent disposal of used nuclear fuel in granite rock, with salt deposits as a second option. In 1978, the governments of Ontario and Canada established the Canadian Nuclear Fuel Waste Management Program. The federal government, through AECL, had responsibility for managing the program and developing the technology for long-term disposal of used nuclear fuel, while the province of Ontario, through its electrical utility, the then Ontario Hydro, had responsibility for advancing the technologies of interim storage and transportation.

Canada's long-term nuclear used fuel management program is now administered by the Nuclear Waste Management Organization (NWMO), which was established in 2002. After a three-year study focusing on three waste storage concepts (deep underground storage, and above-ground storage at reactor sites or at one central disposal area), the NWMO delivered its report in 2005 and the Federal Government accepted it in June 2007. The report recommends an "Adaptive Phased Approach", with public consultation and decision points allowing changes along the way.

Canada and other countries around the world are also evaluating new fuel cycles — using different nuclear fuels — as ways of extending nuclear fuel resources, reducing waste and enhancing proliferation-resistance.

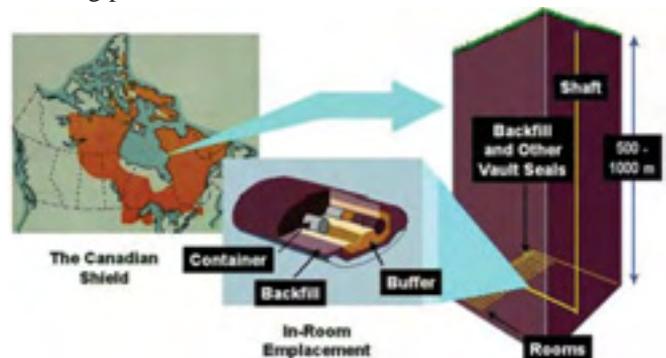


Figure 5: Technology has been developed for the geologic disposal of used fuel.

CONCLUSION

The need for safe, clean, economic electricity is causing governments and the public to seriously consider the building of new nuclear power plants, while obtaining every possible megawatt out of existing plants. AECL's new reactor product, the ACR-1000, builds on the proven CANDU line, which has been successfully deployed in Canada and in six other countries around the world. The ACR-1000 will provide clean, safe and economic electricity and — based on successful recent new-build CANDU projects — will be delivered on time and on budget.

OUR KNOWLEDGE IS POWER



▲ On-Site High Voltage Management

▲ Substation Inspections, Maintenance and Repairs

▲ Lab analysis and diagnosis of high voltage insulating fluids

▲ Co-ordination, arc flash, grounding, power quality, harmonic and load studies

▲ Thermography

▲ Commissioning of high voltage substations and associated switchgear

▲ Station battery discharge testing and cell conductance analysis

▲ Design and implement preventive/predictive maintenance programs

▲ Transformer and switchgear modifications, repairs and testing

▲ Doble Insulation Power Factor Testing

▲ Sweep Frequency Response Analysis

▲ SF6 filling, top-up, and condition analysis

▲ Circuit Breaker contact timing

▲ Troubleshooting

▲ Cable testing

▲ Ground Fault Protection

▲ 24/7 Emergency Response

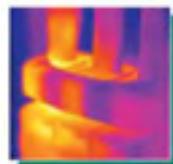
For more information call

1-800-263-6884



RONDAR INC.

Visit our website at www.rondar.com • e-mail: techserv@rondar.com



POWER AND UTILITY COMPANIES: GO ULTRASONIC TO STAY UP AND RUNNING

By Bruce Boyers

Worldwide, power grids are more fragile than ever. In many areas, unexpected outages happen often enough that they are taken for granted, and whole industries have sprung up to assure continuous power in emergencies. It's not an enviable position: power as well as other utilities such as gas and water, responsible to entire populations, must remain operational.

Many such utilities utilize hydro and gas-powered turbines, composed of hundreds of small parts. Often, the reliability of those small parts can mean the difference between operational and non-operational. So that these parts remain reliable, utility companies plan periodic turbine shutdowns so that they can be disassembled and inspected, and parts can either be thoroughly cleaned or, where needed, replaced. Many utility companies are turning to Omegasonics ultrasonic tanks to get those parts quickly and thoroughly cleaned.

Traditionally, parts cleaning has been laborious and costly. "The last time we performed an outage on one of our gas turbines, we rented a commercial parts cleaning agitation type machine," says Kim Townsend, maintenance foreman for Farmington Electric, provider of electrical power to Farmington, New Mexico and the surrounding county of San Juan. "We would wash the parts for 12 to 14 hours, then take them out, and then have to hand-clean them. I actually had 4 guys tied up for probably a week of 8-hour days, with lots of little brushes,



The tanks utilize specialized environmentally friendly but effective cleaning solutions, heat, water, and ultrasonic sound waves for cleaning.

sitting around this table and scrubbing and scrubbing and scrubbing." The reason for the extra hand-cleaning was that the rental machine had not done the job. The turbine contains a thousand bolts and several hundred turbine blades, so it was a very involved process.

Townsend points out that a cause of cleaning ineffectiveness is weak solvents. "Going back a ways, there were solutions that worked a little better, but they were extremely caustic," he says. "You definitely wanted to wear gloves. Over time, the cleaning agents that you're allowed to use have gotten progressively weaker because of the disposal issues with them. The last solution we used essentially didn't work at all."

Jerry Pulver, plant manager for a Minnesota Methane power plant located in Southern California, has had similar problems. "We had a hard time cleaning our Solar turbine fuel nozzles," he says. The unit has 12 fuel nozzles, and each nozzle costs approximately \$8,000, so proper cleaning and maintenance is vital. "We were soaking them in a heated solvent for a 24 to 48-hour period, and even then they weren't really that clean. They would still plug up and give us a poor flame pattern."

Such problems can mean poor turbine performance. "We would get a lot of false starts when we tried starting the turbine — the unit wouldn't start up," Pulver says. Inspection finally revealed

the reason. “We did a borescope down the fuel flow passages in several of the fuel nozzles and saw that our method wasn’t cleaning that well. There was still a bunch of debris in there, and when you started up the turbine, the debris would come off and block the inside of the nozzle.”

The only solution was to pull the nozzles out and clean them again — and in some cases resort to desperate solutions such as knocking the nozzles against wooden platforms in an effort to loosen the debris. “It was quite a pain,” Pulver says.

Of course, such performance could certainly affect utility customers as well.

Fortunately, both Townsend and Pulver have discovered a solution to their parts cleaning problems in the form of Omegasonics ultrasonic cleaning tanks. The tanks utilize specialized environmentally-friendly but effective cleaning solutions, heat, water, and ultrasonic sound waves for cleaning. Users have not only found the method to be more cost-effective in terms of labor and time, they’ve also found it to do a more effective job of cleaning, due to cavitations within the liquid reaching areas unable to be cleaned by human hands or other devices.

Kim Townsend has found the tank to be a considerable blessing. “Using this method, we were able to get all of the parts cleaned up in a matter of 4 days, and I only devoted 1 guy to it,” he says. “This was instead of 4 men working a week of 8-hour days.” He also reports that the result was considerably better than with the older method. “The parts were actually much cleaner coming out of the ultrasonic cleaner than they were even after we had hand-cleaned them.”

Townsend says the ultrasonic cleaning tank was a very cost-effective investment, and will have paid for itself within 2 planned outages without question.

Omegasonics personnel went to Minnesota Methane and performed a demo to get the correct soap, temperature, and cleaning parameters. The results speak for themselves.

Jerry Pulver found that instead of the ineffective 24- to 48-hour soaking he had to give his nozzles, he can now have them thoroughly clean within a couple hours. “It paid for itself on our first use,” he says. There are also no more operational problems—the turbine starts right up.

For power and utility companies, reliable provision of service is the number one priority. Smooth equipment operation is a vital ingredient for that reliability. Ultrasonic parts cleaning cost-effectively provides peace-of-mind that the many components that make up intricate equipment such as turbines will be clean and will function properly.

Bruce Boyers is a freelance writer based in Glendale, California.



Industry Announcement

St. Thomas Holding Inc., wholly owned by the City of St. Thomas, and the owner and operator of St. Thomas Energy Services Inc. (STESI), has entered into an agreement to purchase the shares of two companies near the Town of Tillsonburg: Tiltran Services and Lizco Sales. This is the first transaction of its size in Ontario involving a municipally-owned utility company purchasing a competitive, privately-owned services company.

Tiltran specializes in the engineering, construction and maintenance of high voltage electrical power, wind and solar systems. Lizco has the largest, privately-owned transformer inventory in Canada.

Together, the companies will have the ability to gain access to broader markets and larger projects, find ways to secure new revenue streams and be aggressive in pursuing new business opportunities. The transaction will be completed on January 2, 2008.

St. Thomas Energy Services Inc. along with their new partners Tiltran and Lizco will continue to provide excellence in service to their customers in Ontario, Canada and North America.

For more information, please contact Brian Hollywood, President and CEO, St. Thomas Energy Services Inc. at 519.631.4211 ext. 238, www.stesi.com or Pat Carroll, President, Tiltran Services at 519.842.6458 ext. 225, www.tiltran.com.



TESTING AND ANALYZING YOUR POWER SYSTEM APPARATUS

By Doble Engineering

In one year, an insurance group reported 25 substation transformer failures costing over \$100,000 each. That news gets worse: At a nuclear power plant, a transformer failed in “an eventful mode”. Translation: The resulting substation fire caused weeks of production downtime. The estimated loss of revenue was \$1 million a day.

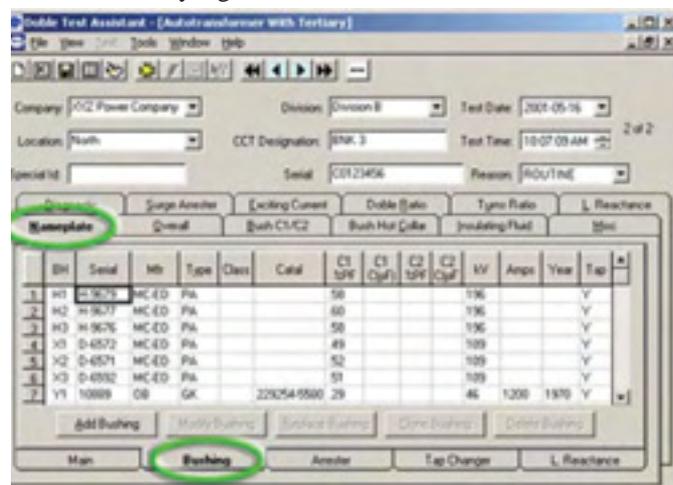
The long-term prognosis is even more dismal. A study by another insurance group indicates the operational life cycle of transformers is decreasing. They found deteriorating insulation was causing failures in equipment that had been in service an average of just 17.8 years. Yet another major insurance group



predicts substation transformer failures will rise by 500% within 10 years.

Adding to today’s challenges in testing, statistical failure analysis shows there is a range of possible reasons causing transformer failures. These include abnormal operating conditions, over-voltages, system short-circuits, abnormal operations, improper maintenance, substandard materials, substandard manufacturing techniques, and design deficiencies.

For beleaguered asset managers trying to cope with these issues, the old rules of thumb are proving less and less effective. The best strategy is to focus on data that is first and foremost statistically significant. Therein lies the rub.



The data record for an apparatus — a transformer with tertiary — centers on the nameplate. All attached equipment, such as bushings are part of the single apparatus record.

Suppose you have a transformer with an unusual test result. How can you be certain of your diagnosis, when all you have to work with are limited number of test results from a handful of similar transformers in your inventory? In all likelihood, you won’t have a “statistically significant” sample for guidance

This is where Doble Test Assistant plays a critical and

INHIBITED



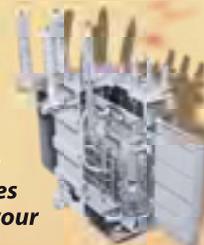
**Sludge?
Insulation Degredation?
High O₂ Levels?**

Extend your transformer life expectancy by renewing your inhibitor

Using a process acquired from Westinghouse®, CMI manufactures a concentrate that when added to your existing oil can bring inhibitor levels back to industry standards.

Contact CMI with your current inhibitor values and we can calculate your concentrate needs.

www.custommaterials.com







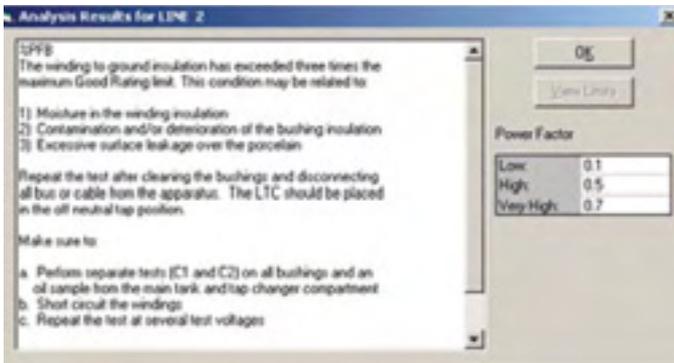
Custom Materials, Inc.
16865 Park Glendale Drive
Chagrin Falls, OH 44023-9904
Phone: (440) 543-8284
Fax: (440) 543-7636
E-mail: sales@custommaterials.com

decisive role. Doble has that needed breadth of data. The DTA Expert System includes knowledge gained from millions of test results that were collected from hundreds of Doble clients over many years.

DTA in a nutshell is an easy-to-use “smart” software system, designed for use by apparatus maintenance, operations, and management teams. Once DTA is on the scene, the test technician is on the fast track to having knowledge based on statistically significant data.

The process starts with the DTA Field Test module, with its many testing capabilities and its ability to analyze each test result. DTA’s Field System module collects and processes test data. Later, the DTA Office module takes all of the test results from the Field System and incorporates that data into your company’s DTA database for planning and analysis.

From the get-go, DTA makes it easy for technicians to build a useful and significant collection of test results. By enforcing strict data formats and naming conventions, DTA sets up a uniform framework that assures that all apparatus types, accessories, test plans, and test results can be accessed and analyzed universally.



When examining the test data for the transformer, the DTA expert system module can be invoked to provide help in the analysis of the data and recommended courses of action needed to be taken.

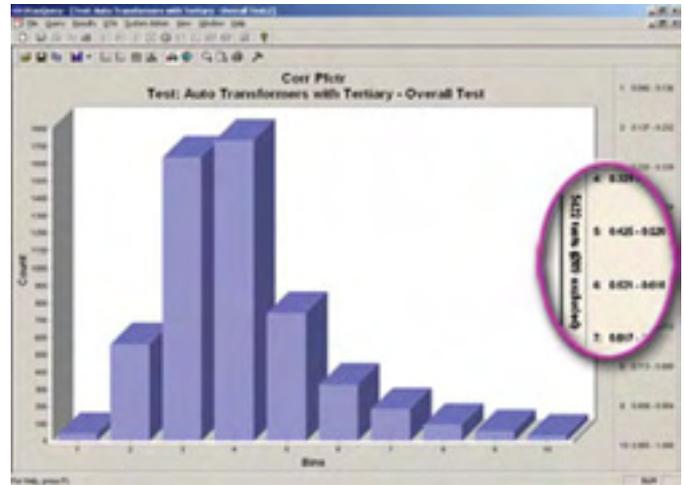
To make it easy to comply with these rules when testing in the field, the DTA user interface has drop-down menus and pick lists. Automated electronic test plans reinforce standardized test methodology and test sequences for each apparatus type. In addition, DTA’s Field System automates calculations required for older manual instruments.

For example, DTA applies a temperature correction factor for accurate comparison of test results, regardless of the ambient temperature when the tests were run.

What’s more, the user receives a highly dependable conclusion about the condition of apparatus insulation, based on norms established by thousands of test results. DTA even tells the test technician about next steps, once the facts are in.

Once a questionable or unacceptable test result turns up, the DTA Field System lists recommended follow-up investigative procedures. DTA is recognized for its unique analysis, leveraging an expert system that incorporates over 3,700 rules derived from more than 10 million tests from Doble’s master database. In effect, the DTA Field System provides the virtual presence of an engineering guide with over 80 years’ experience.

That vast library of information continues to grow. Each year, thousands more test results are added to the master Doble Database, from which norms, rules, and expert help are formulated. Virtually no problem “stumps” the system.



With DTA Office, engineering managers can query their database to reveal trends and distributions in their own data. If that sample is too limited, they can request Doble to query the entire master database for a particular apparatus. In this case, a particular transformer has over 5,200 valid data points.

FROM FIELD TO OFFICE, DTA POWER MULTIPLIES
DTA’s Office module provides a database into which all of the DTA Field data is loaded. In this database, records are structured by apparatus. The apparatus nameplate and all of the test history for the apparatus are located in one record. This

NEW from INCON

Model 1250-LTC

Condition Monitor / Position Indicator



- Tap (position variation, 0.1° resolution)
- Number of tap changes “up/down to” each tap
- Number of consecutive tap changes in one direction
- Number of days since first or last change to highest and lowest tap (draghands)
- Number of days since passing through neutral
- Momentary relay acknowledgement at each tap change
- Still provides “best available” absolute position feedback

INCON[®]
INTELLIGENT CONTROLS

P.O. Box 638 Saco, ME 04072
Tel: 800.872.3455 or 207-283-0156
FAX: 207-283-0158

Visit, www.incon.com
Click on “Power Reliability Systems (PRS)”

ISO 9001
REGISTERED
COMPANY

NEW!

MICROPROCESSOR
CONTROLLED
GLOVE, SLEEVE
AND BLANKET
TESTERS



AUTOMATICALLY
SETS ALL TEST
PARAMETERS

FAST & EASY
A VON TRADITION



1 (205) 788-2437
voncorp@voncorp.com
www.voncorp.com

provides ease of access for analysis, reporting, and maintenance scheduling.

Using DTA Office, engineering managers can compare multiple tests over a period of time to distinguish emerging trends. Reports can be run on specific test results or the location of equipment.

This information supports proactive guidance of maintenance operations. More importantly, managers can minimize unplanned outages and maximize utility profits. This is where DTA literally pays.

While rules based on thousands of tests are necessary to diagnose an apparatus problem, rules alone are not sufficient to analyze a trend in multiple assets.

When results differ dramatically and

your data is limited, how do you distinguish a trend from an aberration? To accomplish this task, access to a very large data sample is vital for any analysis to be statistically significant.

DTA is just as essential for the asset manager performing a trend analysis as it is for the field technician diagnosing an equipment problem. As part of the Doble Services Program, clients can ask their Doble Client Service Engineers to make queries on the master database, with its repository of results from over 10 million tests.

With DTA, engineering managers concerned about the way an apparatus is behaving can rest assured that an answer based on significant real-world data will always be readily available.

You Said It

Dean Bacon, a Manager-Eng. & Design with the Public Service of New Hampshire in Dunbarton, New Hampshire writes, "Best magazine I receive."

Dave Townsend, a Consulting Engineer with Unified Investigations and Sciences in Bellevue, Washington State says, "I would like to see more (articles) on failures, legal liability, and the aging of the workforce."

Edward Fatherly, a Senior Electrician with the U.S. Army Corps of Engineers in Russellville, Arkansas writes, "You're doing a great job of keeping me current with my trade."

Michael Lynch, an Electrical Engineer with the Naval Base in Kitsap-Bremerton in Washington State says, "I would like articles on application for protective relaying. Thanks."

Carl J. Priddle, an Electrical Maintenance "A" with Newfoundland Hydro in Milltown, Newfoundland-Labrador writes, "Good magazine."

Tracy Coriell, a System controller with Hutchinson Utilities Commission in Hutchinson, Minnesota says, "Just had your magazine handed to me today. Being a Controller (Power Dispatcher) I found your Sept. 2007 issue interesting and would like to see more."

Melvin Liwag, a Construction Manager with Orlando Utilities Commission in Orlando, Florida writes, "This magazine has proven to be a great source of interesting topics. Keep up the good work."

IPPSA 14TH ANNUAL CONFERENCE AND TRADE SHOW - KEEPING COMPETITION CLEAN BANFF, ALBERTA - MARCH 9-11

Climate change policy and market power mitigation; these are the two latest issues confronting Alberta's power industry.

Climate change is the subject of dueling federal and provincial legislation, with significant impact on Alberta's supply mix, and ultimately on the market. At the same time, new and complex market power rules are being designed which will also shape the direction of the industry.

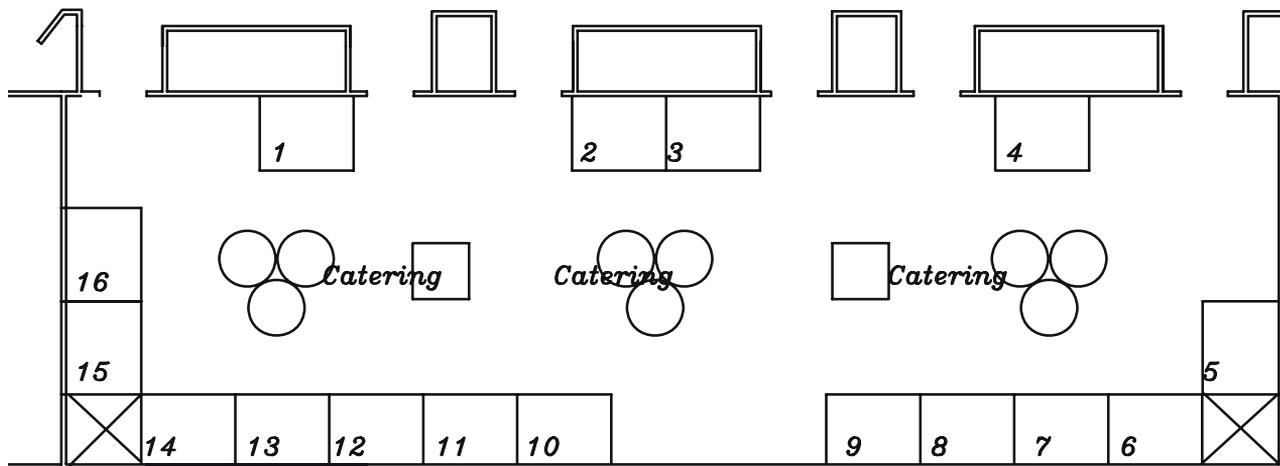
This conference, held at the Fairmont Banff Springs, will assess the impact of these far-reaching policies.

About Independent Power Producers Society of Alberta (IPPSA)

Founded in 1993, Independent Power Producers Society of Alberta (IPPSA) represents Alberta's power suppliers, power marketers and their supporting industries in the province's competitive power market. IPPSA's vision is to promote an open, fair market for power suppliers in Alberta's competitive electricity industry.

For further information about IPPSA, and to register for the Conference please visit: www.ippsa.com

FLOOR PLAN AND EXHIBITORS



Booth - Exhibitor

14-	ABB Inc.	9-	ECNG Energy LP	13-	Montana Alberta Tie Ltd.
16-	Canadian Hydro Developers Inc.	2-	GE Energy	1-	NrgSteam
10-	Canadian Wind Energy Association	8-	Golder Associates	3-	SNC-Lavalin T&D
		11-	Innovative Steam Technologies	5-	TransAlta Corporation
		12-	LandSolutions Inc.	6 & 7-	TransCanada

B.C. HYDRO FUELS GROWTH WITH PLANT INTEGRATION

By David Apps, protection & control team leader, B.C. Hydro, Burnaby, British Columbia & Terry Bauman, Senior Engineer, L&S Electric Inc., Mosinee, Wis.

As one of the largest electric utilities in Canada, B.C. Hydro takes its responsibilities very seriously. A pseudo-government entity, B.C. Hydro is responsible for power generation, transmission and distribution to the majority of British Columbia's four million residents.

B.C. Hydro marks its beginnings to 1860, when the Victoria Gas Company was founded. The company built the territory's first hydroelectric plant in 1898, and was absorbed by Montreal-based Power Corporation in 1928. The provincial government created the B.C. Power Commission in 1945, setting in motion the electrification of the entire province. Within 20 years, a new Crown Corporation was created, British Columbia Hydro and Power Authority, or B.C. Hydro.

ENVIRONMENTALLY CONSCIOUS

Throughout its steady growth, the utility has remained committed to the environment. B.C. Hydro believes it has responsibility for the health of water, land and air resources in British Columbia. The utility challenges itself to find effective ways to minimize the environmental effects of its operations and still meet its responsibility to supply its customers with some of the lowest cost electricity in the world. Its belief is that in addition to being good for society, environmental responsibility is a competitive advantage because consumers prefer a company with a commitment to the environment.

Since June 2003, B.C. Hydro has employed an ongoing, systematic retrofit of the operational equipment in many of its hydroelectric plants. The retrofit includes the integration of system control, monitoring, alarming and protection equipment for each turbine-generator unit in the utility's plants. To underscore the utility's environmental commitment, the retrofit includes a substantial reduction in the amount of hydraulic oil needed to operate each generator. The new hydraulic pressure units (HPUs) on the

generators use 75 percent less oil than the old units.

Since each plant is built to take advantage of its unique hydraulic conditions, the water passages, turbines and generators in that facility are designed specifically for the characteristics of the site. Every unit is one of a kind, dating back to when the plants were built by different consulting firms that had their own design approaches. Typically, the way each plant operates differs from most other plants in the system.

B.C. Hydro operates approximately 35 power plants with a capacity of nearly 11,300 megawatts. Daily winter peak demand is in the neighborhood of 9,400 megawatts. As its name implies, approximately 90 percent of the power generated by the utility is hydroelectric. Most of it comes from installations in the Peace and Columbia River basins, as well as facilities in the Kootenay region; a significant amount of power also comes from the Coastal region. The rest of the utility's power is generated by fossil fuels.

The electricity B.C. Hydro produces travels a long way to get to the province's homes and businesses. The high-voltage transmission system consists of 18,286 kilometers (11,362 miles) of transmission lines, operating at voltages from 60 kV to 500 kV. The 500 kV bulk transmission network connects the major generators in the northern and south interior regions of the province with the major load centers in the heavily populated southwest region of British Columbia. The transmission network is also used for bulk electricity trade with neighboring transmission owners/operators. The utility's 55,254 kilometers (34,333 miles) worth of distribution lines carry the power to its ultimate destination.

STATING CASE FOR RETROFIT

B.C. Hydro determined that a standardized system-wide retrofit was necessary for numerous reasons. First, the number of forced outages at many of the

power plants was reaching a critical stage. Those outages resulted in lost opportunities to generate power, thus lost revenue. For example, a governor air compressor failure might cause an automatic shutdown for 24 or even 48 hours. At present day energy costs, this could easily translate to a loss of \$250,000. Another typical example of a forced outage is an unreliable bearing temperature sensor that mis-operates when the bearing is at normal temperature, thus causing an unnecessary unit shutdown.

Second, the age of the equipment resulted in higher maintenance costs. Maintenance and parts availability became issues, particularly on the older, mechanical governors. Those old units contained relays, contacts and switches that were both inefficient and cost-prohibitive to replace. New digital governors would mean lower maintenance costs.

A third reason was that updated equipment would have internal diagnostics, allowing operators access to digital readouts to determine the cause of equipment failures. The exact cause of a failure is not always obvious, and without a readout to determine the source, operators can be left to search for the problem through trial and error.

A fourth reason was improved performance from the units. This includes: higher turbine efficiency; increased ability to hold load; faster synchronizing; improved stability when operating islanded; predictable and repeatable set-point response for units operating in automatic generation-control mode; stable speed droop; and improved governor dead band and dead time. Some of these performance measures are expected to be regulated and enforced by the North American Electric Reliability Council (NERC), and by regional reliability councils, in an effort to avoid major blackouts such as the 2003 blackout in the Northeast region of North America. B.C. Hydro has a strong desire to be ready if and when regulatory enforce-

Continued on Page 44

2008 EDIST Conference & Exhibition

We will exceed
your expectations.

EDIST

(Electricity Distribution Information Systems & Technology)
Conference & Exhibition

MARK YOUR CALENDARS

January 16-18, 2008

**Refocusing Core Business Performance
Through Technology**

Presented by:



Sponsored by:



Exclusive Media Sponsor:



For Engineering, Operational and IT Professionals

Hilton Suites Conference Centre
8500 Warden Avenue
Markham, Ontario (Warden/Hwy 7)

For more information on exhibiting and sponsorship
opportunities, contact Winnie Chan at (905) 265-5332 or
visit www.edist.ca

B.C. Hydro

Continued from Page 42

ment becomes a reality.

A fifth reason was to reduce the risk of serious damage or a catastrophic failure of major equipment. Many older units are reaching a stage where failure of a simple control device could cause serious damage to turbine bearings, generator brakes, or rotor structural failure due to turbine speed runaway.

Finally, and most important for the utility's engineering staff, was the ability to monitor and analyze problems. For example, by being able to time-stamp equipment failure alarms to within one millisecond and record trends, engineers could go back and study those trends, diagnose the problems and prevent them from happening in the future. The ability to study trends and have a historical record of each plant's operation was key to B.C. Hydro's engineers.

The utility determined that the retrofit would involve control equipment, monitoring systems, alarms and protection. Control equipment included speed governing, excitation, unit automation and local and off-site control. Monitoring systems involved the logging of analog trending information and time-stamped alarms and events to an archiving system. Alarming included time stamping of all hard — physical device operation — and soft, or calculated abnormal operating conditions. Protection included both the electrical and mechanical protection of each retrofitted unit. Retrofit decisions were then made on a plant-by-plant basis.

10-YEAR RFP ISSUED

Once B.C. Hydro determined the extent of the retrofit project, the utility issued a request for proposal (RFP) to include many of its hydroelectric plants, rather than individual contracts with selected facilities, and designated a 10-year time frame. This was unusual in two respects: Typically, RFPs were issued separately for each plant; and upgrades to equipment must receive financial approval before an RFP is issued. B.C. Hydro made the case to go a different route.

The reasoning behind this approach was novel — establish an ongoing partnership with one vendor that, over a period of time, would eliminate re-work, improve operational consistency, improve post-failure diagnosis and reduce spares inventory. There would be a huge cost savings for the utility. B.C. Hydro has estimated that when the retrofits are complete, it will save the utility millions of dollars in operating and maintenance costs. The key for B.C. Hydro was to find a system integrator willing to work with the utility to arrive at the best overall solution on such a wide-ranging project.

The utility awarded the contract to L&S Electric, Inc. in Mosinee, Wis., a system integrator with extensive expertise in the electric power generation industry. Key to the relationship is L&S Electric's ability to work closely with the utility to arrive at the best overall solution on such a wide-ranging pro-

ject, and L&S Electric's demonstrated staff expertise in the hydroelectric industry. This involved implementing an "open" approach to the retrofit process by installing identical equipment at multiple plants. Also important is the system integrator's ability to provide solutions tailored to B.C. Hydro's business needs, and a willingness to take on added investment at the outset for the long-term success of the overall project.

This preferred vendor relationship allows B.C. Hydro and L&S Electric to design and co-engineer modular solutions that will work in hydroelectric plants throughout the utility. It also puts to rest the industry belief that, since no two plants are alike, each facility has to be custom engineered, including all the automation solutions. Instead, the utility and the system integrator took a long look at what each plant needed and developed a system where each would have all of the functions needed for a specific plant, and the ability to "turn off" the functions that are not required.

OFF-THE-SHELF ADVANTAGES

The off-the-shelf, standard design philosophy to retrofitting multiple plants gives B.C. Hydro several advantages:

- It facilitates the inter-connection design, installation and commissioning process because the same software and hardware design are used each time. Less than five percent of the design actually changes from plant to plant.
- There is a common look and feel across multiple plants. A key example is each facility's unit control module, supplied to L&S Electric by Schneider Electric North America. Every function necessary — unit start/stop sequencing, auxiliary device controls, manual start and stop of all devices, etc. — is built into each panel, so they can

be installed in any of B.C. Hydro's 35 facilities. Once a B.C. Hydro engineer is trained on that unit control module, he or she can step in at any plant. This shorter learning curve also saves on training time and expense. Operators are presented with a user interface that has a common look and feel throughout all plants.

- A concerted effort to use off-the-shelf, readily available components. This builds a modular approach to the retrofit, so components are interchangeable throughout the utility. In addition, spare parts inventory is greatly reduced throughout the system, since there is no longer a need to stock components used by only a handful of plants.

- The retrofit architecture is scalable from single-unit plants to facilities with as many as 10 turbines.

- Control functions are tailored to the requirements of each plant, so no facility has more controls, displays or alarms than necessary. For example, when synchronous condensing a Francis turbine, engineers must deal with the seal water valve and air depression system. However, Impulse turbines do not

The reasoning behind this approach was novel — establish an ongoing partnership with one vendor that, over a period of time, would eliminate re-work, improve operational consistency, improve post-failure diagnosis and reduce spares inventory. There would be a huge cost savings for the utility.

Continued on Page 46

The best training seminar in the world on large power transformers



Learn from the experts about the most critical aspects of large power transformers. Thousands have already benefited from this remarkable experience. Come and see for yourself why this world-class event has become the most sought-after training experience in the industry.



The 2008 Doble "Life of a Transformer" Seminar February 18 – 22, 2008 Buena Vista Palace Lake Buena Vista, Florida

Seminar highlights include:

- Outstanding technical presentations on everything from Transformer Design, Specification writing and Manufacturing to Transportation, Diagnostics and Failure analysis.
- **NEW!** Second track with Focus Group discussions
- All students earn Continuing Education Units for attending
- Manufacturers Exposition
- Win a Harley Davidson motorcycle, sponsored by A-Line
- **NEW!** Evening Hospitality Suites
- Field Trip to GE Energy Transformer Manufacturing Facility
- **NEW!** Visit "TITANIC – The Experience" at the Orlando Science Center, including dinner reception - sponsored by ABB.
- Special Keynote speaker - sponsored by Waukesha

For more information and to register, go to

www.doble.com

TOGETHER WE POWER THE WORLD

B.C. Hydro

Continued from Page 44

require these devices; they can be disabled via the configuration software.

All of the digital control equipment used by L&S Electric is supplied by Schneider Electric. B.C. Hydro required Schneider Electric controls in its RFP because it preferred the long product life cycle of Schneider Electric's digital technology, its familiarity with the software tools that accompany the Quantum PLCs, and the excellent field support from the company's technicians.

Quantum PLCs provide a scalable, modular architecture that can be configured to meet application requirements from a single facility to utility-wide architecture, ideal for B.C. Hydro's needs. Integrated web server capability provided by Schneider Electric's Transparent Ready web-enabled power and control technology allows Quantum PLCs to store and serve database information and process diagnostics via standard web browsers.

KEY RETROFIT COMPONENTS

Major retrofit components supplied by L&S Electric are the governor system and unit controller. A microprocessor based programmable electro-hydraulic type, the governor controls the turbine speed, keeping the generator electrical output at precisely 60 Hz and the power at the operator adjustable set point. Speed sensing, regulation and stabilizing of the governor system are accomplished through a digital algorithm and electronic circuits that provide signals used to control the turbines. The governor is equipped with a self-diagnostic function for rapid fault identification.

Similar governor models are used for the Francis and Impulse turbines specified in this project. The Francis turbine governor includes control for the wicket gate servomotors. The Impulse turbine governor includes control for the deflector servomotors, along with independent control of the six needles. Independent needle control is implemented to support needle sequencing (operating the turbine with fewer needles at lower flows), providing better overall unit efficiency throughout the full range of turbine operation.

A flexible needle sequencing algorithm is provided, field configured for 2-, 4- or 6-needle operation, depending on the generator demand. As mentioned earlier, a new HPU that uses 75 percent less hydraulic oil, along with integrated HPU control, is also included as part of the governor. Oil pump starts and stops are controlled and monitored by the Quantum digital controller, providing data and alarm information.

The turbine-generator's start/stop control is incorporated into the unit controller. The following four checks are the major steps in the unit controller when in automatic mode:

Start Permissives. Verification that the unit is both

mechanically and electrically ready to receive a start command (e.g., no mechanical or electrical protective trip on the machine).

Run Permissives. After a unit start has been issued, verification that the turbine auxiliaries (e.g., brakes, cooling water, lift pump, bearing lube oil system) are operating correctly before the unit is allowed to start spinning.

Start Sequence. Supervision and visualization of the turbine-generator parameters as the unit accelerates from dead stop to rated speed, including starting the governor, flashing the generator field and closing the generator breaker.

Stop Sequence. Supervision and visualization of the turbine-generator parameters as the unit is shutdown, including tripping the generator breaker, de-energizing the field, starting the lift pump and applying the brakes. At dead stop, the integrated creep detection is enabled.

In the manual mode, the starting and stopping of the various devices (e.g., pumps, valves, governor, exciter) are accomplished by operator-controlled actions via the unit controller HMI.

CRITICAL ALARM SYSTEM

L&S Electric has also provided the Quantum PLC-based protection, alarm and monitoring (PAM) system designed into each hydroelectric plant. Although the utility has PAM panels in selected facilities, B.C. Hydro intends to install new PAM systems in all of its locations and upgrade the existing PAM software to provide greater configuration flexibility and maintenance features.

The PAM system plays a critical role in the utility's operations. B.C. Hydro time-stamps all events that occur within the system and these are tied to the overall operational sequence, so that events like a pump start or a breaker operation can be viewed in the context of the facility's overall operation. Alarms and protection targets are also time-stamped. By collecting and organizing the data, the PAM system can greatly aid troubleshooting efforts.

The principal reason for the PAM system is to have historical knowledge of critical events, which can then be used as a key part of a predictive maintenance management system. For example, if the PAM system records an abnormally slow valve operation time, that deterioration can be monitored and a warning issued when the valve reaches a certain performance level. The existing PAM system hardware in selected plants consists of a main panel and a remote I/O panel. The new panels specified will have identical hardware as well as additional I/O modules.

Controller failures will trigger an audible alarm if they are non-critical, whereas critical failures will trip a shutdown mechanism within the turbine, avoiding a catastrophic event. All of the retrofitted equipment — PAM system, governor system and unit controller — has also passed stringent seismic requirements, since British Columbia is in the center of Canada's earthquake zone.

The principal reason for the PAM system is to have historical knowledge of critical events, which can then be used as a key part of a predictive maintenance management system.

Continued on Page 48

Powering Toward the Future

Join Your Colleagues From Around the World

2008

IEEE PES TRANSMISSION AND DISTRIBUTION CONFERENCE AND EXPOSITION

2008 CONFERENCE, APRIL 21-24/EXPOSITION, APRIL 22-24
Chicago, Illinois, USA – McCormick Place

Created and structured to concentrate on the transmission and distribution industry and all of its aspects. Our Chicago event will provide power-delivery professionals throughout the United States and around the world with timely information about operating procedures and technologies that are needed in today's electric utility industry.

TECH PROGRAM

Through individually-crafted technical and business paper presentations, group panel discussions and poster sessions, the program examines the impact of technical and business solutions, and the methods and procedures for operating and maintaining power-delivery systems at peak levels.

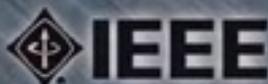
HUNDREDS OF EXHIBITORS

Chicago will attract hundreds of exhibitors and will be the headquarters for innovations and technologies from around the world. All of the exhibitors in Chicago will be eager to see you. Remember your business is their business.

Watch for updates at www.ieeet-d.org



www.ieeet-d.org 810-p-1500



ComEd

An Exelon Company

B.C. Hydro

Continued from Page 46

RETROFIT COST DECREASING

The retrofit time frame calls for completing three to six units each year, which will span the 10-year time period. As each project is completed, the cost per retrofit is gradually decreasing. This is due to the reuse of the standard design and familiarity with the retrofit process. Also, the commissioning time and expense is greatly reduced because the utility and system integrator are dealing with the same hardware and software.

In addition, the uptime of retrofitted facilities is higher, the performance has improved and the maintenance is much lower. This is a direct result of being able to troubleshoot problems faster and with more accuracy, and also improvements in component reliability, accuracy and repeatability.

Although early in the process, B.C. Hydro says it is very pleased with the progress of the plant retrofits. The utility anticipates the 10-year partnership with L&S Electric will save millions of dol-

lars in operating and maintenance costs over the lifetime of the products.

A key reason for B.C. Hydro's partnership philosophy is the system integrator's knowledge of digital technology. The utility's engineers are able to review and approve the design drawings rapidly due to their familiarity with L&S Electric's technology and their confidence in the L&S Electric design team.

As new technology is introduced in future retrofits, L&S Electric's learning curve will be virtually eliminated. The result is factory testing is more cost-effective. Developing costly procurement specifications for each project is also eliminated. Field testing is significantly reduced, ensuring the units are back on line in record time. The cost savings due to the elimination of extra spare parts is estimated at \$100,000 per station.

B.C. Hydro estimates they will also save money when the retrofitted units enter their operational phase. Estimated savings for a 50 MW class unit are shown here. Units with a poor operational history tend to be at the high end of the estimate range:

- Less time and money required for annual maintenance routines. Digital

technology is more reliable and requires very little routine calibration. A simpler hydraulic system requires less mechanical maintenance. Estimated annual cost savings of \$30,000 to \$60,000 per unit.

- The event recording, advanced alarms and self-diagnostics features ensure the facilities are rapidly returned to service. Examples include:

1. Event recorder accurately time stamps an uncommanded governor shut-down.

2. Alarm generated when a control valve fails to open within expected time during start sequence.

3. Pinpointing of failed components, such as a PLC module or external sensor.

Estimated annual cost savings of \$40,000 to \$200,000 per unit (run-of-the-river plant).

- Forced outages attributable to control failures are reduced from an average of two per unit, per year, to virtually none. Estimated annual cost savings of \$50,000 to \$250,000 per unit (run-of-the-river plant).

- Avoiding major equipment damage or catastrophic failures. Although rare, an extreme event may cost up to \$10 million in lost revenue and equipment repair.

- Efficiency improvements on impulse turbines. Estimated annual cost savings of \$10,000 to \$40,000 per unit. Savings due to other performance improvements are believed to be significant but difficult to quantify.

LOOKING TO THE FUTURE

Although still early in the partnership program, the relationship among B.C. Hydro, L&S Electric and Schneider Electric is paying dividends. With seven generator-turbine units retrofitted and operational, the predicted benefits are already evident. B.C. Hydro expects to accomplish 10-15 more retrofits as part of the program. The companies will continue to look for ways to maximize efficiencies during the remaining seven years of the partnership.

Beyond the current RFP, B.C. Hydro is already looking to future retrofit projects. The utility's long-term plans call for more plant upgrades throughout the system, incumbent on funding approvals. The utility plans to continue its partnership with L&S Electric and Schneider Electric as well.

With an eye to its responsibilities to the people of British Columbia, B.C. Hydro will stay the course.



wire
SERVICES

Airborne LiDAR Data Solutions

- Thermal Rating Analysis
- Vegetation Management
- Digital Imagery & Video
- Upgrade Engineering

www.wireservices.ca

 **Manitoba Hydro** POWERED BY A TRADITION YOU CAN TRUST 

CUEE

CANADIAN UTILITIES EQUIPMENT AND ENGINEERING SHOW

MAY 13-14, 2008
INTERNATIONAL CENTRE
MISSISSAUGA, ONTARIO
CANADA

**Join thousands of Professionals at
Canada's largest and most important
transmission, distribution and
equipment trade show.**

50
Canadian

Honored by Tradeshow Week as One of
the 50 Largest Tradeshows in Canada

The Marketplace for Utility Products & Services for over 30 Years.

- ◆ Explore over 300 exhibits, technologies & services
- ◆ Learn about new and innovative products
- ◆ Benefit from hands-on demonstrations & expert advice
- ◆ Take advantage of great networking opportunities



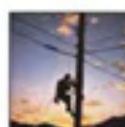
Electric



Gas



Water



Telephone



Cable-TV



Sewer

For inquiries call (905) 265-5332. For exhibit and sponsorship opportunities visit www.cuee.ca

Presented by:



Sponsored by:



Exclusive Media Sponsor:



MARK YOUR CALENDAR FOR

ENERCOM 2008

March 31 – April 2, 2008
Fairmont Royal York Hotel
Toronto, Ontario

The meeting place for buyers, sellers, distributors, marketers,
Producers and major consumers of electricity, natural gas,
oil and renewable energy

For information on sponsorship and exhibit opportunities,
VISIT: WWW.ENERCOM.TO OR CALL 905 265-5332

Presented by:



Sponsored by:



Exclusive Media
Sponsor:



Finepoint's 15th Annual Circuit Breaker Test & Maintenance Training Conference



Join Us In Pittsburgh This October!



- A day at the AREVA T&D facilities in Charleroi and the Mitsubishi facilities in Warrendale
- Over a dozen useful substation and switchgear presentations
- A Siemens BZO circuit breaker maintenance seminar
- An outdoor air disconnect switch maintenance seminar
- Supplier exhibits every evening in the hospitality rooms

October 6 -10, 2008

**Omni William Penn Hotel
Pittsburgh, Pennsylvania**

For further information and on-line registration, please visit
www.circuitbreakerconference.com



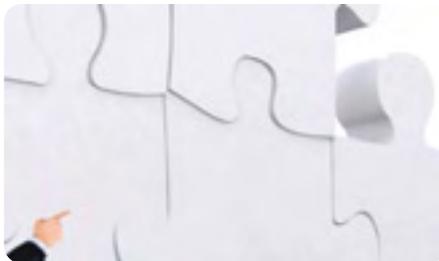
9th Annual

METERING AMERICA BILLING/CIS AMERICA

Metering the smart grid for the smart customer



piecing it all together



The 2008 lineup is here!

Business strategies and market trends | Hands-on technical courses | Hands-down the best experts

There's no better way for electricity, water and gas utilities to **piece it all together** - learn, connect, explore and gain an edge in the metering and customer-end technology sector.

Think smarter – Register today and bring your smart metering and customer management experience full circle.

Sponsors:



Host publication:



April 19 - 23, 2008 San Diego, CA, USA

Lightweight Thermal Imager From Industry Heavyweight

NOW WITH FUSION!



Forget struggling with bulky, hard-to-use infrared images. Invest in the new FLIR T400 infrared imaging camera and make your job easy.

This camera uses the latest technologies including optics that tilt at the flick of a wrist, an LCD that also serves as a touch screen, 4-hour rechargeable battery, and software that makes reporting and documentation a snap.

DETECT hot spots, avoid electrical failures, increase worker safety, and protect building assets now! For Electrical, Mechanical & Building Inspections!

To request your **FREE** demo or to obtain more information call: **1 800 613-0507 ext: 24** or go to www.goainfrared.com



Touch Screen Text/Sketch Functionality



Tiltable Optics Reduces Back and Arm Strain

LIZCO SALES INC.

ELECTRICAL POWER EQUIPMENT SPECIALISTS



Mike Raposo

Steve Mucci

Don Ketchabaw

Our sales team is dedicated to *Tomorrow's Solutions Today*

- New/New Surplus/Rebuilt: Oilfilled/Dry Transformers
- New Oilfilled "TLO" Substations
- New S&C Fuses/Loadbreaks
- High and Low Voltage
 - Vacuum/Gas Breakers
 - Air Circuit Breakers
 - Molded Case Breakers
 - Busduct-Busplugs
 - QMQB/Fusible Switches
 - HV Towers
 - Medium Voltage Starters
- Emergency Service
- Replacement Systems
- Design Build Custom Systems

1-877-842-9021

www.lizcosales.com



Meet the

PowerXplorer PXS.

The one solution for power quality and demand and energy analyzer needs.

The PowerXplorer PXS is the first handheld power monitoring instrument that does it all. With its unique color touch screen and automated setup, this 8-channel workhorse measures at 50/60 and 400 Hertz, AC and DC, captures sub-microsecond transients, harmonics and much, much more.

Why carry around 5 or 6 instruments, when the PowerXplorer PXS does it all!



In Canada contact: On Power Systems Inc. Tel: 1-800-363-9133 or E-mail: jkerr@onpower.com

Parts, Repairs, Service Joslyn VBM™* & VBU™* Switches & Controls



Vacuum Electric Switch Co.*

526 S. Main St. Suite 122

Akron, OH 44311 USA

Phone (330) 374-5156

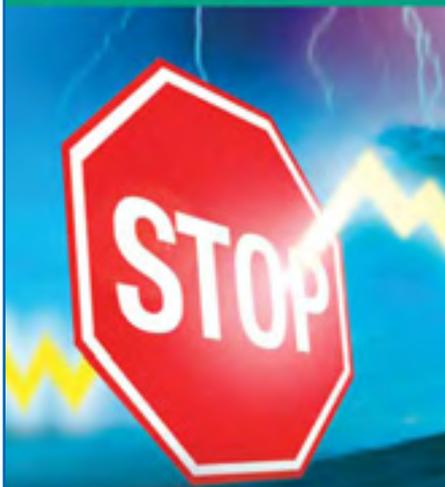
Fax (330) 374-5159

www.vacumelectricswitch.com

*VBM & VBU are trademarks of the Joslyn Hi-Voltage Corp.

*Vacuum Electric Switch Co is not affiliated with or endorsed by Joslyn Hi-Voltage Corp

DEHN stops Surges.



Safety for your Property.

To be Sure - use DEHN Lightning and Surge Protection Solutions.

R3&A Limited - Cobourg

Phone (1) 905 377 8577

Fax (1) 905 377 8578

info@r3alimited.com

Website www.r3alimited.com or www.dehn.de

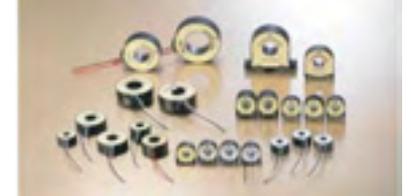
Clamp-on Current Transformer

Where you don't want to cut the power line for measuring or monitoring AC currents.

- Portable power measuring device
- Sub-metering
- Easy open/lock mechanism
- Compact size
- High accuracy from 1class to 3class



CTs for 0.1, 0.2 class Energy Meter & CTs for accurate voltage measuring



Web: www.taehwatrans.com

E-mail: sales@taehwatrans.com

Tel: 82 31 315 8161 Fax: 82 31 315 8165

ADVERTISER	PAGE	CONTACT INFO
3M	5	www.3m.com www.electricityforum.com/products/3M_Canada_Company.html
Albarrie Environmental	21	www.albarrie.com
Brosz & Associates	31	www.brosz.net
Candura	11	www.candura.com www.electricityforum.com/products/CANDURA_Instruments.html
Circuit Breaker Sales	55	www.cbsales.com www.electricityforum.com/products/circuitbreaker.htm
Colt	16	www.coltonline.com
CS Week	33	www.csweek.org
CUEE	49	www.cuee.ca
Custom Materials, Inc.	38	www.custommaterials.com
Doble	45	www.doble.com
EDIST	43	www.edist.ca
Elster Intergrated Solutions	2	www.elster-eis.com www.electricityforum.com/products/elster.htm
Enercom	50	www.enercom.to
ESA Inc.	7	www.easypower.com www.electricityforum.com/ici/ESA.html
Finepoint	51	www.circuitbreakerconference.com
FLIR Systems Ltd.	30, 53, 56	www.goinfraed.com http://www.electricityforum.com/products/flir.htm www.gbctechtraining.com
George Brown College	13	www.gridsense.net
GridSense	24	www.gridsense.net
High Voltage, Inc.	19	www.hvinc.com www.electricityforum.com/products/highvolt.htm
IEEE/PES T&D	47	www.ieeet-d.org
Incon	39	www.incon.com www.electricityforum.com/products/incon.htm
Lineal	23	www.lineal.com http://www.electricityforum.com/careers/lineal.htm
Lizco	53	Sales www.lizcosales.com www.electricityforum.com/products/lizco.htm
Metering America	52	www.meteringamerica.com
MIDAS Metering Services	22	www.midasmetering.com
NovaTech	8,9	www.novatechweb.com www.electricityforum.com/products/NovaTech.htm
On Power Systems, Inc.	53	www.onpower.com
Optimized Devices, Inc.	15	www.optdev.com www.electricityforum.com/products/optimized_devices.htm
Phenix Technologies Inc.	34	www.phenixtech.com http://www.electricityforum.com/products/phenix.htm
R3&A Limited	53	www.r3alimited.com
Rondar	35	www.rondar.com
TAEHWATRANS CO. LTD	53	www.taehwatrans.com
Tiltran Services	37	www.tiltran.com
Vacuum Electric Switch Co.	53	www.vacuumelectricswitch.com
Von Corp	40	www.voncorp.com http://www.electricityforum.com/products/von.htm
Wire Services	48	www.wireservices.ca www.electricityforum.com/products/wire_services.htm

**PROVIDING ELECTRICAL
SOLUTIONS WORLDWIDE**

CIRCUIT BREAKER SALES, Inc.

A Group CBS Company

CIRCUIT BREAKERS LOW & MEDIUM VOLTAGE

- General Electric
- Cutler Hammer
- Allis Chalmers
- Federal Pacific
- Westinghouse
- Siemens
- ITE/ABB
- Square D

TRANSFORMERS 1000 – 5000 KVA

- Dry type transformers from stock
- Cast resin from stock
- Load break switch & fuse

LIFE EXTENSION

**LET US DESIGN A PROGRAM TO EXTEND
THE LIFE OF YOUR SWITCHGEAR**

- Vacuum retrofit
- Vacuum retrofit
- Solid state conversion
- Vacuum motor control upgrades

MOLDED CASE CIRCUIT BREAKERS & LOW VOLTAGE MOTOR CONTROL

- Circuit breakers
- Motor control components
- Upgraded buckets
- Panel mount switches

SWITCHGEAR

480V – 38kV NEW AND SURPLUS

- New General Electric switchgear in 4 weeks
- Match existing lineup
- Reconditioned from stock
- Complete unit substations
- Indoor and outdoor available

RENEWAL PARTS

SWITCHGEAR & CIRCUIT BREAKER PARTS

- All low & medium voltage renewal parts, 1945–today
- Obsolete vacuum interrupter in stock
- www.circuitbreakerpartsonline.com

MEDIUM VOLTAGE MOTOR CONTROL AIR & VACUUM MOTOR CONTROL

- New General Electric available from stock
- Reconditioned starters and contactors

SERVICE & REPAIR

- Field service and testing
- Shop repair of all switchgear and circuit breakers



24 Hour Emergency Service

800-232-5809

Fax: 940-665-4681

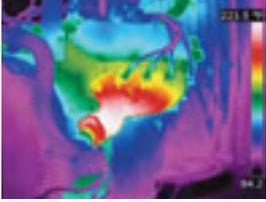
www.cbsales.com

info@cbsales.com

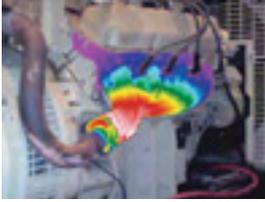


Lightweight Thermal Imager From Industry Heavyweight

NOW WITH FUSION!



240 x 320 thermal resolution



FLIR FUSION: pinpoint problems fast



1.3 mega pixel visible image



Forget struggling with bulky, hard-to-use infrared images.

Invest in the new FLIR T400 infrared imaging camera and make your job easy.

This camera uses the latest technologies including optics that tilt at the flick of a wrist, an LCD that also serves as a touch screen, 4-hour rechargeable battery, and software that makes reporting and documentation a snap.

Check out these great features

- New IR Detector Delivers Four Times the resolution of Competing Brands
- Large 3.5" Full-Colour LCD
- Optics head tilts 120° for ease of use
- Microsoft® Compatible, Email Friendly
- 1.3 megapixel visible light camera
- FUSION made for combining visible light and IR images
- Removable SD/Memory Card
- Rugged Yet Lightweight - Less than 2 lbs
- Long 4-hour Battery Life
- FREE QuickReport Software
- Touch screen annotating tool

DETECT hot spots, avoid electrical failures, increase worker safety, and protect building assets now! For Electrical, Mechanical & Building Inspections!

To request your FREE demo or to obtain more information call:

1 800 613-0507 ext: 24 or go to www.goinfrared.com

FLIR
SYSTEMS™
The Global Leader in Infrared Cameras
🍁 Servicing Canada for 46 years



Holster for Portability and Easy Access to Camera



Target Illuminator and 1.3 Mega Pixel Visual Camera



Tiltable Optics Reduces Back and Arm Strain



Touch Screen Text/Sketch Functionality