



Electric Energy T&D
MAGAZINE www.electricenergyonline.com



OFFICIAL SHOW GUIDE



5th Annual
Life of a Transformer
Seminar

February 19-23, 2007

KEY QUESTION FOR THE FUTURE

Who helps you to keep
the **power** flowing?



AREVA T&D's experts...

Thanks to its reliable and internationally renowned products, systems and services, AREVA T&D helps you power your projects.

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Please visit AREVA T&D energy experts in booth 15 at Doble's 2007 Life of a Transformer Seminar.



A
AREVA



Greetings Fellow Transformer Students!

Welcome to Doble's 5th annual "Life of a Transformer" Seminar.

We are all on a mission to better understand and manage every aspect of dealing with large power transformers. Each of you are here to soak up as much information as you can about these critical assets. We have gathered some of the world's top experts in their field for your benefit. They will share their impressive knowledge of important aspects of power transformers with you. The experts that you will hear from this week are also students here to learn - from your experiences and from one another. This event is like no other in the world.



From our humble beginnings in 2003, when we hosted approximately 200 attendees and 6 exhibitors, to our expected 2007 attendance of over 500 attendees and up to 50 exhibitors - this event has now become the "Gold Standard" of the industry, and will be attended by people from virtually all 50 states and approximately 30 countries. This truly has become a world-class event! I'd like to take this opportunity to thank you for your support, and for taking a full week out of your busy lives to be here.

The entire week will be incredibly jam-packed with great speakers, loads of important information, and the opportunity to meet new colleagues and establish valuable contacts. Please take advantage of this unique and powerful opportunity to learn from the finest experts in the industry. Ask questions, make contacts, develop new relationships. This seminar is all about **you**. It is our goal to put the most powerful information of the industry into your hands, the rest is up to you!

Wishing you all the best for a very productive, informative, and fun week,

A handwritten signature in black ink, appearing to read "Richard K. Ladroga".

Richard K. Ladroga, P.E.
Seminar Chairman

Electric Energy T&D is committed to providing valuable information to the electric power industry. We have been working with Doble for several years as a sponsor of their annual Client Conference in Boston. We are very pleased to now be a part of Doble's "Life of A Transformer" Seminar. I sincerely hope you enjoy the editorials and exhibitor information provided to you in this Show Guide.

Doble is leading the way in offering new venues for sharing valuable knowledge and expertise. As the industry's workforce ages and retires, events like this seminar are essential for passing along critical information to the engineers who manage the world's power.



Thank you for coming!

A handwritten signature in black ink, appearing to read "Steven Desrochers".

Steven Desrochers
Publisher
Electric Energy T&D Magazine



A message from the Doble Materials Laboratories

Paul Griffin, Vice President, Laboratory Services

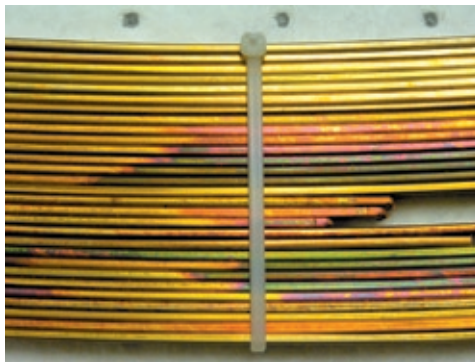
About “The Life Of A Transformer” Seminar

It just keeps getting better. Like a fine wine, “The Life Of A Transformer” Seminar continues to improve with age as it celebrates its fifth year. After being sold out last year we made sure this year’s facility could meet the increasing demand. The industry is losing experience on transformers and how to manage them. Get the training on everything you need to know about transformers, diagnostics, failure analysis and much more. Meet people in the industry that you can later contact when problems arise. Mingle with your peers and develop your own network. You can’t know everything about transformers, but you can learn so much more and know where to find important answers to any transformer-related question. Design issues, changes to specifications, potential transportation problems... you’ll learn it all here from the experts.

Update on Corrosive Sulfur in Oil

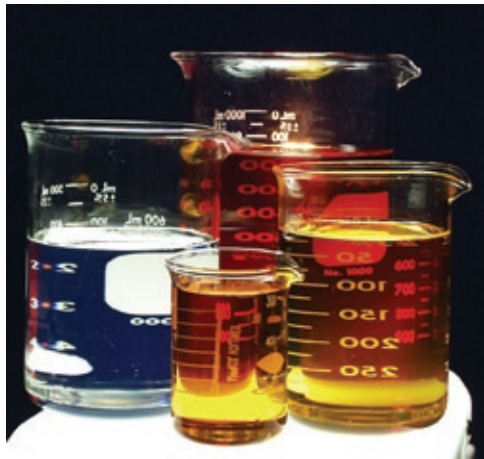
Thursday afternoon,
February 22, 2007

Corrosive sulfur has been implicated as a cause of failures in some large power transformers and shunt reactors. The problem is quite complex, but there have been some developments that shed light on detecting this problem. Come hear the latest on this emerging topic.



About Day 5 of this week’s Seminar: “Electrical Apparatus Condition Assessment Using Laboratory Diagnostics” -

The most cost effective tests to determine the condition of transformers are oil tests. They provide early warnings, indications of the type of problem, and a sense of the urgency... if you know what to look for. Take a day and learn how to read the tea leaves, or in this case the oil data.



“We had a 24 year old transformer with some historical oil degradation and heating problems. That was before I attended Doble’s “Life of a Transformer Seminar” in 2006, and gained useful transformer knowledge, as well as a better understanding of Doble Engineering’s capabilities. A worsening oil sample prompted me to have Doble evaluate the transformer.

They conducted a series of tests: Power Factor, Sweep Frequency Response Analysis, Leakage Reactance, Dissolved Gas Analysis and other Laboratory tests. They also did an on-site internal inspection of the transformer and reviewed our historic test data. As a result, Doble was able to identify the issues the transformer was having. They also put me in contact with a substation service company to help with the internal inspection and the oil reclamation. Thanks to Doble, we now know what needs to be done to keep our transformer going for at least another fifteen years. “

Joe Morley, Engineering & Operations Manager, Braintree Electric Light Department.

KELMAN SERVICES

KELMAN SERVICES is a specialist group within Kelman Ltd. designed to help meet the needs of the modern electrical utility. In today's world electrical power networks are under more pressure than ever before. It is often the case that more is being demanded of ageing systems, while maintenance resources and the essential knowledge base are being eroded.

KELMAN SERVICES employs industry acknowledged experts, headed by Dr. Viktor Sokolov, in order to bring the most in depth knowledge possible on electrical transformers to our customers. Ally to this the suite of cutting edge Dissolved Gas Analysis (DGA) equipment from Kelman Ltd. and Kelman Services offers ground breaking support to the Power Industry.

Kelman Services offers three main areas of support to the customer:

Field Services

Online condition assessment and ranking of plant

Training Seminars

Comprehensive courses on all aspects of transformers

Continuous Monitoring of Transformers

On-line DGA and expert analysis



Contact **KELMAN SERVICES**



Over the past decade diagnostics for oil data have improved and been extended from the main tank to load tap changers. With the right knowledge you can know what to look for when reviewing laboratory data.

A recent case of a transformer problem that was being reviewed revealed some subtle changes in the gassing pattern that a discharge condition went from discharging in oil to discharging in paper. Would you know what to look for to detect this change? Would a change in the 2-furfural content detect this, or would the indicator be the carbon dioxide content, or maybe the carbon monoxide content? What if the transformer had been overloaded and cooled down suddenly, could the increasing relative saturation of water in oil reduce the dielectric breakdown strength of the oil enough for a discharge to occur? Come find out and leave with the tools to help your company manage its transformer fleet.

With offices, analytical and consulting services available worldwide, Doble Materials Laboratories and High Voltage Laboratories provide a myriad of tests and services to thousands of clients. For more information, go to www.doble.com or email to LabRequests@doble.com

The Doble Materials Laboratory, established in 1933, is staffed by dedicated, experienced chemists, and supported by engineering personnel knowledgeable in apparatus diagnostics.



The Doble Laboratory can provide answers and solutions to your problems based upon quality data from a wide scope of testing capabilities and a rich experience in apparatus diagnostics. We can help you develop the most cost-effective testing program for condition assessment or help identify and solve apparatus problems. All test reports include an analysis of the data and recommendations for remedial action if warranted.

Testing Capabilities

The Doble Laboratory is fully equipped to perform a wide variety of tests on insulating materials, with more than fifty tests offered on a routine basis. All test data is entered into our custom-designed database and reports are created in Windows® Excel, and are therefore readily transmitted electronically. Reports can also be supplied in TOA format. Let Doble help you to customize a Condition Assessment Program that meets the specific needs of your system.

Doble Laboratories Testing Capabilities Include:

- [Dissolved Gas Analysis](#)
- [Furanic Compounds In Oil](#)
- [Water In Oil Analysis](#)
- [Degree of Polymerization](#)
- [Oil Quality Screens](#)
- [Metals-In-Oil](#)
- [Polychlorinated Biphenyls \(PCBs\)](#)

At the Doble High Voltage Laboratory tests can be performed as received or after thermal or voltage-endurance aging, and under a variety of conditions.

- Doble is experienced in testing apparatus with different waveforms including lightning and switching impulses, power frequency and D.C.
- We can help with specifications for compliance testing, problem detection, endurance testing, research on dielectric behavior, failure analysis, and partial discharge detection.
- Doble can also perform accelerated aging and thermal cycling tests on cables and life endurance testing on stator winding coils.

PCORE ELECTRIC

The Power To Serve™

An independent domestic manufacturer, we will provide tailored solutions to the North American electric industry for bushings and related components. We are committed to delivering the best possible value to our customers, employees, owners, vendors & community.

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WHY PCORE?

- PCORE is North America's only company 100% focused on the manufacturing of capacitance-graded bushings, and related components, for transformers and OCBs, in the ANSI and CSA marketplace.
- PCORE proudly holds an ISO 9001:2000 registration through the Quality Management Institute - The 1st North American bushing company to become ISO certified and be part of the less than 3% of all North American companies to be registered to the 9000 Standard.
- PCORE offers a wide range of products; 15kV-69kV PRC® Bushings, 25kV-500kV POC® Bushings, and 25kV GSU Bushings as well as time and cost saving products & services; PCORE® Test Terminals, Bushing Repair and the patented Quick Link Bushing™
- PCORE's website provides many tools to assist our customers; Bushing Catalog, Cross-Reference Guide, Suffix Explanations, Technical Documents, Certified Test Reports, Sales Rep Locator and more!



The Power To Serve™



When you invest in quality equipment, you expect it to run in top form at all times—whether you're rounding a hairpin turn on the Le Mans circuit or driving performance throughout your business.

GE Energy offers the expertise and service capabilities you need to keep your equipment in peak operating condition. From power system design to remote monitoring to remanufacture to repairs, we have the know-how and experience you can rely on to help ensure the smooth and efficient operation of your transformers, substations, motors, switchgear, drives and other power related equipment. Contact your GE Energy sales representative today and find out how we can help you with your winning performance.

Visit us on the web at ge-energy.com/industrial-service.

A winning performance starts with expert service.



imagination at work

Join GE for dinner and a guided tour of our industry leading transformer repair and manufacturing facility on February 21st. Visit us at Booth #3 for details.



A-Line E.D.S. is excited to exhibit for the first time at the Doble "Life of a Transformer" Seminar. We specialize in on-site transformer decommissioning and forensic teardowns. We provide service for on-site work as well as the disposal of distribution transformers.

We are pleased to announce that A-Line E.D.S. will be giving away a **Harley Davidson Motorcycle** to one of the attendees at this year's Transformer Seminar. We look forward to you visiting our booth to sign up for your chance to win a Harley. See your seminar binder for entry details. In the meantime, please check us out at www.alineeds.com. We look forward to meeting all of the attendees and good luck at winning the Harley!



Extend Maintenance Budgets, Uptime with Remanufactured Power Transformers

Submitted by GE Energy, sponsors of Wednesday's field trip to GE's premier transformer remanufacturing facility

Like today's baby "Boomers", many of the nation's large power transformers (1000MVA or 500kV) will soon be facing retirement. Whether a retired Boomer learning to live on a fixed income or an engineer dealing with limited maintenance funding, common financial sense dictates that you leverage existing assets where possible. Because remanufacturing allows you to leverage

existing assets, maximize your budget, increase uptime, and achieve the same performance standards as a new unit, it may be the best approach for managing many of the aging transformers in your fleet.

Maximizing your budget

While the average lifespan for active components in a transformer is considered 30 years, the framework (shell, core and other) components are built to function for infinitely longer. These components also represent a significant portion of the cost for a newly manufactured transformer due to the increased price of metal. By repurposing these functionally sound components and upgrading all active components, GE can provide a remanufactured unit that meets contemporary performance standards at a cost well below that of a new unit. Another savings advantage for the remanufactured unit is maintaining the same footprint. Customers typically avoid costs associated with redesigning and reworking the site and/or transformer connections that accompany installation of a new unit.

Accelerated delivery

For new unit manufacturing, outstripped capacity and raw material shortages have resulted in unmet deadlines and delivery schedules that can be in excess of two years. With three remanufacturing service centers available globally and the ability to repurpose key components, GE can shorten that schedule by three months to one year depending on the specific unit being rebuilt.

Continuous monitoring offers another option to help reduce downtime related to transformer failure. As the age of a unit reaches its predicted lifespan, performance can become unpredictable and result in unplanned outages. With remote monitoring, GE can evaluate the condition of the transformer, make recommendations on timing for minor repairs and help plan required remanufacturing as needed to prevent unplanned outages.

Contemporary design techniques & guarantees

GE's remanufacturing team leverages the same contemporary design techniques used to build new transformers. This ensures that the remanufactured units meets ANSI C57 performance requirements,



VISIT OUR FACILITY – REMANUFACTURING 101

"The Doble organization provides a truly global forum for engineers to exchange ideas, solve problems and discuss technology enhancements...a real learning experience," notes Geoff Cobb, GE Energy's Industrial Service Growth Leader. "Consistent with this effort, GE is offering a tour of its Bradenton transformer remanufacturing facility on Wed. Feb. 21 at 2:00 pm followed by dinner. We want to continue Doble's tradition of idea sharing and offer colleagues an opportunity to understand the specifics in remanufacturing technology. We've approached the development of this tour as if we were creating an entry-level course in transformer remanufacturing. The time you spend in Bradenton should establish the baseline for your expectations for remanufacturing," finishes Cobb.

The tour will provide a visual experience of common failures, permit dialogue with career manufacturing and design personnel and will aid in an improved understanding of good transformer construction practice and testing. Nowhere else in North America can you simultaneously view the shell and core form technologies being utilized in this facility.

The tour will include a session at each of the following workstations:

- Coil Winding
- Phase Assembly
- Welding and Fabrication Area
- Shell Form Assembly
- Core Form Assembly
- Vaportherm
- Unit Assembly
- Testing
- Shipping Prep
- Schanbel Car (if available)
- Cooler and Radiator Inspection
- Control Cabinet Assembly and Wiring

Waukesha Electric Systems... Your Power Partner



Your customers need power they can rely on, and they need that power available 24/7. Whether you need new transformers to meet load growth demands or help servicing your current transformers to keep your power systems reliable, the right choice is Waukesha.

For over 30 years, Waukesha Electric Systems has engineered and manufactured quality power transformers for a wide variety of Public Power companies, Investor-Owned Utilities, Independent Power Producers and Industrial customers. Backed by our industry-trusted, highly knowledgeable customer technical support team and experienced and well-equipped service group, Waukesha is the power partner you can trust to help provide the service and quality your customers expect.

Medium and Large Power Transformers (up to 200 MVA, 345kV)
Transformer Installations, Relocations, Retrofills, Oil Processing, Service and Maintenance

LTC, Transformer, Circuit Breaker Components and Transformer Health Products™

Reverse-Engineered and Custom Solution Parts / Accessories

Training and Technical Leadership

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TRAINING • COMPONENTS

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Extend...

enabling customers to include operational enhancements that exceed the original design. Some of the added performance features that can be considered are below:

- Reduced load loss
- Increased bill
- Increased short circuit withstand
- Reduced electrical stress in insulation structure
- Increased thermal capability
- Decreased hot spot temperatures
- Better control of stray magnetic fields
- Increased kVa output

The added performance is backed by guarantee. All rebuilt units undergo the same level of performance testing as a new unit. GE also extends the same warranties as those offered with new transformers. These practices enable GE to provide a remanufactured unit with the same performance, reliability and life expectancy as a new unit.

Global service network

GE has over 65 services centers globally; backed by work practices founded in six-sigma quality to address any problems a customer may have with existing transformers, from minor repairs to complete remanufacturing.

In addition, GE provides a wide range of services for other electrical and mechanical equipment including; motors, switchgear, drives, hydro turbines and other non-process specific equipment. GE's engineering staff is a highly trained, internationally recognized team. They are available 24/7 for on-site needs providing a full lifecycle service portfolio from designing power systems to installing and optimizing drives and controls to long-term motor maintenance. Service practices are built on 125 plus years of design and manufacturing experience. GE's service network also includes a continuous remote monitoring program for transformers, motors and other critical equipment to help achieve optimum performance and extend lifespan.

Please visit GE Energy at booth 3 & 4 during the Industry Expo to learn more details about the tour and GE's remanufacturing process.

WAUKESHA HELPS PLATTE RIVER POWER AUTHORITY CONTINUE ENVIRONMENTAL STEWARDSHIP IN THE STATE OF COLORADO

Platte River Power Authority is no stranger to Environmental Stewardship, and Waukesha Electric Systems recently became a part of that tradition when an agreement was reached to retrofit five 167 MVA (top rating), 230kV transformers with 17,200 gallons per unit (86,000 gallons total) of Envirotemp® FR3® natural ester dielectric fluid from Cooper Power Systems.

Envirotemp® FR3® is a patented, fire resistant natural ester dielectric coolant specifically formulated for use in distribution and power transformers where its unique environmental, fire safety, chemical and electrical properties are advantageous:

Environmental

Formulated from edible vegetable oils and food grade performance enhancing additives, this natural ester fluid does not contain any petroleum, halogens or silicones. It quickly and thoroughly biodegrades in both soil and aquatic environments, reducing environmental impact in the event of an accidental spill. And because it is 100% made up of a renewable natural resource, it replaces a depleting non-renewable resource in petroleum-based mineral oil.

Fire Safety

FR3® has an exceptionally high fire point of 360°C and flash point of 330°C. It has the highest ignition resistance of less-flammable fluids currently available and is listed by FM Global and Underwriters Laboratories for use in complying with the National Electric Code (NEC) and insurance requirements. The National Fire Protection Association has no reports of fires or explosions involving transformers filled with FR3® fluid.

Chemical and Electrical Properties

Compatible with standard transformer insulating materials, components and fluid-processing equipment and procedures, FR3® demonstrates improved thermal characteristics with a viscosity closer to conventional transformer oil, superior dielectric strength

and excellent chemical stability over time. Tests conducted by Cooper Power Systems indicate a dramatic increase in transformer cellulose insulation life, anywhere from 5–8 times. In addition, FR3® offers better loadbreak dielectric strength retention and superior resistance to coke and sludge formation which also can increase power equipment reliability and life.

Waukesha Electric Systems, Inc. is the largest U.S. manufacturer of medium-power transformers and a respected supplier of large-power transformers; transformer, LTC and circuit breaker services, training, reverse-engineered components and replacement parts. The company operates manufacturing facilities in Waukesha, Wisconsin; Goldsboro, North Carolina and Dallas, Texas. Markets served include public power, investor-owned utilities, independent power producers, wind farms and industrial/commercial firms.

Platte River Power Authority (www.prpa.org) generates electricity utilizing coal, wind, natural gas and hydropower for its Colorado owner communities of Estes Park, Fort Collins, Longmont and Loveland. As an example of its dedication to the environment, Platte River recently invested over \$15 million in its Rawhide Energy Station, a coal-fired generator, already one of the cleanest coal facilities in the nation. In 2006, Rawhide became the first power plant to utilize biodiesel to start up the coal-fired boiler to further reduce emissions. For this and other environmental initiatives, the Fort Collins Area Chamber of Commerce presented Platte River with the 2005 Environmental Business Award for Resource Conservation.

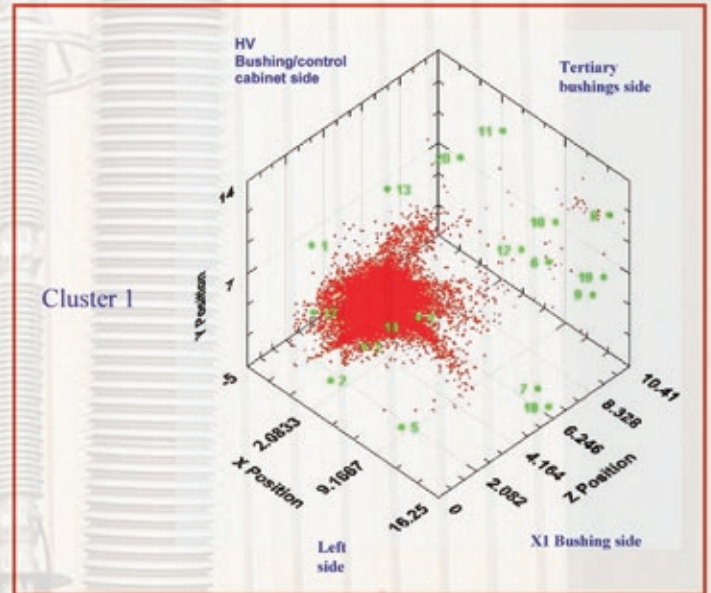
While Waukesha has considerable experience building transformers designed for FR3® fluid and retrofitting other units originally designed for mineral oil, this will be the largest natural ester project since its introduction. Platte River and Waukesha have agreed to work together to monitor and gather important data that will be important to better understand the long-term characteristics of the natural ester fluid and its benefits.

For more information on Waukesha transformers, service, training, components or Envirotemp® FR3® dielectric fluid, visit www.WaukeshaElectric.com or call **800-835-2732**.

Power Transformer Evaluation

On-line Detection, Location and Assessment of Electrical and Thermal Faults

- Database of over 275 successful field tests
- Non-invasive and applied on-line
- Applies to all sources - more sensitivity than other methods
- Locate the problem(s) in an accurate, 3-dimensional plot
- Nursing and/or on-line monitoring capabilities



Core damage at bottom of center limb (cluster1)



Detects:

- Partial discharge
- Overheating
- Static electrification in GSU transformers
- Arcing
- Loose connections
- Core problems
- Other thermal sources

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WAUKESHA...

Note: The 2007 "Life of a Transformer" Seminar agenda includes a presentation on "Natural Ester Based Dielectric fluids".

From Richard Ladroga, founder of the "Life of a Transformer" Seminar:

"Waukesha has been a strong supporter and participant in Doble's "Life of a Transformer" Seminar each and every year since its original inception. When I was first developing the original agenda for the event, I turned to my good friend Jin Sim at Waukesha for advice and support. Jin has been a presenter every year since the beginning - his knowledge and expertise have been invaluable in making this seminar a success. The presentation on "The Making of a Transformer" which was developed by Jin Sim and Scott Digby has been one of the cornerstones of the class. David Harris, also from Waukesha, does a top-notch job delivering our seminar segment on "Transformer Specifications". In the very first year we also enjoyed an outstanding presentation on "Materials" by Mr. Fred Schaeffer, who is now retired from Waukesha and also a presentation on Factory Testing by Sam Mehta. I'd like to take this opportunity to personally thank Jin and Dave and everyone at Waukesha who has helped Doble make this event so beneficial to the industry."

I am proud to again participate in Doble's 5th annual Life of a Transformer seminar. Why? To help educate the next generation of power engineers.

After spending the last decade on downsizing, rightsizings, re-engineering, and business process improvements, the electric power industry is facing a disquieting turnover of qualified power engineering personnel that are needed to perform basic transmission & distribution planning and engineering. What's causing the "turnover"? Today, the engineers that remain at the utilities and engineering firms, -- those that designed and built our electric infrastructure in the 1960's and 70's -- are now in their late 50's and 60's; and many are considering, or accepting early retirement packages.

Today, our universities are turning out electrical engineering graduates with specialization in microelectronics, digital computing, and packet communications. For whatever reason, student enrollment in power engineering has been diminishing for over a decade.

Recent attendees at the Doble seminar and other professional conferences have indicated they have some responsibility for transformers, but have only a few years experience and no formal training. This seminar will help to fill that void.

William H. Bartley P.E., Assistant Vice President Engineering Dept., Hartford Steam Boiler

PCORE® TEST TERMINALS

PCORE® Test Terminals allow utilities to perform field dielectric tests of substation equipment such as transformers and circuit breakers faster, safer and at a substantial savings to alternative testing methods. These are benefits that hundreds of utilities worldwide are already experiencing as they turn to regular field testing as a means of extending the service life of existing equipment.

The test terminal functions as an electrical switch permanently connected in series between the power bus and the equipment to be tested, eliminating the need to physically remove the power bus during testing.

In the closed position, the test terminal permits electrical power to be transferred from the power bus to the equipment. When you wish to test the equipment, you first de-energize the power bus. Then you back off the four captive bolts at the top of the test terminal and loosen the four bottom bolts to let the terminal's blades swing out in an open position. With the bus grounded, the equipment is now isolated from the power bus and you may perform standard dielectric tests.

During testing, the equipment is energized by the high voltage cable from the Doble test set, and the center casting of the terminal is connected to the test set's "guard" so any stray leakage current is bypassed and returned to the test set without being measured.

Loosening and tightening the bolts on the test terminal and connecting the terminal to the test set takes only a matter of minutes. What's more, depending on the equipment you're testing and its location, testing can often be accomplished without a boom or bucket truck, or extra personnel. By reducing boom & bucket truck time by up to 60% for the typical maintenance interval you eliminate some safety risk to your employees and save thousands of dollars per outage. Additionally, because the test terminal makes it possible to isolate virtually any substation equipment from its power bus, without having to physically remove the power bus, it eliminates the risk of equipment damage associated with other testing methods.

By extending the service life of existing substation equipment without performing periodic field tests, you face the risk of that equipment

failing electrically, resulting in expensive downtime, lost revenue, and costly repair & replacement. On the other hand, if you perform regular field tests without test terminals, your testing costs can be significant. Because the test terminal makes it so easy to test your substation equipment, it allows you to extend the equipment's service life without these added risks and testing costs.

Consider a typical maintenance interval to complete testing on a 345kV bulk-oil circuit breaker to be 5 days. If a test terminal is installed on the equipment, dielectric testing would require a boom truck only on the first and last day of the maintenance interval, thus saving 3 days, or 24 hours, of boom truck time. You would accrue this same 3-day savings for the bucket truck used in conjunction with the boom truck. Further, you would save approximately 7 hours for a typical 5-man crew since there is no need to bend, physically remove, and reconnect bus runs before and after the testing.

The test terminal may be used with any substation equipment which can benefit from periodic measurement of power factor or dissipation factor, including:

- Bushings on power transformers
- Bushings on SF6 gas circuit breakers (both live and dead tank versions)
- Bushings on air blast breakers
- Bushings on bulk oil circuit breakers
- Lightning arresters
- Current transformers
- Voltage transformers

Different terminal configurations are available for the top and bottom castings to tailor the test terminal for each application. Terminal configurations include spades with custom drillings, smooth and threaded studs, smooth and threaded female stud connectors, and custom drillings in the face of the top and bottom copper castings. Through system voltages of 230 kV, the Test Terminal is used without corona rings. At 345 kV, one corona ring is recommended. At 500 kV and 765 kV, two rings are recommended.

In December 2006, the aluminum test terminal was introduced to the marketplace as an alternative to the existing copper model. Weighing as much as 55% less than the equivalent copper version, the aluminum test terminal adds an even greater level of convenience & safety to the industry.



Doble has the answers.

Turn to Doble Engineered Strategies for answers you can trust with confidence, for your Transformers, Rotating Machinery and Circuit Breakers.

Doble Engineered Strategies (DES) is Doble's expert consulting engineering division. DES was founded in 2002 to respond to the electric power industry's need for knowledge-based solutions. Due to deregulation, downsizing and a shrinking workforce of experienced personnel, companies are increasingly looking to outsource for expertise to solve their tough problems. DES leverages the resources of Doble's extensive library and experienced team of engineers, in order to deliver the highest level of consulting services and knowledge-based solutions.

Doble has been the electric power industry's trusted information resource for over 85 years. Our KnowledgeBase contains that many decades of statistically significant data, including test data results on over 100,000 types of apparatus, manufacturers service advisories, and thousands of documented client experiences in the form of case studies, technical reports and presentations. This information is invaluable to the DES team as they evaluate a client's situation.

Since its inception, DES has completed over 300 projects worldwide. Companies served have included utilities, nuclear, industrial, aluminum and steel and petro-chemical.

DES Services include:

- Specification Writing
- Design Review
- Factory Audits
- Witnessing of Factory Tests
- Field Commissioning
- High-level Field testing, including high voltage electrical testing to detect the increasing problem of Corrosive Sulfur
- Condition Assessment
- Forensics Analysis

DES works in conjunction with other departments at Doble and other Doble offices worldwide, bringing together the resources needed for the job.

Joe Morley, Engineering & Operations Manager of Braintree Electric Light Department: "We had a 24 year old transformer with some historical oil degradation and heating problems. That was before I attended Doble's "Life of a Transformer Seminar" in 2006, and gained useful transformer knowledge, as well as a better understanding of Doble Engineered Strategies' capabilities. A worsening oil sample prompted me to have DES evaluate the transformer. They conducted a series of tests: Power Factor, Sweep Frequency Response Analysis, Leakage Reactance, Dissolved Gas Analysis and other Laboratory tests. They also did an on-site internal inspection of the transformer and reviewed our historic test data. As a result, DES was able to identify the issues the transformer was having. They also put me in contact with a substation service company to help with the internal inspection and the oil reclamation. Thanks to Doble, we now know what needs to be done to keep our transformer going for at least another fifteen years."

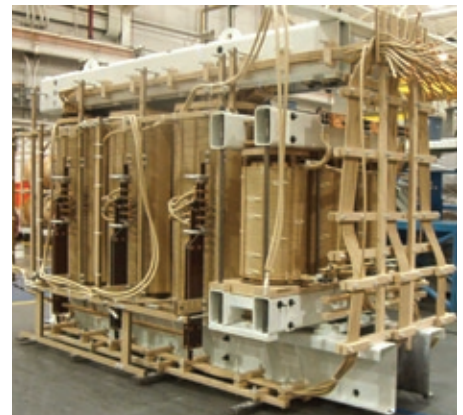
Doble Engineered Strategies is also responsible for the creation of "The Life of a Transformer" Seminar – now considered the industry's Gold Standard for comprehensive knowledge on large power transformers. Over the last five years, over 2000 delegates from 30+ countries have attended this one-of-a-kind intensive training event. Attendees come from all corners of the world, serving as proof of the incredible need for this information.

"According to a recent industry publication, 40% of electric utility engineers will reach retirement age over the next 5-10 years," remarked Rick Ladroga, Manager of Doble Engineered Strategies, "While attending the IEEE Transformers Committee Meetings in Niagara Falls back in 2001, I looked around the room and it became startlingly clear to me – an entire generation of expert engineers would soon vanish from the workforce. How could we make sure their knowledge wasn't lost?"

Here in the United States, over the course of the past 100 years or so, critical knowledge concerning large power transformers was primarily gained through the interactions of electric utility engineers with US based transformer manufacturers. "That landscape has changed dramatically over the past twenty years or so" according to Ladroga. Industry pioneers such as Westinghouse, General Electric, Allis Chalmers, McGraw Edison, and others have ceased manufacturing large power transformers in the United States. The vast majority of large power transformers purchased for use in the US are now supplied by manufacturers outside the US borders. Therefore the mechanism used to transfer tribal knowledge was altered significantly, and a large educational void appeared and continues to expand.

To meet this need, DES developed the world's first – and best – knowledge crash course on all aspects of large power transformers, from cradle to grave. The course has developed a reputation for excellence, attracting the top experts in the world who present their knowledge in a rather intense fashion. The topics are arranged in a natural flow pattern, beginning with specification and design of a new unit, and finishing at failure analysis and end of life issues, while encompassing virtually every relevant topic in between. There is no other seminar in the world like this one!

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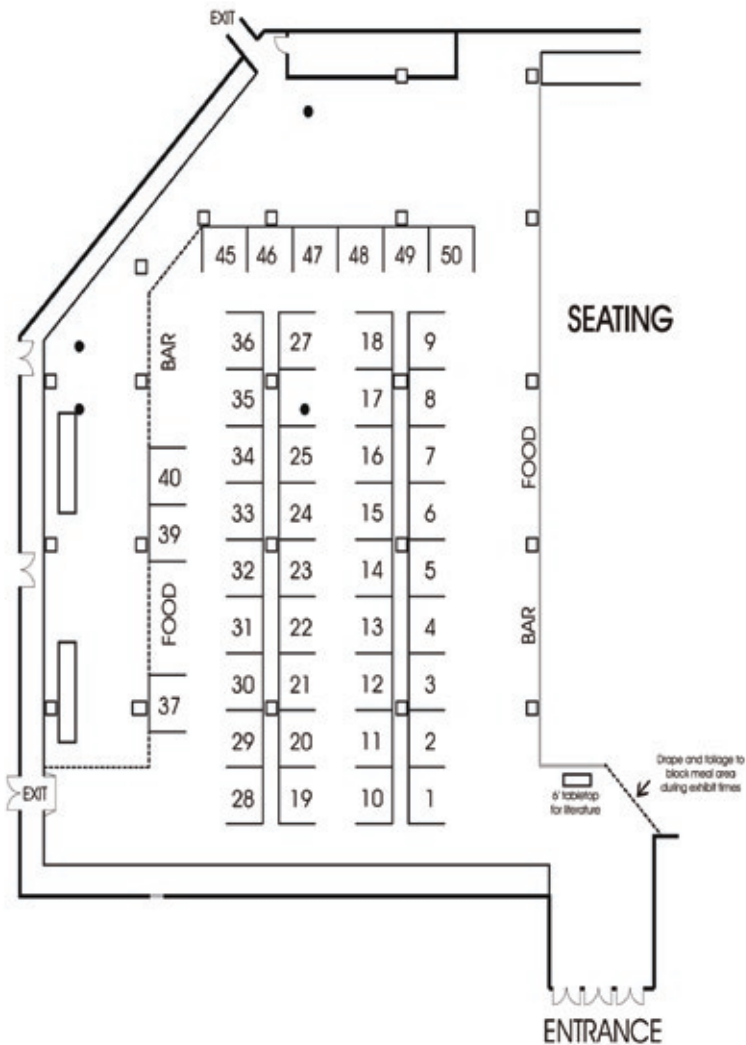




2007 Life of a Transformer Expo

FEBRUARY 19-20, 2007
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At some utilities these transformers can account for up to 70-80 % of the utility's total transformer asset base. With this in mind, ABB undertook the task of providing for the industry (users of ANSI/IEEE as well as IEC standards) a reference guide with detailed, yet easy to understand, information for the proper care and maintenance of transformers. This information should in no way supersede the maintenance guidelines provided by the transformer manufacturer.

The material presented in this handbook is not meant to provide theoretical insights into the methods used for maintaining

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A copy of *Service Handbook for Transformers* is provided for all attendees of Doble's Life of a Transformer Seminar. Use and enjoy!

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ABB wishes to thank our customers for your continued interest and support of ABB products and services. We also wish to thank Doble Engineering for providing this valuable industry forum for the continuing exchange of transformer knowledge and experience. ABB wishes all participants a wonderful week. Stop by our booths and say hi!



"A Day at Disney" Sponsored by ABB

Doble Engineering is pleased to have ABB participate in the 2007 Seminar as presenters, exhibitors and sponsors. At last year's Transformer Seminar ABB hosted a wonderful excursion to the Kennedy Space Center.

This year ABB is offering 2007 Transformer seminar attendees a one-day adult ticket to the Disney Theme Park of their choice:

- Magic Kingdom® Park: Enter a fantasy storybook world of beloved characters, timeless tales and bold adventures.
- Epcot®: Explore the awe-inspiring possibilities in a world of endless wonder and high octane thrills.
- Disney MGM Studios: Enjoy a backstage pass to the place "where showbiz is" and entertainment comes to life.
- Disney's Animal Kingdom® Park: Experience creatures real and imaginary in thrilling adventures and magical surprises.

Attendees will be able to use this ticket on any one day from Sunday, February 18, 2007 through Saturday, February 24, 2007. Only a limited number of Disney tickets were available. Registered attendees were emailed in advance of arrival and asked to RSVP; the tickets were assigned on a first-come basis.

Tickets are transferable, but are only valid for one person's usage on one day. Attendees can select which Theme Park they would like to go to on the day they redeem it. Tickets will be distributed on site at the Doble Registration area at the Transformer Seminar. Additional Disney tickets can be purchased on site at the hotel.

On behalf of ABB, welcome to Disney World and the 5th Annual "Life of a Transformer" Seminar!

Note - Seminar exhibitors, Doble staff and Doble sales representatives are not eligible for this offer. ABB reserves the right to decline the "Day at Disney" invitation to any individual at their discretion.

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Industry Change and Transformer Losses

by Donald S. Schubert
MARSH

Don Schubert has been a regular presenter at the Doble Transformer Seminar, and was the Keynote Speaker at the 2006 International Conference of Doble Clients. His presentations are always popular, with timely and interesting information from the Insurance industry's perspective. At the 2007 "Life of A Transformer" Seminar, Don will be providing an Insurance Industry Update.

Over the last two years, the electric power industry has seen a greater number of losses – at a higher frequency - than in the previous 15 years. The incidence of loss can be evaluated from many perspectives, starting with aging equipment, changes in loading and operations due to competitive environments, and the fact that maintenance and operations have been altered to better manage the cost of production. Useful remaining life assessment processes need to be redefined for today's population of units. Life extensions (Re rates) do not generally extend to work on the core of a unit. Testing and analysis are now done at extended intervals in some cases to accommodate competition. And there are operations to "End Point of Life" for components known to be at or near failure modes, such as bushings.

Combine all that with the evolution of the power industry, new plant development and the expansion of existing plants. The result is that demand is far outstripping supply in many different ways. It now takes longer periods of time to receive a new unit or rewind an existing unit, and shop capacity is filling up with unit production work. There is a lack of "Spare" units in the industry, as well as a lack of "used" units, particularly 450 MVA and larger worldwide. We have a growing lack of expertise in the field and plants as the workforce ages, and a need for well defined "Asset Management" plans specific to transformers.

Numerous plant events had significant station impact in the new competitive environment in 2006. Plant shutdowns occurred, blackouts happened, and nearly 511 major confirmed power reductions were associated with transformer events from 2005 to 2006.

This is based on reported events and events – it does not include the multitude of plant "De Rates" due to transformer failures. 87% of the losses resulted in Business Interruption claims to the insurance industry, while generation production was even higher, not to mention high repair costs.

The Impact of Industry Changes

The "Contributing Causes" noted above indicate a consistent pattern of losses increasing from one year to the next. Trends regarding insurance have been predictable. The industry's response is to increase property damage deductibles and change Terms and Conditions to eliminate some of the factors that cause loss - sulfur-related corrosion is one example. Another more extreme practice, although quite old, is the application of Depreciation to old equipment, which has been shown to apply 70% to the claim. Here's an example in the simplest form of the loss to a transformer: Let's say we value the transformer's worth as \$1.00 and assess it for an insurance claim. The claim is adjusted to address all items of non-betterment, and the adjustment yields an agreement to pay for 80 cents of the damages. Then apply a deductible of 50 cents, leaving 30 cents to pay before the application of Depreciation. If the agreed upon Depreciation is 50% due to the age of the unit, you get 15 cents per dollar of agreed upon loss. Multiply that amount by any dollar amount of losses you are aware of and the impact of the current industry conditions starts to rise in alarming levels.

The Insurers participating in the Power and Utility risks face challenges of their own. Deregulations and Competition have changed the rules, and also led to increased claims. Companies that are still regulated, or semi-regulated, still pay the price for those companies that are competitive regarding loss to the insurance industry. The separation of generation, transmission, distribution, and supply functions has resulted in new elements of a company being responsible for assets never before under their care, custody, nor control. This has changed concentrations of risk. Companies had to reduce operating costs, in some cases significantly, changing their risk profiles. Changes in O&M practice have categorically altered the risks faced by underwriters. Now companies insurance risks include loss of revenue and replacement power. As an example, a recent loss of a 740MVA GSU was \$8,000,000 for the physical damages, while the business interruption was \$36,000,000 by the time the unit was returned to service. The combined impact of these factors has shifted in the claims patterns experienced by the power industry over the last 15 years.



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Power and Utility Insurance Market Cycle

The insurance industry is cyclical. It can be shown that the premium levels, breadth of coverage and deductible level fluctuates as a direct function of available capacity and loss experience. The more capacity is available, the greater the competition leading to competitive terms for clients. As capacity dries up due to adverse loss ratios, premium levels increase along with associated coverage and deductible levels. The use of financial captives is an avenue to many companies. It can however be shown that even advanced risk financing becomes problematic when losses continue to happen.

Course Corrections

1. Know the remaining useful life of a unit (condition assessment) – not just guessing.
2. A transformer-competent person should be assigned the in-plant responsibility of monitoring the testing and repairs of all the station's main transformers.
3. There should be a detailed Asset Management program specific to the fleet of transformers.
4. There should be a detailed Pre-Emergency Plan. Look for a spare 740MVA unit before you actually need it! Assuming these kinds of losses cannot happen to you is really dangerous.

5. Understand the RISK impact of your units, particularly if the operating regime has changed.
6. Apply "Reliability Centered Maintenance" concepts, "RCM is here!"
7. Apply advanced Condition-based Monitoring and Performance Monitoring concepts to avoid risk issues.
8. Perform routine inspection of the unit.
9. Ensure the unit is under the most current I&C for operations and monitoring.
10. Control room operators should provide indications of transformer operating conditions at all times and the least deviation observable.
11. The alarms for transformer winding and oil temperatures should be multi-staged to alert operator and performance monitoring personnel. Apply the "ACID" test based on monitoring so you can decipher mode and time of failure.
12. Three final steps: Testing, testing, and testing with the most advanced practices available.
13. "Best Practices" must be defined for your units and your plants!

On behalf of Marsh, I look forward to being part of the 2007 "Life of a Transformer" Seminar and meeting you all.

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