

Vol.21 Issue 5



## Feature

### **Report: the 73rd Annual International Conference of Doble Clients--**

On April 9-14 2006, about 1000 delegates from [23 countries](#) and from all aspects of the electric power industry gathered to learn and to share their experience. The presenters, as well as many in the audience, included some of the world's most knowledgeable and highly-regarded engineers in maintenance and testing of high-voltage apparatus, and the climate was one of sharing information on a global basis.

For a complete report, please [Click Here](#)

## Knowledge Exchange

### **Doble Client Committee Meetings: Time Well Spent**

The Doble Client Committee Meetings will take place September 24-29, 2006 in Phoenix, Arizona, and are open to all utility clients and testing/maintenance organizations – not just members of a committee.

Unfortunately, many of our clients will miss it, citing workload and budget restraints. What they may not realize, however, is that the benefits of attending far outweigh the travel costs – and gathering information and sharing knowledge may be the most profitable use of their time. [Find out more.](#)

## Doble Tested

### **The Value of AC (versus DC) Testing of Dry-Type Transformers**

By Long Pong

In this article, we will explore the benefits of AC testing of dry-type transformers. We will also draw upon field test experience to discuss the differences between the AC and DC testing.

For the complete article, please [Click Here.](#)

## Technology Briefing

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## **Dissolved Gas Analysis of Load Tap Changers**

By Norbert Gilbert

The fourth meeting of the Dissolved Gas Analysis of Load Tap Changers (DGA of LTCs) Subcommittee, held at the Westin Hotel in Boston this year, was devoted to studying the dissolved gas-in-oil patterns of LTCs to identify units requiring maintenance and to prevent failures. The analysis technique allows the maintenance engineer to identify which LTCs are having trouble and to fix the problem, hopefully eliminating a major transformer failure.

For the complete paper, please [Click Here](#).

## **Safety Matters**

**On Sunday, Sept 24, 2006, a Tutorial on "Handling Combustible Gases" will be presented at the Doble Client Committee Meetings.**

Following is an [excerpt](#) from the Doble Knowledgebase on the subject.

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## Report: the 73rd Annual International Conference of Doble Clients

### OPENING SESSION

“**The world is flat,**” commented Gregory Bennett of Xcel Energy, referring to the interdependence of utilities all over the world and the corresponding mergers, acquisitions, and general evolution that has created an industry far different from that of a generation ago.

That interdependence, according to Robert A. Smith, President and CEO of Doble, underscores the importance of empowering each other. “Sharing knowledge is a very important part of powering the world,” he remarked, “and this Conference of Doble Clients is one that is directed, advised, and created by the clients themselves.”

The comments of Smith and of Bennett, Chairman of the Client Advisory Committee, reflected the implications of “Together, we power the world,” the theme for the 73rd Annual International Conference of Doble Clients and Industry Expo, held April 9-14, 2006 at the Westin Hotel in Boston, MA, USA. It was a theme that proved an accurate description of the scope, intent, and content of the Client Conference.

In all, about 1000 delegates from [23 countries](#) and from all aspects of the electric power industry gathered to learn and to share their experience. The presenters, as well as many in the audience, included some of the world's most knowledgeable and highly-regarded engineers in maintenance and testing of high-voltage apparatus, and the climate was one of sharing information on a global basis.

### TUTORIAL

**Knowing where not to step** -- The Conference was launched Sunday, April 9 with the tutorial entitled “Transformer Internal Inspections.” It was a sharing of personal and industry expertise. It covered everything from justifying the inspection to jumping into the tanks and “**knowing where not to step.**”

Internal inspections are common in determining whether a new transformer is acceptable. The same techniques can be used to assess, confirm, and sometimes even repair a problem within the transformer at the substation – making it a valuable tool in saving time, improving efficiency, and curtailing outages.

Four Doble clients, each with extensive experience in internal inspections, covered specific aspects of the issue:

- David Deines of Progress Energy Florida spoke on justifying internal inspections;
- Philip Prout of National Grid covered Pre-Tanking Inspections and added yet another justification: “it gives you an opportunity to see the manufacturer’s quality program;”
- Gregory Bennett of Excel Energy focused on Training, emphasizing, “Take it one step at a time when you are in the tank;”
- Harry Ruggles of American Electric Power addressed Safety Concerns and Inspection Techniques.

The tutorial concluded with David Deines’ presentation on Receipt Inspection, where he explained the Transformer Internal Inspection Checklist, a simple spreadsheet that lists all items to check upon receipt of the main transformer, series transformer, and preventive autotransformer. The checklist is part of the tutorial presentations posted on the Doble Web site for access by Doble clients. For more information, contact [events@doble.com](mailto:events@doble.com).

### EMERGING TOPICS

**Managing risk** -- At the Monday morning keynote address, "Transformer Losses and Recent Trends," presented by Donald Schubert of Marsh USA, one of the world's leading risk and insurance services firm. Schubert examined risk management issues facing the electric power industry. Specifically, he noted that transformer and generator losses are on the rise and cited 14 transformer failures since January 1 – which translates to about one a week.

In terms of quantifiable loss, these failures amounted to about \$ 300,000 in actual physical damage but a staggering \$ 32 million in business interruption.

The most significant cause of these transformer failures? According to Schubert, inadequate maintenance accounts for 48% of these failures, largely due to winding and connection problems, and is, for insurance companies, an alarming statistic.

"Yes, there have been budget cuts in the utility maintenance departments, but what the insurance companies want to see are substantive, clear documentation on the preventive maintenance of these assets."

He also stated that human error accounts for an enormous part of the loss picture: that 72% of the time, the reasons for failure were given as "forgot to look," "didn't look," or "it wasn't on the checklist."

But he did offer several solutions, including advanced asset maintenance and testing. Said Schubert, "it offers the best return on investment for risk mitigation – in fact, a 10:1 cost/benefit ratio."

Doble clients who would like a copy of Schubert's presentation should contact their Doble Client Service Engineer.

## **SAMPLING OF THE COMMITTEE SESSIONS**

- Asset & Maintenance Management
- Arresters, Capacitors, Cables & Accessories
- Bushings, Insulators and Instrument Transformers
- Circuit Breakers
- Insulating Materials
- Rotating Machinery
- Transformers

The papers presented in these sessions were selected by Doble clients during the September, 2005 meetings of the Doble Client Committees.

**Insulating Materials** -- In the Insulating Materials Session, an entire team of experts surveyed the issue from various perspectives. They began with a general update on corrosive sulfur, which has become a critical issue over the last several years, with failures of large power transformers and reactors all over the world. Gary McCulla of the Salt River Project (SRP), shared the results of SRP's testing all of their main transformers for corrosive sulfur contamination via the Doble modified method. Wanda Brown of Georgia Power provided the test results on their population of transformers evaluated for corrosive sulfur contamination.

**Furanic Compounds** -- Another highlight was the presentation by Lance Lewand of Doble Engineering in which he discussed practical experiences in the use of furanic compounds and trends that have developed over time, including those involving active generation of furanic compounds, stability, the impact of oil degassing, replacement and reclaiming, and replacement with different types of insulating liquids. One of the conclusions was that, in terms of furanic compound analysis, "the more information, the better."

**Oil power factor** -- Attendees cited oil power factor issues as another topic of high interest in that same Insulating Materials Session. A panel of industry experts discussed possible material compability problems with paints in contact with transformer oil and its effect on transformer power factor.

A study was performed that showed paints used for protecting the interiors of subassemblies in medium power transformers have, in some cases, been associated with elevated oil power. They noted that the power factor has been low initially, but has risen with time and is influenced by temperature.

During these times, other oil properties such as dielectric strength and interfacial tension have remained at normal levels throughout. The panel examined the issue from various perspectives and made a number of observations.

**Rotation Machinery Session** -- A key component of the entire week-long conference was the ongoing appraisal of what is new in testing techniques and options. The Rotating Machinery Session, for example, featured a discussion of technological developments such as enhancements. These include a new digital excitation system that speeds up performance testing, as well as oscillography and real-time chart recorders. The technology is increasingly important in power reliability, and the consensus was that operating software must be more intuitive and user-friendly for the engineers.

**Training** -- There is mounting pressure to maximize efficiency and minimize risk, often with limited resources, including people. With fewer training opportunities available, utilities attending the Conference were looking for ideas, information, and answers – which they found in great quantity all week long.

“Basic Insulation and Power Factor Theory,” presented by William Bailey of Doble Engineering, was, as the name indicated, basic. It began with fundamental definitions and covered some of the critical principles of power factor testing: always test the smallest piece possible and always break an insulation system into the smallest possible part to detect insulation faults. Power factor testing, emphasized Bailey, “measures the average condition of an insulation system.”

For engineers at all levels, the respective Conference Committees hosted their highly detailed and technical sessions.

## OVERALL REACTION TO THE CONFERENCE

Preliminary survey results were impressive, indicating that, on a scale of one to ten (ten being the highest value), respondents gave the Conference an 8.5. The personal remarks seemed even more relevant. Typical of these remarks is the following observation by Jeffrey Smith of Northern Indiana Power Service Company about the training value of the Conference:

“In this industry, older, experienced people have left or retired, so these days there's just no one in-house with the same depth of knowledge. Training budgets are being cut, people are being cut, and some departments are being outsourced. So Doble is really filling a need.”

James Campbell of Georgia Power shared his insights about the ongoing nature of the Doble sharing of knowledge:

“One very important aspect (of Doble's involvement) is being able to go back to archives and finding that a question you might have today was asked and answered by someone 20 or 30 years ago.”

But perhaps Richard Wehman of Lower Colorado River Authority put it most succinctly:

“After 73 years of putting these together, you guys really have this all together. I always enjoy the opportunity to attend.”

**Note:** If you did attend but did not fill out the [short survey](#), please do so right away -- you could win one of three Sony Memory Sticks!

**Final Reminder:** The 2006 Doble Conference presentations are now part of Doble's extensive KnowledgeBase of information, and a link to these presentations has been sent to Doble clients. For more information, contact your Doble Client Service Engineer or e-mail [events@doble.com](mailto:events@doble.com). See a [complete list](#) of the presentations and abstracts.

## What's Next?

In June, Doble will begin collecting submissions for the 2007 Client Conference. Preparations are already underway for the September Client Committee Meetings at the Wigwam Resort in Arizona, and registration is now open. For more information, go to [www.doble.com](http://www.doble.com)



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## **Doble Client Committee Meetings: Time Well Spent**

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Unfortunately, many of our clients will miss it, citing workload and budget restraints. What they may not realize, however, is that the benefits of attending far outweigh the travel costs – and gathering information and sharing knowledge may be the most profitable use of their time. In the paragraphs that follow, we will address the most common reasons for missing (and benefits of attending) the meetings.

### **Too little time. Too much work.**

Though these would seem valid reasons for avoiding spending time at the Client Committee Meetings, they are equally valid as reasons to attend. In fact, the hands-on knowledge gained at these meetings may help improve, minimize, or even eliminate certain processes.

Knowing about an inherent apparatus problem before a failure occurs can save weeks of work, and contacts with industry peers can uncover resources which can help identify and resolve complex problems quickly and efficiently.

### **Lack of funding.**

Since there is no charge for attend the meetings, the costs are limited to travel and living expenses. The wealth of industry-specific knowledge to be gained can easily offset these costs.

### **Someone else in the company attends.**

Meetings and activities typically begin at 7:30 AM and run until about 7:30 PM. Given that schedule, it is difficult for a single person to attend everything and take enough notes to share with the rest of their team. Sending more than one person from each company would ensure that the expertise is communicated effectively though the company, for maximum return on investment.

### **Looks like a planning session for the Spring conference.**

While the meetings do guarantee that clients create the agenda for the Spring Conference, they are not planning meetings. What they really are is a comprehensive forum for discussing problems and issues of critical interest to utility maintenance engineers.

You can help put a stop to the “brain drain” in the utility industry by attending the Doble Client Committee Meetings September 24-29, 2006 in Phoenix. It will give you a chance to learn and to share your expertise and share in that of your peers. You will have a golden opportunity to keep abreast of new developments in your industry.

*It will, without question, be time well spent.*

**[Find out more](#) about the Doble Client Committees.**



Please don't hesitate to share your thoughts on this article. Send your opinions and comments to: [DobleExchange@doble.com](mailto:DobleExchange@doble.com). We are always interested in **Doble-Tested** case studies and field photographs from the Client Community. Please send these to [DobleExchange@doble.com](mailto:DobleExchange@doble.com).

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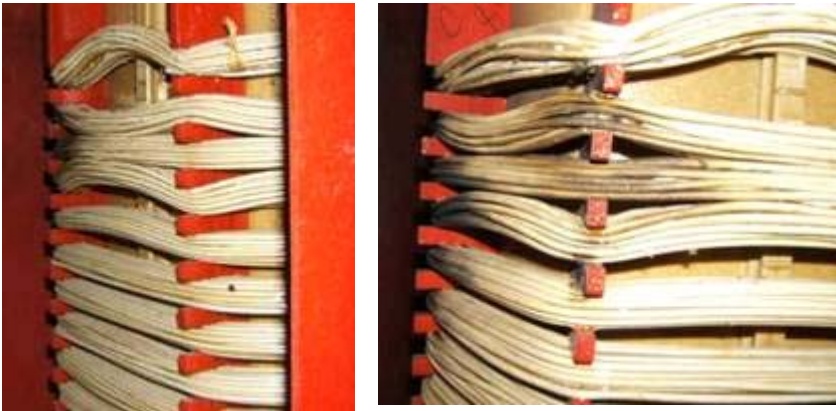
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## The Value of AC (versus DC) Testing of Dry-Type Transformers

By Long Pong

This article describes the benefits of AC testing dry type transformers and the differences between the AC and DC testing based on field test experience.

During a classroom discussion, a group of Doble clients complained that some electrical tests did not detect an obvious winding failure. The electrical tests they referred to were the low voltage (LV) transformer turns ratio (TTR) and a DC testing, known as a Megger test. In fact, the Westinghouse dry-type transformer, rated 13.8/0.48kV Delta/Wye, 750kVA vintage 1988, had tripped out the service by a blown fuse on phase A on the HV side and a breaker on the LV side. The LV TTR and Megger tests were performed as troubleshooting and did not indicate any problem. When they were connecting the transformer to return it back in service, they fortunately noticed the phase A winding deformation as shown in Figure 1.



**Figure 1 Visible HV Winding Damage on Phase A**

The author proposed diagnostic testing the failed transformer with AC High Voltages and to evaluate the effectiveness of each test techniques. The AC HV tests consist of Doble Overall (%Power Factor and Capacitance), Exciting Current, Doble turns ratio and leakage reactance (LR) tests.

**Overall Test:** The overall test results in Table 1 shows clearly the change in condition of the winding insulation, mostly on the HV winding. The CH % Power Factor (PF) went from 0.32% on 12/15/2003 to 5.3% on 3/17/2006 and the CH capacitance increased about 15%.

**Table 1 Doble Overall Test Results**

	kV	12/15/2005		Previous data 3/17/2003		ΔCap
		%PF	Cap	%PF	Cap	
CH	10	5.3	255	0.32	222	15%
CHL	10	3.15	1096	0.36	1075	2%
CL	0.5	1.88	3933	0.3	3845	2%

An increased watts loss or %PF indicates the deterioration of insulation quality and an increased capacitance or charging current signifies short-circuited insulation layers, physical damage or deformation.

**Exciting Current and Doble Turns Ratio:** The test results are in Table 2 and located the problem on the HV winding phase A (H1-H3). The exciting current at 5 kV did not reveal an abnormality, but at 10 kV the exciting current of the

phase A (H1-H3) was much higher than the phase C current. At the higher voltage, the two outer windings stopped having the expected similar high currents and the difference was more than 10%. The abnormally high current on phase A indicated either a turn-to-turn insulation or a core lamination problem in that winding. The next step was to use the HV turns ratio test to identify which problem existed and locate the defective winding. The phase A winding had the turns-ratio error of -0.81% which exceeds the acceptable limit ( $\pm 0.5\%$ ). A decreased turns ratio means the turn-to-turn insulation failure in the HV winding.

**Table 2 Test Results of Exciting Current and Doble Ratio**

Phase	Nameplate	49.8		2005		2003
		Ratio@10kV	%Error	5kV	10kV	5kV
<b>A</b>	<b>H1 - H3</b>	49.4	<b>-0.81%</b>	58	<b>63</b>	59
<b>B</b>	<b>H2 - H1</b>	49.6	-0.37%	38	41	41
<b>C</b>	<b>H3 - H2</b>	49.7	-0.25%	60	56	60
			<b>Ratio Test</b>	<b>Exciting Current Test</b>		

**Leakage Reactance Test (LRT):** LRT is a short-circuit test measuring the leakage impedance which is mainly a function of the geometry of the two windings under test, called the leakage channel. A change in leakage impedance indicates a winding deformation. The test results are in Table 3 and confirmed the winding deformation. The measured three-phase equivalent leakage impedance exceeded the nameplate (NP) impedance by more than 3% which indicated the winding deformation.

**Table 3 Test Results of Leakage Reactance**

	Measured	NP %Z	%Error
<b>3-Ph.Eq.</b>	5.8	6	-3.33
<b>H1-H3</b>	6.16	2.7%	1.8%
<b>H2-H1</b>	6.07	1.2%	0.3%
<b>H3-H2</b>	5.92	-1.3%	-2.1%
<b>Average</b>	6.05	<b>%Err/NP</b>	<b>%Err/Avg</b>

**Note:** %Err/NP is the error of the measured impedance compared with the nameplate value and %Err/Avg the error of the measured impedance compared with the average of measured values.

**CONCLUSION**

This field experience demonstrates that there is a group of tools to assess the condition of the transformer. The user should choose the right tools for the job. For an insulation condition assessment, an apparatus designed for AC high voltage system should be tested with an AC high voltage. This experience has shown that the turn-to-turn insulation failure could be detected only at 10kV and that the DC voltage test (Megger) could not detect the insulation deterioration or failure of this transformer winding. The deficiency of DC voltage test is mainly due to a masking effect imposed by the good insulation layers in series with the degraded or failed insulation [1].

**Reference**

1. George A. Cavigelli, Dennis J. Kopaczynski, Mark F. Lachman, and Raka Levi, "AC Power Factor Versus DC Insulation Resistance Measurements", Proceedings of the 65th Annual International Conference of Doble Clients, 1998, page 1-8.1



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## **Dissolved Gas Analysis of Load Tap Changers**

*By Norbert Gilbert*

The fourth meeting of the Dissolved Gas Analysis of Load Tap Changers (DGA of LTCs) Subcommittee, held at the Westin Hotel in Boston this year, was devoted to studying the dissolved gas-in-oil patterns of LTCs to identify units requiring maintenance and to prevent failures. The analysis technique allows the maintenance engineer to identify which LTCs are having trouble and to fix the problem, hopefully eliminating a major transformer failure.

The time-based inspection and rebuilding of the internal components is a rather inefficient method to maintain a load tap changer. In fact, the process of going into an LTC and checking the mechanical components, only to find that everything checks out, makes less sense than simply sampling the oil and looking at the gassing pattern to determine if the unit is healthy. The latter approach allows a more efficient use of resources, and it has attracted high interest, bringing more than 170 Subcommittee members and guests to the meeting.

The creation of online diagnostic techniques for LTCs has been an important activity of the Transformers Committee of Doble for many years. A subcommittee of the same name previously developed a guide that was provided to Doble client utilities in 2001, and this guide is still available through your Doble Client Service Engineer.

A presentation was given by Rick Asche at the 2002 Doble Conference that described the guide, and then the subcommittee was dissolved. The subcommittee was requested to be reopened in 2004 because it was felt that the industry had been taking samples for many years so that the original guide could be improved. Also, the previous guide omitted gassing patterns for some troublesome LTCs due to lack of data. The previous database of data included about 7000 samples for study. The success of this guide and the interest in this technique has allowed the database to grow: at this point, over 44,000 dissolved gas records have been collected.

Rick Asche, Portland General Electric, the Subcommittee Chair, restarted the project at the Fall Meetings in 2004, and he continues to chair the meetings at each of the conferences and Fall meetings. He moderates the discussion and engages volunteers to further the study. The committee is in the process of drafting an "Oil Sampling and Filling Section" for the guide so that the people taking the oil samples will obtain a representative sample in a safe manner. The taking of samples eventually lowers the oil level in the LTC tank, so filling procedures are also needed and will be developed by this group.

Some LTCs are fitted with oil filters to improve the long term operation of the unit. The presence of a filter may impact the gassing signature of the LTC, and a few members have volunteered to study the effects to help interpret the condition of the LTC. A concerted effort to collect information from those clients using filters was initiated at this meeting.

At each meeting a group of LTC types are assigned to members of the committee to study their gassing signatures. At this meeting, the analysis of Allis-Chalmer type TLH LTCs was presented by Mark Tostrud of We-Energizes. He was able to identify that the normal gassing pattern for the TLH-10 LTCs is different from the TLH-20 and TLH-21 LTCs and requires a separate set of limits. There was also a proposal defining the gassing limits for the Westinghouse type URS LTC. These proposals will be incorporated into the guide for the next release.

The DGA of LTCs subcommittee is very active. The Committee plans to create a document in the near future that the utilities can use to increase their system's reliability and stretch their maintenance budget. The committee always encourages new members but requires that members participate in the subcommittee activities. This activity includes, but may not be limited to, providing discussion at the meetings, reviewing documents that the subcommittee develops and providing data to the subcommittee for study. We encourage you to come to the meetings and provide your

expertise on this subject or help decide whether your company can profit from implementing a dissolved gas analysis of LTC program on your system.



Please don't hesitate to share your thoughts on this article. Send your opinions and comments to: [DobleExchange@doble.com](mailto:DobleExchange@doble.com). We are always interested in **Doble-Tested** case studies and field photographs from the Client Community. Please send these to [DobleExchange@doble.com](mailto:DobleExchange@doble.com).

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