



**2008 EuroDoble Colloquium**  
Lifetime Care in the Power System  
Benalmadena-Costa, Spain  
20-22 October 2008

**OPENING CEREMONY**

**Monday 20 October at 8:30 AM**

**WELCOME** *Vegard Larsen, President, DobleEurope*

**FORMAL OPENING** *Martin Clayton, NationalGrid, UK, Chairman of the EuroDoble Committee*

**OPENING ADDRESS** *Eva Pagan, Director of Maintenance of Installations, REE*

The opening address will describe the experience and some of the challenges faced when integrating the 220kV network assets acquired from other Spanish utilities, thereby tripling their number of assets.

**TRACK ONE: ASSET MANAGEMENT AND HIGH VOLTAGE TEST SESSIONS**

**Monday 20 October at 9:45 AM**

**Tuesday 21 October at 8:30 AM**

**SESSION 1 CAPITAL SPEND FOR MANAGING OWNERSHIP COSTS THROUGHOUT THE ASSET LIFE**

Capital purchase has become more difficult as companies are realizing the need to replace aged assets. Countries elsewhere such as India and China are rapidly expanding their networks. All of this adds to the pressure on factories to produce more. As many traditional factories have closed, this new pressure has led to a global marketplace.

**LEAD PRESENTATIONS**

**1.1 The Utility Perspective on Managing Purchases of Major Assets**

*Tom Kydd, Hydro One, Canada*

The Canadian utilities are facing major challenges with the contraction of facilities in North America and the need to replace aged or under-rated assets. This means competing with utilities around the world to gain access to good facilities. Delivery times are approaching two or more years in factories, most of which are remote and unknown. The challenges imposed will be described in this opening presentation.

**1.2 The OEM Perspectives on Supply within the Global Marketplace**

*Benedikt Schmitz & Geoffrey Cao, Siemens, Germany*

The globalization of suppliers and the reduction of manufacturing capacities has been witnessed since the start of the present century. Replacements in traditional markets and unplanned increase in new markets have brought a complete turn-around for an industry that appeared moribund. This paper will review the post-war manufacturing cycles in domestic industrialized markets, illustrating how these uncertainties of demand cycles have led to these changes. New business models may apply for the current rapidly changing environment, with new alliances between suppliers and customers, however within the context of risk for long-term investment in capacity.

**1.3 Working with Suppliers to Improve Lifetime Costs and Performance**

*Jose Anguas, REE, Spain and Miguel Oliva, ABB, Spain*

This paper will describe the Spanish experience to enhance the lifecycle costs and performance. The process starts with the purchase of equipment with maximum flexibility for network location. This includes purchasing standardised, universal and multi-voltage transformers, aiding order scheduling and spares cover. Once in service a condition assessment must lead to the optimum choices for maintenance, repairs and rebuilds on site or in service. These are choices to be made depending on time frame, problems with transportation and the availability of factory space, but these choices are ones best made with an active collaboration between the user and supplier.

**OFFER A PREPARED CONTRIBUTION TO THE DISCUSSION**

Following the lead paper contributions, the attendees are invited to discuss the Preferential Questions identified below. This is most beneficial if participants offer a short PowerPoint presentation describing their response prior to the meeting. Please review the programme below to see where YOU can contribute. Send all contributions to Liv Anna Besteland at [liv.anna.besteland@doble.no](mailto:liv.anna.besteland@doble.no)

## PREFERENTIAL QUESTIONS

- 1.1 Have you used a forward buy option in order to obtain delivery slots in selected factories, initially to a generic specification and sending detailed specification shortly before the construction slot? Have you done this as part of the EU procurement directive legislation and a framework agreement? Have you used provisions within the negotiated and restricted procedures?
- 1.2 Has this market development led to changed practices such as to increase spares cover, OEM- user alliances or greater use of re-builds? Have turnkey contracts successfully passed the responsibility for timely delivery over to the OEM. Has greater use of major re-build on-site been effective? What is your experience of any of these options? How effective has been life extension through re-builds or factory refurbishment and cleaning?
- 1.3 How extensive is the evaluation of potential factories in this worldwide supplier base for capability and performance? As a buyer do you undertake such assessments- as an OEM do you see much activity- and is there a mutual benefit or just to the buyer?
- 1.4 What factors do you considered at either purchase or in-service stages? Factors can include cost of losses, cost of late delivery, factory failure rate, ongoing cost of maintenance/refurbishments, cost of outages, unreliability/unavailability and others. Can you put a cost on unreliability, possibly including capital and operating expenditure, safety or business interruption?
- 1.5 What processes are in place to provide an accurate record of the ownership costs for key assets? Is there an organizational learning process to obtain experience lifetime expenditure feedback into new purchase processes?
- 1.6 Do you work with suppliers to improve lifetime costs and performance? Or, with customers if you are a supplier?

## SESSION 2 RELIABILITY, CONDITION OR RISK BASED – HOW DO YOU IDENTIFY BEST VALUE FROM THE MAINTENANCE BUDGET?

Many utilities have been seeking to improve both costs and performance achieved from their maintenance strategies by moving away from reliance on corrective and time/duty based triggers. Some utilities have introduced reliability centred, condition based or risk based. As we discussed in the 2007 EuroDoble colloquium, many companies are choosing a combination determined by asset type and risk mitigation required. What are the problems or issues associated with this change?

### LEAD PRESENTATIONS

Several speakers will describe their experience in implementing a change in maintenance strategy, the time scales needed, resources, software tools and particularly the problems and obstacles to be met and overcome.

#### 2.1 A 12 Year Journey into Maintenance

*John Stead, AltaLink, Canada*

Improving reliability in conjunction with lowering costs can be described as a journey rather than a process or project. AltaLink first implemented reliability centered maintenance (RCM) in 1996, the major accomplishment was that staff was more cognizance of the effectiveness of the maintenance program and how it related to reducing the risk of failures. Total acceptance of new strategies would come later as new condition-based maintenance tasks were applied and on-line monitoring systems installed. One of the concepts used was the generation of a “saves database” indicating where condition based maintenance tasks prevented a failure that would have occurred had the company adhered to the original time based triggers. It was also possible to demonstrate the cost saving by ignoring a time-based trigger in situations where condition assessment indicated the work was not needed.

#### 2.2 Reliability Centered Maintenance (RCM) Experience in Romanian TSO Company

*Ciprian Diaconu, TRANSELECTRICA – Romanian Power Grid Company, Romania*

The paper presents the profile and the core activities of Transelectrica Company, focusing on current concerns regarding the general maintenance philosophy of the company correlated with sound assets management; maintenance requirements and the ways to meeting them; justification of the Maintenance Assurance Program by scientific and planning criteria, activity planning, programming, coordination and maintenance-specific IT applications as per the principles of the Reliability Centered Maintenance Methodology (RCM).

#### 2.3 A Mixed Maintenance Strategy

*Aðalsteinn Guðmannsson, Landsnet, Iceland*

Landsnet is a small grid company with 66 substations and 2916 km of overhead lines operated on 66, 132 and 220 kV. The maintenance strategy is an optimised mixture of time based, condition based and RCM, selected to match individual activities.

## PREFERENTIAL QUESTIONS

- 2.1 Has your company attempted to move from time based/corrective strategies to a one single strategy such as condition based, reliability centred or risk and criticality? Or do you have a broader mix of strategies appropriate to asset class?
- 2.2 How have you decided the most appropriate strategy for each asset class? Is it based on engineering applicability eg use CBM for tower painting because you can see very easily when they need painting? Or do you focus more resources on more critical assets and if so how do you decide what is critical?

- 2.3 How have you identified the benefits of any changed maintenance strategy, benefits such as a saving of resource in manpower, costs or improved performance?
- 2.4 What are the most effective targets for asset performance? These can include targets for availability and reliability, safety and the environmental impact, and cost effective operation.
- 2.5 Are the performance drivers set? How are they measured (e.g. SAIDI-type customer service statistics) or benchmarking? Can real year-by-year improvements be identified?
- 2.6 What about reducing system security during a planned maintenance outage? Do you have staged tasks with system recovery points should the circuit be required before the work is complete?

### **SESSION 3 IMPLEMENTING PROCESSES TO MANAGE RISK EXPOSURE DURING WORK ON SITE**

Governments, regulators and insurers all expect a company to establish and maintain processes for ongoing assessments of risk exposure and to have control measures.

#### **LEAD PRESENTATIONS**

##### **3.1 Asset Risk Management in Power Utilities – The Requirements and a Structured Approach to Auditing Compliance**

*Peter Jay, The Woodhouse Partnership Limited, UK*

Risk management is a legal requirement for the power industry and as a consequence evidence of compliance is one of the defining characteristics of good practice asset management. Therefore it is a significant element in the PAS 55 assessment. This paper introduces the range of risks associated with physical assets and outlines the structured approach within PAS 55 for assessing an organisation's approach to risk management.

##### **3.2 The Insurance Industry View on How the Power Companies Should Identify and Manage Risks**

*Don Schubert, Marsh, USA*

The presentation provides insight into the insurance industry "Best Practice" perspectives of 14 insurance companies and how they examine property risks in a power companies as regards to Identification, Quantification, Mitigation of risks for operating plant. The focus will be on transformers and generators. The presentation leads off with a summary of losses in the industry over the last 5 years, as well as a look at the 15 year history perspective. Current technology issues and accident patterns in equipment and plant are discussed. The role of Maintenance and Testing as a part of Operation & Maintenance (O&M) Best Practices is discussed with cost benefits highlighted. The value of advanced O&M concepts such as reliability centered Maintenance and Enterprise asset management are discussed, case study is provided along with suggested approaches (tools) for measuring success.

##### **3.3 A Company's Description of Identifying Site Risks and Their Management**

*Martin Clayton, NationalGrid, UK*

Ownership of assets in a power system involves a duty of care to the stakeholders. The first step is to identify and categorise these; the second is to devise appropriate means to minimise and manage any risk exposure. This will involve identifying the impact or risk exposure from normal operation, from malfunction and failure of assets on the system, on operating costs, environmental impact, financial exposure, legal action reduction in reputation and most importantly safety risks to staff, contractors and public.

#### **PREFERENTIAL QUESTIONS**

- 3.1 Do you maintain risk registers for each site with such methods as documenting the assessment, control measures and the recording of implementation of these measures? What does this cover, just asset risks such as COSHH, PCB levels, pressure vessel tests, and perhaps SF6 use, or is it for any work done on site to ensure staff is adequately trained and company exposure from unsuitable actions are minimised?
- 3.2 Do risk registers include the assessment of the likelihood of failure for key assets on each site together with the consequences to the site safety, environmental impact, performance and outage on the broader network? Do you use risk management zones?
- 3.3 Have you assessed risk in terms of functional failure due to condition, exposure to outside factors (i.e. floods, lightning, system faults, protection malfunction)?
- 3.4 What processes do you employ to mitigate and manage risks? Examples are site induction, safety passports, work instructions, activity risk assessments and mitigation. Are some tasks identified to be of specially high risk
- 3.5 Are risks recorded on site, on a company database and on spreadsheets or dedicated software?

### **SESSION 4 HIGH VOLTAGE MAINTENANCE AND TESTING**

#### **LEAD PRESENTATIONS**

##### **4.1 Failures of Resin-Bonded Bushings of LV Circuit Breakers - Investigation Methodology and Results**

*Eric Alzieu, EDF, France*

*Rabih Hayek, SES2i, France*

Before a field test programme involving more than 100 LV bushings, the methods to be used were assessed in the laboratory in order to define their feasibility and diagnostic parameters. Following this stage, tests were performed on-site during several scheduled maintenance outages in order to establish a review of the fleet's condition. This has allowed EDF to classify the bushings into 3 categories; good, doubtful and bad. Also this allowed EDF to minimize the risk of a failure during the CBs running by programmed testing replacement. The programme involved dismantling, dissection and visual examination of a defective bushing, conducted in a workshop to try to locate the fault and validate the diagnostic criteria.

#### **4.2 Winding Resistance Measurements on Power Transformers**

*Eddie Brynjebo & Lars Adeen, EON-ES, Sweden*

*Peter Werelius, Pax Diagnostix, Sweden*

Measuring the winding resistance (WR) is one of the most used methods for finding abnormalities in power transformers. The WR reveals the most common problems in a power transformer such as bad contacts on LTCs and OLTCs, bad joints or loose connections. However, measuring the WR on a transformer winding can be time consuming as well as a difficult thing to do because of the difficulties of saturating the core. This paper will show some hints and tricks on how to save time and improve the measurements on "tough" transformer units.

#### **4.3 Case Studies Using Acoustic Emission and UHF Probes to Detect and Locate Partial Discharge in Power Transformers**

*Sacha Markalous, LDIC GMBH, Germany*

An important role for any physical method responding to internal partial discharge in transformers is to be able to localise the source. Two techniques are particularly appropriate here, using AE probes on the tank walls and UHF probes in an oil valve. This paper will describe applications on a number of transformers, including UHF probe applications and the use of several AE probes to triangulate the source.

#### **4.4 Reliable Detection of Dangerous PD-Sources in HV-Insulating Systems of Power Transformers**

*Jitka Fuhr, BKW FMB Energie AG, Switzerland*

For oil-filled power transformers, the first indication about the permanent PD-activity in the insulating system is usually an increase of the content of dissolved gasses in oil. In such case a sensitive on-site PD-measurement (sensitivity less than 50 pC) should be performed to avoid failure. Practical examples will be described showing that it is possible to distinguish between dangerous and less dangerous PD-sources provided the correct measurement of PD-signals and by the consequent application of an "in-depth" analysis of PD-results are both appropriate. Furthermore the origin and consequences of typical PD-sources in HV-insulating systems of power transformers will be discussed.

#### **4.5 SFRA Reveals Loose Connections on Large Generator Step-Up Transformer**

*Eddie Brynjebo, EON-ES, Sweden*

A large 1-phase GSU unit produced gasses differing from 2 other units in the bay. Transformers diagnostics were performed and 3 sister units plus a spare unit was compared. The gassing unit showed different SFRA traces and slightly elevated winding resistance on low side. The unit was opened and the findings clearly showed a classic "close call." Several bolts on connection bars from bushing down to windings were only finger-tight. The problem was corrected and tests were made at three stages: before untanking; after tightening, without oil; and after refill. This paper will show the benefits of comparing sister units and what happens with traces with or without oil in the unit.

#### **4.6 Unusual Use of Gas Monitoring Systems**

*Miguel Martínez Ronderos, Julián Vadillo Iturrioz, Hugo Gago García and Laura Hernández Fernández, Iberdrola Distribución, Spain*

Examples are to be given of the use of gas monitoring equipment to investigate partial discharges and breakdowns by monitoring changes in the rate of gas production.

#### **4.7 Experience of Complex Diagnostic Inspections of Transformers in Electrical Power Engineering of Russia**

*Vladimir Smekalov & Anisim Dolin, Federal Grid Company of Unified Energy System  
Sergey Otmorskiy, Nina Pershina & Sergey Smekalov, Scientific and Production Enterprise "Technoservice-Electro" and Juan Francisco Muñoz, Aretch Solutions*

This presentation describes an extensive program of complex diagnostic inspections of about 350 transformers, operated for more than 20 and more years. Results show that 30% can be operated without any limitations and only 2% should be replaced. About 15% of the transformers need active execution of overhaul, and other transformers - either relatively small and not expensive renewals, for example, inspection of tap changers and cooling system oil pumps, replacement of entries etc. or more frequent diagnostic monitoring (23% and 30%, respectively).

#### **PREFERENTIAL QUESTIONS**

Particularly relating to how useful are partial discharge measurements, regardless of the type of measurement – IEC 60270, AE or UHF probes or even DGS. Is their role:

1. A measure of quality in a new transformer

2. A risk measure in new and old
3. How do you know if any detected PD signal or signature will lead to a shorter life – or a PD induced failure mode. Would it be better to concentrate on detecting PD in bushings than main windings since they are more likely to lead to PD onset and transformer failure.
4. Is rate of change in magnitude the more important piece of knowledge than magnitude alone
5. For electrical detection, is the signature-phase resolved pattern or frequency content more useful since it can give information as to the type and location of the PD?
6. Is the better process than to focus on magnitude measurement (i) to identify (ii) to locate and (iii) to decide either to ignore as innocuous or fix the problem
7. What is the relative usefulness of (i) measurements at terminals, (ii) probe measurements or (iii) DGA?

## **TRACK TWO: PROTECTION**

**Monday 20 October, Tuesday 21 October & Wednesday 22 October**

### **2008 EuroDoble Protection Testing Training, Colloquium, and Presentations**

Mr. Yngve Aaboe of Troll Power will lead the training and colloquium sessions. Troll Power is a consulting and testing company located in Bergen, Norway. The program enclosed below, consist of a training session to be held on 20<sup>th</sup> October and discussion sessions on the 21<sup>st</sup> and the 22<sup>nd</sup> of October.

#### **Monday, September 20, 2008**

- 9:45 AM – 5:00 PM      **Protection Training**  
The training session will provide details regarding new applications and their influence on existing power system. The prerequisite for attending this training is a working knowledge of protection system and related testing of protective devices. The training session will be conducted by Jarle Helle of Troll Power.  
The topics discussed will be:
- Testing of distribution protection systems
  - Testing of protection applied at wind mill parks
  - Testing of transmission protection
    - Modern numerical line current differential protection
    - Numerical line distance protection
    - End-to-end testing
  - System commissioning
- 12:30 – 1:30 PM      Lunch
- 1:30 – 3:00 PM      Protection Training (Continued)
- 3:00 – 3:30 PM      Break
- 3:30 – 5:00 PM      Protection Training (Continued)

#### **Tuesday, October 21, 2008 – Technical Colloquium and Presentations Day 1**

Each session in this inaugural year will be led by an invited speaker who will address the issues as identified in the session below. However, an important element in each session is the “sharing of audience experiences.” Here attendees are encouraged to offer any informal material, such as short Power Point presentation, describing their experiences.

- 8:30 – 8:45 AM      Opening Remarks and Welcome  
*Yngve Aaboe, Chairman of the session*
- 8:45 – 9:45 AM      Protection issues associated with the integration of HVDC into AC transmission system.  
*This discussion will be led by Bertil Lundquist of ABB*
- 9:45 – 10:45 AM      Communication used in Protection.  
*This discussion will be led by Bertil Lundquist of ABB*
- 10:45 – 11:15 AM      Break
- 11:15 – 11:45 AM      IEC 61850 Implementation in the US Utilities  
*This discussion will be led by Ed Khan, Doble Engineering Company*
- 11:45 – 12:30 PM      Managing Relays as an Asset in Today’s Environment  
*This discussion will be led by Ed Khan, Doble Engineering*
- 12:30 – 1:30 PM      Lunch
- 1:30 – 3:00 PM      Protection Documentation  
*Led by Ana Morales DigSilent*
- 3:00 – 3:30 PM      Break

- 3:30 PM – 4:00 PM Results of Maintenance Practices Survey that was conducted by Doble Engineering in US  
Presented by Doble Engineering Company
- 4:00 – 5:00 PM Calculations for Protection Planning  
This discussion will be led by Ana Morales DigSilent

**Wednesday, October 22, 2008 – Technical Colloquium and Presentations Day 2**

- 8:30 – 8:45 AM Welcome and Introduction to Day 2 Program  
*Yngve Aaboe, Chairman of the session*
- 8:45 – 10:00 AM Wind Power Technologies; System Studies, Specifying Protection, and Interface Issues.  
*This discussion will be led by Yngve Aaboe*
- 10:00 – 10:30 AM Results of survey on Battery Applications conducted by Doble USA  
*Presented by Doble Engineering Company*
- 10:30 – 11:00 AM Break
- 11:00 – 12:30 PM Maintenance Planning Based on Simulation of Power System Reliability and Economic  
Consequences  
*This discussion will be led by Yngve Aaboe of Troll Power*
- 12:30 – 1:30 PM Lunch
- 1:30 PM – 2:00 PM Protection Testing Tools - Technology Update  
*Presented by Doble Engineering Company*
- 2:00 PM – 3:00 PM Protection as a Damage Limiter  
*This discussion will be led by Yngve Aaboe of Troll Power*
- 3:00 PM – 3:30 PM Wrap up comments by Yngve Aaboe of Troll Power

**TRACK THREE: HV DIAGNOSTIC TRAINING**  
**Monday 20 October & Tuesday 21 October**

This session will be suitable for the new entrant to testing HV equipment, as well as those with some experience wanting to learn more. It will be run on Monday, as well as Tuesday morning parallel with the asset management session. This will allow attendees to join the Asset Management group for the testing session in the main hall for Tuesday afternoon.

**MONDAY 20 OCTOBER FOUR SESSIONS**

**9:45 AM – 11:00 AM TUTORIAL 1 INTRODUCTION TO TESTING ON SITE**

*Dr. Richard Heywood, Doble PowerTest, UK*

This tutorial will give an introduction into the many different requirements of testing on site including:

- The Testing Environment – site induction, safety control, hazard areas, protective equipment, risk assessment
- Testing – on line, off line, invasive, non-invasive, testing and condition assessment
- Identifying critical failure modes is the important starting point including identifying those specific to the equipment and identifying matching diagnostics.
- Software for handling test data both in the field and in the office, particularly the use of web enabled databases for analysis, coordination of multi-source information and archiving

**11:00 AM – 12:30 PM TUTORIAL 2 DETECTING DETERIORATION AND DAMAGE**

*John A. Lapworth, Doble PowerTest, UK*

This tutorial will introduce the important measurement techniques used in assessing the condition of HV equipment. These techniques will range from those used on line such as infrared, UHV, visual inspections. Oil testing is one of the simplest and most widely used diagnostic. For offline use, Power Factor is an important quality property of an insulation system indicating ingress of contamination. Partial discharge will allow localized defects to be identified.

**12:30 PM – 1:30 PM LUNCH BREAK**

**1:30 PM – 3:00 PM TUTORIAL 3 CASE STUDIES**

*John A. Lapworth, Doble PowerTest, UK*

Examples will show how various diagnostic methods are combined to provide an integrated package to monitor and investigate. Cases will include investigation of problems in power and measurement transformers, capacitors, surge arresters and generators.

**3:30 PM - 5:00 PM TUTORIAL 4 ESTER TRANSFORMER FLUIDS FOR ENVIRONMENTAL PROTECTION, IMPROVED FIRE SAFETY AND HIGH TEMPERATURE OPERATION**

*James O'Brien, Engineer, M+I Materials*

Environmental and safety concerns together with reducing availability of good traditional mineral oil are raising interest in alternative fluids such as synthetic and natural esters. This tutorial will describe these materials and aspects such as biodegradability, environmental performance, fire safety, ageing, moisture tolerance, high and low temperature performance, cooling properties, compatibility with materials and electrical properties.

**TUESDAY 21 OCTOBER SPECIAL DOUBLE SESSION TUTORIAL – PARTIAL DISCHARGE**

**8:30 AM – 12:30 PM TUTORIAL 5 PARTIAL DISCHARGE TECHNIQUES**

*Dr. Sacha Markalous, LDIC, Germany*

Partial discharge is an important failure mode for insulation systems. This tutorial will introduce the problem and how it is assessed. This tutorial will start by describing the range of problems where partial discharge failures have occurred in HV plant. It will then proceed to describe various detection, measurement and location techniques. These will include measuring to IEC standards together with field applications using acoustic and UHF measurements.

## **UTILITY ONLY SESSION – EQUIPMENT RELIABILITY**

**Wednesday 22 October**

8:30 AM – 5:00 PM with breaks at 10:15 AM and 3:00 PM, Lunch from 12:30 – 1:30 PM

This is a session for utility-only clients to share their operating experience by contributing to the Preferential Questions identified.

### **SESSION 5.1 FOCUS ON INSTRUMENT TRANSFORMERS**

There has been some tradition of instrument transformer failures and attendees are encouraged to share their experience, both good and bad.

Contributor 5.1.1 *Dagmar Kopejtková, CEPS, Czech Republic*

Review of Instrument Failures in Czech Transmission Systems

Contributor 5.1.2 *John Stead, AltaLink, Canada*

The Canadian Experience

Contributor 5.1.3 *Tim Noonan, ESBI, Ireland*

Failures in ESBI

Contributor 5.1.4 *Presented by Doble*

Failures in ITs reported by Power Grid at the 2007 Doble India PowerForum

### **PREFERENTIAL QUESTIONS**

#### Current Transformers

- 1.1 Have specific designs made some CTs more or less reliable? Live tank, dead tank, metal or rubber bellows, bushing construction. Give some reliability data or case studies.
- 1.2 What diagnostics have proven the most effective?
- 1.3 How have you managed safety risks?

#### Voltage Transformers

- 1.4 Have you had leak problems with capacitors, leading to failures?
- 1.5 Do you have testing experiences with the electromagnetic unit?
- 1.6 How have you determined PCB content in older units and how do you dispose of the units?

### **SESSION 5.2 ASSESSMENT OF MOISTURE IN OIL IMPREGNATED PAPER INSULATION**

All appreciate the deleterious effect on transformer life caused by ingress of moisture. A paper at the 2008 Boston Doble Client Conference from ABB and HydroOne showed that technology exists for very effective in-situ dryout solutions. They used low frequency heating and vacuum, removing 150 and 160 litres of water from two 750MVA units. But where are the problems with this and controversy as to best methods to measure moisture.

Contributor 5.2.1 *John Lapworth, Doble PowerTest, UK*

### **PREFERENTIAL QUESTIONS**

- 2.1 Do you have a view on the moisture content within your transformer fleet? Is this based on techniques such as:
  - a) Measurement of solid samples removed from a transformer and laboratory tested?
  - b) Measurement of relative saturation of the oil with a capacitive probe and using Piper curves to calculate paper moisture?
  - c) Indirect measurements using dielectric loss with either DC, 50Hz or variable frequency energisation?
- 2.2 What experience have you with dryout attempts with hot oil, vacuum, vapour phase, low frequency/vacuum?
- 2.3 Is it bad for a transformer to be dried from wet to as-new moisture levels? The ABB Doble Boston Conference paper claimed to be drying a wet transformer to only 0.3% moisture after dryout. How extensive should dryout be? What experience is there for bagging in the paper affecting oil flow, and loosening of binding or clamping then affecting mechanical strength after dryouts?

### **SESSION 5.3 CORROSIVE SULPHUR ISSUES**

We have discussed corrosive sulphur at some detail in earlier meetings. But we are seeing more of the effect in colder climates and also in free breathing units. Companies are also testing oils much more for corrosivity.

Contributor 5.3.1 *Alan Wilson, Doble PowerTest, UK*

#### **PREFERENTIAL QUESTIONS**

3.1 Are there recent reports on failures with free breathing transformers?

3.2 What oil testing are you doing to assess corrosivity and by which test methods: CIGRE, ASTM 1275B?

3.3 Are you passivating oils? What other steps are you taking?

#### **SESSION 5.4 GENERAL EQUIPMENT EXPERIENCE**

This is the opportunity for each attendee to share both good and bad experiences where there was a good learning experience that can be shared such as a failure or a failure avoided by intervention.

- Failure in factory test
- Failure in transport or commissioning
- In service failure
- Experience with asset disposal.
- Fatalities

Contributor 5.4.1 *Eddie Brynjebo, EON-ES, Sweden*

Field Repair of 130kV Transformer on Top of a Mountain in Norway

Contributor 5.4.2 *Aðalsteinn Guðmannsson, Landsnet, Iceland*

Root Cause failure Analysis after a Flash over at a 75 MVAR Capacitor Bank

Contributor 5.4.3 *Tim Noonan, ESBI, Ireland*

ESBI Tyco Surge Arrester Fault

Contributor 5.4.4 *Tim Noonan, ESBI, Ireland*

ESBI Passoni Villa Bushing Failure