

HIGHLIGHTS FROM THE APRIL 2008 DOBLE CLIENT COMMITTEE & USER GROUP MEETINGS

Held April 6 – 11, 2008 in Boston, Massachusetts, USA

The following is a brief report of highlights from the recent Doble Client Committee and User Group Meetings. Detailed Committee Reports will be posted on the Doble Knowledgebase in July. If you have questions or would like additional information on any of the following subjects, please contact your Doble Client Service Engineer or Regional Sales Manager for assistance.

The comments in red in this document are typical of a reminder that a meeting attendee might put in his or her notes so that some action will be taken when returning to his or her company. These summaries are NOT the complete discussion that took place in the meetings.

Arresters, Capacitors, Cables and Accessories Committee

CAPACITORS:

Action Item: I need to get the capacitor survey filled out.

Mr. Rick Asche introduced a survey on capacitor failures. These were provided electronically prior to and in paper form during the meeting. Mr. Asche stated his belief that since the capacitors are a commodity item and are relatively easy to replace, and consequently, the failure rate of capacitors is not being reported to Doble. He is concerned and would like to know if certain manufacturers have a higher failure rate than others. His opinion is such that as a committee we are missing out on a lot of important information on the rate of failures for different designs and manufacturers.

Mr. Asche went on to explain the intent of the survey, which is to capture failure and trouble information from events that would have occurred within the last five years. He encouraged those in the audience to, if applicable, fill out a questionnaire with whatever details they could remember and drop it off at the registration desk at any time during the week. Furthermore, he went on to detail some of the specifics, such as switching frequency, type of switching device, and whether they were new or existing installations. The goal of this exercise is to collect this information over the next few months and present an update on the findings at the next committee meeting. The officers then asked the group whether they thought this would be a useful exercise and a majority of hands were raised.

Action Item: Get permission to attend the Tutorial on Capacitor Subjects. Do we have it in the budget? Have we had failures that we can report?

A tutorial has been proposed to address the problems associated with capacitor and breaker failures. This will be a joint committee effort between ACCA, Circuit Breakers and the Protection Apparatus Committee. The tutorial is planned for the 2008 September Doble Client Conference and Committee Meetings in Atlanta, GA.

Should we routinely test capacitor banks? Review this paper.

Testing Fuse-less Capacitor Bank with Serial Unit String Using the M4000 Test Instrument – Update of the CapBank test Procedure

Action Item: Check if we have capacitor fuses that have exposed fiberglass due to weathering. Determine if we need to provide corrective action.

PGE has experienced problems with their fifteen year old GE Series Capacitor banks. The paint coating on the current limiting fuses and fuse bodies has weathered, exposing the fiberglass layer to moisture ingress. GE's recommendation was to paint the tubes, however; the paint is not sticking to the wet tubes. This procedure was performed, as directed by GE, but we are still experiencing rapid degradation. Replacing these could run into the millions of dollars. Given the large amount of these in the system, a cost effective approach was needed to address this condition.

Instead of painting the tubes, PGE personnel decided to use DSG-Canusa's CBTM heat shrink to cover the fuse tubes and current limiting bodies. This product was designed for covering electrical bus bar, but they have discovered that the heat shrink forms a weather tight seal on the fuses. The fuses and tubes are oven dried, then allowed to cool. The heat shrink is slipped over the fuses and placed back in the oven for shrinking. The heat shrink is a cross linked polyolefin. The process is being performed by in house labor.

CABLES:

Do we need to modify our policy for grounding splices in manholes?

Harry Hayes, Ameren commented on his reasons for grounding every splice in every manhole. He stated they did so to follow code requirements and make sure they had good grounds. As a result they have not had any problems in this area.

See if we need to consider the use of cable rejuvenation techniques.

“Recently, Hydro One experienced a failure of a 5 kV cable that connects Hydro One's switchyard to a large nuclear customer. The 5 kV cable is a three phase Teck cable consisting of three individually unshielded cores in a triplex arrangement. Each of the cores is individually insulated with carbon black-filled polyethylene. There is also an uninsulated ground wire and filler. The conductors, ground wire and fillers are contained in a cable jacket over which there is a helical steel armor (unsealed). There is a further polymer jacket over the armor. The total cable length exceeds cable 3400 ft or 1036m.

On reviewing replacement versus refurbishment options they are considering cable rejuvenation by means of fluid injection which they understand has been used by a number of utilities worldwide. Hydro One is interested in your experiences both positive and negative on the cable rejuvenation process please.”

Don Prien, SMUD stated they have used cable injection with good success on 15 and 21 kV cables. He went on to elaborate the differences between doing it online while the cable is energized or performing this activity offline. The latter is similar to the process presented in an earlier Doble Conference paper by John Hinkle, PPL Utilities. The biggest differences noted by Mr. Prien was the dangers involved while performing it online and the cure rate. Apparently online takes longer to cure. Reg Gamblin, Manitoba Hydro asked how the success of the venture was measured. In summary, Mr. Prien stated success was measured by post treatment cable non failure rates and not by diagnostics test methods.

ARRESTERS

Action Item: Check if arrester spacers could collect water. The water may freeze causing a failure.

Mark Theryl, Alliant Energy presented an impromptu discussion on the problems surrounding change out of lightning arresters on the GSU transformers. The slides showed some of the problems encountered in the application of arresters in a cold climate. In summary, the spacers (hollow tubes) were not sealed properly and water got in, froze and lifted the arresters off their base. Had this not been discovered the possibility of a phase to phase flashover was imminent. In addition, it was discovered that the base of the units did not have sufficiently sized weep holes to allow the water to drain.

Action Item: Do we want to start an arrester receipt testing program? Need to go to the Doble Website and download the paper.

A paper was given on Manitoba Hydro's arrester acceptance test program by Reg Gamblin of Manitoba Hydro

GENERAL:

Have our thermography group read this paper.

Best Practices for using Infrared Thermography for Condition Monitoring of Utility

Asset and Maintenance Management Committee

Do my asset people know about this PAS 55? Action: Ask them.

Ken Elkinson, Doble Engineering provided a brief overview of PAS 55. Mr. Elkinson stated that PAS 55 is a Publicly Available Specification developed in the United Kingdom to act as a standard for asset management in a similar way to QA standards such as ISO 9001 act for Quality. PAS 55 is limited to physical assets and requires that the organization has a clear understanding of risk and a strategy to deal with it, along side auditable systems and processes. PAS 55 helps identify what an organization needs to do in their efforts to balance risk, cost and performance. Mr. Elkinson went on to explain that a Doble Engineering guide to asset management has been proposed as a committee project. This document would include all the essential elements for asset management accreditation. The PAS 55 document could be incorporated or used as a model.

How have regulatory agencies affected our maintenance activities?

One member of the audience commented that his company has been posting their findings on equipment failures and they are now discovering the insurance companies and regulators going through the public documents of those failures. This has caused the regulators and insurance companies to begin mandating the time frames for various maintenance and repair activities. He stated that there has been much pressure regarding adopting these time frames.

The ISO's are getting more involved with the control of systems so it is becoming more difficult to get equipment out of service for required maintenance.

Another utility employee is now noticing that at the state level, interested parties are looking at his company's internal written maintenance practices with more scrutiny. Audits are being performed and as part of the process, the auditor is using those documents to see how well the company is complying. He also commented that as the states are acquiring the information, it is becoming public record. He stated that they are becoming very prescriptive on the individual maintenance tasks, such as timeframes for substation inspections and infrared scanning.

One company member has recently heard from their attorneys that FERC may be leveling fines for companies that do not have control of their maintenance and testing records. He thought this may have been a reaction to a recent outage that had occurred in Florida. He wasn't sure what would trigger such a fine.

Are we having issues with integrating information from multiple sources into a common database?

Greg Bennett, Xcel Energy, commented that his company has several databases that house information from a variety of information gathering tools. This information is in many formats. He stated that his company is using Passport as their work management system in the substation organization. The process currently being utilized is a process where documents from these sources will be attached to a passport history brief so that history can be archived. These attachments can be in formats such as .pdf, .jpg, etc. He noted that they have not investigated a process to merge all of their information into a common database as of yet. He stated that it is a challenging task to try and integrate data into one database.

Mark Schneider, American Transmission Company, commented that they are beginning to use the Doble DTA Web program to try and consolidate all testing data (power factor, frequency response analysis, Transformer Oil Analyst, circuit breaker timing, attachments, etc.). He is hoping to ultimately interface with Cascade in the future. Mr. Schneider thinks this is also advantageous since FERC is typically scrutinizing this data and a company's ability to have it controlled and available.

Tony McGrail, National Grid U.S., noted that there are two issues regarding data. Collection of data that is not valuable or needed can be a problem and data duplication is another. He commented that if a condition based system is the goal then there is a need for a trigger to give an indication of the condition of the equipment. He indicated that this process can be done in a variety of applications and that it doesn't have to be in the work management system but rather as an input to the system.

Are our philosophies of maintenance practices at current standards?

Greg Bennett, Xcel Energy, started the discussion by asking the audience how many of them have recently had changes in their maintenance practices. A majority of the audience indicated that they had. Tom Kydd, Hydro One, commented that his company had been a time-based maintenance organization until the last few years. At that time, reliability centered maintenance (RCM) was sold to the company as the philosophy that would be best for savings of resources, both financial and equipment related. He stated that as the company tried to changeover to a complete RCM philosophy, they realized that the inputs required as well as the manpower requirements to support it were not feasible. The company has never become a truly full RCM based organization. Mr. Kydd noted that RCM activities do exist for many functions but some tasks have reverted back to time based. They have also gone with some predictive based tasks for some activities such as LTC maintenance and oil breaker maintenance. It has become a mixed bag of philosophies for what works best for different equipment.

Doug Hollands, SaskPower, commented that his company used to have percentages of time spent on maintenance vs. capital projects of 70% to 30%. Recently, this philosophy has changed and more time is being utilized from maintenance personnel to work on capital projects. Senior executives are realizing that this needs to change as maintenance needs have suffered. Regulations are also having an effect on the need for maintenance tasks to be more rigid. The need for knowing what is being done and how to document it is becoming quite important.

Here are some ways to reduce copper theft.

Greg Bennett, Xcel Energy, began the discussion by describing many of the countermeasures used by his company to deter copper theft. Xcel Energy has tried locks, chains, modifying gates and lighting, infrared detectors, fence shakers, roving patrols and more. He commented that after trying numerous methods, a company should evaluate which is the best approach and most cost effective for widespread use. To date, Xcel Energy has found that passive infrared detectors that contact the control center in conjunction with a strobe light and siren have been the most effective measures.

Alex Salinas, SCE, indicated his company has tried many of the same measures and that nothing has proven to be very effective. In addition, SCE has begun to work with the salvage yards regarding the theft issue but this has not proven to be a very productive alliance. Mr. Salinas indicated that there have been multiple deaths to the thieves in the substations. He also stated they have been trying a process of applying a microdot technology to the copper. This method allows the copper to be identified more easily at the salvage locations. They don't have much experience with it to date.

Mark Theyerl, Substation Maintenance Consulting/Alliant Energy, commented that Wisconsin has recently passed legislation on increasing the amount of fines to salvage yards accepting the copper. His company is also requiring certain distances from the fence where materials can be stored in substations. Also, in new construction environments, steel storage pods are being utilized to store all copper wire and materials.

Simon Higgins, ESKOM, commented on the copper theft issue being a huge problem for his company in South Africa as well. They are seeing a problem with the theft being done by employees of the company. They have looked at the use of aluminum conductors as well as investigating an online method for detection of corona when a conductor is cut.

Todd Campbell, Austin Energy, noted that his company has tried many of the same devices mentioned as well as encasing grounds in concrete. There has been recent concern regarding the encasement of grounds due to some findings that may indicate the copper can break down and lose some of its properties over time. His company is also beginning to use composite conductors. Tom Kydd, Hydro One, asked about the composite conductors and if it has been successful in deterring theft. Mr. Campbell indicated it has been somewhat successful since there is no value at the salvage yards for this material. He also commented on their phasing out of copper and going with composite conductor with a 40% conductivity rating.

Look into this factory inspections document, it could help us with our audits.

Mr. Alan Wilson, Doble Engineering, began the discussion by giving a brief background of the project that began at the EuroDoble meetings. Originally, the model for the factory inspections was developed by ESKOM on the generation side of the business. They have been using the program for transformer factory inspections and have found it to be successful. Their program was initially triggered from a prior Doble Conference paper by David Deines (formerly of Progress Energy), which discussed a scoring system for various issues within a transformer manufacturing facility. The ESKOM model has changed the scoring system into an exponential type system rather than a 1 to 5 rating system. The EuroDoble project has taken the ESKOM model and varied it somewhat so as to make it less subjective. The project is trying to not only score the facility but help the user to figure out what it would take to achieve perfection and then make criteria judgment in not meeting perfection. The document is still under construction and is now available for comments and is available to any Doble client.

Bushings, Insulators, and Instrument Transformers

This would be good to add to the next tailboard safety meeting. Need to get the full story from the meeting report.

Carl Pankratz, Lower Colorado River Authority (LCRA) discussed a safety incident that happened recently at his company. The technicians were testing a standby auxiliary transformer that provides backup power to one of LCRA's generating plants. The technicians were power factor testing the low side bushings of the transformer, the low side winding was shorted together, and the low side cables were isolated from the bushings. Since this transformer has a low side wye connection, a grounding resistor was in place and the bushings were isolated at the point of connection only. An L-bracket was in place to facilitate connection to the grounding resistor. The L-bracket was the grounding point for the cable static shield. Since the L-bracket was not removed, when the low side bushings were energized, the static shields associated with the cables were also energized. The individual was standing on a step ladder, using a retractable lanyard for fall arrest. All of the cables from the bus connecting to the low side bushings have electrostatic static shield green wires.

Action Item: I need to support this project.

Manufacturer Bushing Questionnaire

The subcommittee has started to provide Doble with preliminary information they have been able to gather from the websites for Passoni Villa, PCore, Trench, HSP and ABB. The subcommittee will continue to provide information on the bushings gathered from the manufacturers.

Action Item: Download the bushing troubleshooting guide and get it into the hands of the testers.

The Secretary reported that the troubleshooting guide/flow chart is complete. The goal of this project was to produce a document that testers and end users could reference to determine the condition of their bushings. The troubleshooting chart also provides guidelines for actions to be taken based on test results, and include proper test procedures and connections and what to do if data is suspect. The flow chart is available through the Doble portal, and can be found under Committee Apparatus Guides.

See how many 230 kV drawlead Trench COTA bushings that we have on our system. Read the whole story in the report and determine if we have exposure to increased risk.

Andre Lux, Progress Energy provided an update on an ongoing investigation of Trench bushing failures at Progress Energy. Progress Energy has experienced several failures of Trench Type COTA 900 BIL, 230kV draw lead bushings. The bushings were manufactured in 2000, in AJAX Canada. The investigation was instigated by a failure that occurred in August 2007 of a H1 bushing installed in a GE Prolec Three Phase Transformer. The H1 and the adjacent H2 bushings were destroyed, however the H3 bushing remained intact. A decision was made to send all three of these bushing to Trench, along with two bushings of the same vintage from a sister transformer in the same plant. The bushings were removed and sent back to Trench in AJAX, Canada for evaluation. It was noted that all load conditions were normal during the time of the failure.

There have been instances of separation of the epoxy cases of some current transformers which causes moisture ingress and eventual electrical failure. Look into these type current transformers on our system for developing problems.

Marshall Turley, Doble Engineering Co. discussed problems reported on current transformers on 72.5 kV SP40 breakers manufactured by Siemens and Westinghouse. The current transformers were Westinghouse Type BYM, Ratio-600:5, L-Spec.-960821, Style-7358D40G09 manufactured in July of 1985. The problem with the CTs was discovered during routine testing. The tests included ratio, polarity, excitation current, saturation curve, and megger insulation tests. While testing CT's in the switchyard, they discovered (9) bad current transformers. The method of detection was low megger ohm readings, and the CT saturation curves would flatten out vertically. In addition the ratio tests were close to the limit or just beyond the limit indicating a problem. It was noted the winding resistance did not detect the problem. When the CT's were disassembled, severe corrosion was discovered between the aluminum casting, and defects found in the current transformer epoxy casting. The root cause of the failure was determined to be the combination of age of the units, and the separation of the epoxy encapsulated cases of the current transformers. This led to moisture ingress, resulting in corrosion causing the current transformer to fail. During the investigation, notable inconsistent encapsulated pores were revealed in the inner middle section of the current transformer. The current transformers have been replaced. The remaining current transformers in service are being routinely tested, and as soon as the tests results are suspect a yearly review is performed on the current transformer.

Do we have signs of corrosive sulfur in our bushings? Action: Make sure that we tell the testers what to look for in the tailboard meetings.

Mark Theyerl, Alliant Energy reported that in August of 2007, while the crew was performing maintenance on a 69 kV McGraw Edison breaker, corrosive sulfur was observed in the sight glass of three of the six bushings on the breaker. The breaker was manufactured in 1981. It was noted that the three bushings had various degrees of contamination.

All six bushings were power factor tested. It was observed that the bushing that had significant blackening of the center conductor had the highest C1 power factor 1.16%. Mr. Theyerl informed the group that he believed the bushings were Type PA.

If we have these ABB Type T bushings we need to make sure the gaskets are inspected for displacement.

Fred Morris, City of Seattle informed the committee of some ABB 13.8 kV type T bushings on a GSU which had failed upper seals. The transformer was put in service 1994, and in 2002 the gasket seals were found out of their groove and the bushings were replaced. These bushings are over 4000 Amp with a lot of expansion and contraction, which may have contributed to the problem. In 2007, City of Seattle had the same problem occur again. They bought replacement bushings, which sucked in tank oil during the vacuum fill process.

We need to be careful to use the correct corona rings on bushings.

Mike Lau BC Transmission noted that during last year's bushing tutorial, it was stated that the transformer is designed to accommodate certain bushing types and sizes. There was an example of a

failure because the corona ring had been installed upside down, changing the voltage stress along the bushing. Mr. Lau questioned if replacing a high voltage bushing, do you try to adapt the existing corona ring to the new bushing, or use a new corona ring? How do you verify that the dimensions are suitable for required electrical clearances?

John Stead, AltaLink, replied that if a utility can't find duplicate bushings, a different bushing can be used, however the corona ring of the new bushing should be used, and not the old corona ring.

Mike Bocovich, XCEL Energy commented that when referring to bushings, grading rings is perhaps a better description than corona rings. The rings work with the bushing to grade the voltage over its length, and are not there so much to prevent corona.

Circuit Breaker Committee

What is our program for safe racking and operation of circuit breakers? Do we need to obtain arc resistant switchgear or use remote operators?

Rick Asche, Portland General Electric, has an issue regarding energizing distribution equipment. They have experienced several failures of metalclad switchgear. The failures were severe and in one case it blew the doors off. They have switched over to many remote devices due to the risks associated with this equipment. Mr. Asche tries to explain to his employees that they do not want to stand around this equipment since they don't always know when it will be operated remotely. Mr. Asche provided photos of a Westinghouse Type ESV failure.

Dave Lemmerman, PECO Energy Company, mentioned a presentation on arc resistant switchgear is taking place during the conference. This arc resistant equipment is a big step towards preventing the types of failures that Mr. Asche mentioned. He believes this switchgear design is a large improvement to reduce danger to nearby employees.

Alex Salinas, Southern California Edison Company, mentioned that there has been several presentations and papers presented on arc resistant switchgear. He thinks this is a great advancement for new switchgear; however, many companies have older equipment that they cannot justify replacement. He polled the group to see how many attendees have a policy to prevent employee exposure during switching of any type of switchgear. The majority of attendees have a policy in place.

Tim True, National Grid, commented that they have automatic rack out devices on their new equipment. Employees leave the area when equipment is operated. Jay Garnett, National Grid, mentioned that in their indoor locations where they have vacuum breakers they have moved all the controls down to the opposite end of the building so the operator is not standing by the breaker during the breaker operation. On some of their stand alone outdoor breakers they have purchased some remote devices so they can operate the breaker from a distance away using a long cord, removing the operator from the blast zone.

This coil signature project looks interesting. Do we record this information?

Alex Salinas, Southern California Edison Company, commented that over the past few meetings some information has been exchanged between several committee members on coil signatures. He has a list that was put together at the last meeting of volunteers to join a subcommittee. If anyone would like to take part in this subcommittee please contact Mr. Salinas. Starting next conference this group will meet separately to work on this project.

Mike Smith, Progress Energy, is interested in participating in this subcommittee. His company has been trying to incorporate coil signature testing in their yearly testing. It would be nice to have a library of signatures that can be used as a baseline for comparison. Don Prien, SMUD, also is utilizing this test method and would like to see a library created. Carl Pankratz, Lower Colorado River Authority (LCRA), would be willing to share their data with the subcommittee. They have a substantial amount of data collected. They have changed their process from testing on a yearly basis to looking at every mechanism when removed from service (first trip and second trip) and then when the mechanism is returned to service take an "as left" signature. They are also starting to apply information from their relays to include with their signatures. Mr. Salinas can use coil signatures to document that maintenance was actually performed at any given time with a date and time stamp. Rich Asche, Portland General Electric, talked to two relay manufacturers requesting trip coil monitoring and signatures to be designed into their product.

He believes if more pressure could be put on the relay manufacturers maybe they could start including these extra enhancements into their products.

I want to see how this list develops. It might be useful.

Linda Nowak, Doble Engineering Company, polled the group to see if it would be worthwhile to create a document similar to the transformer manufacturer list except for circuit breakers. The attendees had good interest in such a project.

Action Item: I need to submit some input for these subjects.

Doble Engineering Company is requesting topics that could be discussed during the September 2008 Conference. Here are some subjects of interest:

Vacuum breaker retrofits for their existing air magnetic breakers. Wayne Cheng, BC Hydro, mentioned that his company for the last ten years has been looking into point of wave control for circuit breakers. They have many applications at 500kV capacitor bank and reactor switching. They have a good deal of experience on this topic and would like to see this discussed in the September 2008 meeting.

Action Item: Give the following to our system people.

Ms. Dagmar Kopejtkova, CEPS, A.S., Czech Republic, decided to bring this subject to the committee after a presentation was given last year on small capacitive current switching and the impact on the features and condition of the circuit breaker. After opening some breakers deterioration of the Teflon nozzle is found and is caused by arcs occurring in the wrong locations. How can you discover this situation before a catastrophic failure occurs? If a catastrophic failure does occur it will not be able to be determined if the problem was a re-strike or something else. They have a method for detecting issues with re-strikes in circuit breakers. This method requires an outage and a special over-voltage detection monitor so there is a cost associated with the equipment and outage. Is there any other option available to determine if a re-strike has occurred? Fault recorders are available at higher voltage substations so the current and voltage curves are available. In these substations can this data be used to determine if a re-strike has occurred and catch the problem before a catastrophic failure occurs.

They have software called AROPO that will detect a re-strike using the data from the fault recorders. This software can detect a re-strike when the sensor used is a magnetic voltage transformer or a capacitive voltage transformer.

Alex Salinas, Southern California Edison Company, was curious if Ms. Kopejtkova had this process in place and working. She confirmed that this has been in place and working for a year. She said it can be put in service very quickly and continually upgraded with new modules as necessary. Mr. Salinas was wondering if it was integrated with SAP. Ms. Kopejtkova confirmed this was true.

Do we have the following type of breaker?

Dan Douglas, Electric Power Systems, reported some problems they found with Alstom 15 kV, 5000A Type VAH breakers. The reported problems Mr. Douglas discussed included a trip failure, cluster failure, alignment issues, contact block problems and off-line heating problems.

The first problem was a trip failure. The breaker in this case failed to open during a normal shutdown. When they investigated this they found the breaker failed to latch. The breaker contacts were closed, but

the breaker shaft had not completely traveled into the proper position needed to allow the breaker to open when the open command was sent. After discussing this situation with the manufacturer they said the lubrication used on this breaker limits the operating temperature to above 32F. This breaker is designed for an indoor application, however, it was installed outdoors. The temperatures were below 20F during the time of the failure. The manufacturer recommended replacing the lubricant with Mobil 32 high temp grease.

The cluster failure occurred on a breaker that had a loading upwards of 3,500 to 4,500 amps. Misalignments can cause the primary stabs to be offset and cause additional heating, this can lead to a cluster failure. Power and Control Systems (PACS) has offered an upgrade to replace the clusters with 6,000 Amp clusters.

Alignment issues: The problem they are having is they can push the breaker into the cubicle and it wouldn't necessarily align correctly. The charging indicator would not drop down after they racked it in so the breaker would not close. Sometimes they would have to rack the breaker in and out 6-7 times to get an indication that it was aligned correctly. The manufacturer has offered a solution to this; a breaker guide wheel kit that will assure circuit breaker centering. The kit uses the fixed plenum assembly under the circuit breaker as a guide. This assembly will help mitigate or reduce any cluster misalignment. This kit has helped but not completely solved the problem.

Secondary contact block issues: High contact resistance was measured on some secondary contact blocks. Excessive contact grease was found on the back of the blocks. The old grease was cleaned off and replaced with Mobil 32 High Temp Grease.

Off-line heating issues: There was excessive moisture found in the switchgear itself. At the top of the gear there are two small heating strips. The moisture was all over and dripping off the insulators. After discussing this problem with the manufacturer they have added additional heaters on the bottom of the switchgear. There was also excessive water in the vault underneath the switchgear. The excessive moisture caused all of the stand-off insulators to fail in one case. All insulators were replaced. The bus bars and insulation were also damaged.

Have we checked our breakers for acceptable rate of rise of transient recovery voltage in our system?

Industry Advisory – Excessive RRRV at Capacitor Banks

Background

This advisory was sent out to the North American Electric Reliability Council. In January there was a major fault on a 230kV, 400 Mvar capacitor bank. There was excessive rate of rise of transient recovery voltage (RRRV) across the breaker. The company has 46 high voltage capacitor banks, many of which are back to back switching configurations with a reactor. The system uses a dual breaker scheme, an IPO for main switching and a ganged breaker as a back-up. In this case there was a wye-ungrounded capacitor bank and with fuseless capacitors. During normal operation the breakers are carrying approximately 1000 amps across each phase.

Fault Event:

In the range of 32 milliseconds a full three phase fault occurred across the capacitor bank. They were shocked to see how fast this fault evolved. They saw approximately 36,000 amps across all three phases.

These phases are physically 25ft. apart. The weather was snowy and windy with a highway nearby. The main breaker was energized for 4.5s when the fault developed in the bank. Both breakers operated correctly and opened. This did not interrupt the fault. Within 32ms the fault developed into a three phase fault at approximately 40kA. The challenge was, since it was an ungrounded bank they had 21 different circuits feeding into this fault. As the fault progressed eventually the gang breaker had a shield melt and went to ground. This was the first time the system saw a ground fault. The main bus protection tripped and was not able to interrupt the fault. This cascaded to adjacent stations and eventually interrupted the fault. The fault was cleared in 287ms; the zone two protection is set for approximately 350ms so they were close to going into a full 21 line trip. The fault going to ground saved this from occurring. This station is in the heart of their system just outside of Toronto. The peak demand at the time was 19200 MW and during the fault they lost 1700 MW from the system. The voltage at many neighboring substations had significant voltage drops.

The station is insulated with RG insulators to control salt contamination. The capacitors that failed were all on the side closest to the CT's (north side) for all three phases. In the fault they noticed the capacitors in the string that were bonded to the frame were the ones that bulged or ruptured. During the post failure investigation they discovered a contaminated capacitor bank that had degradation in the insulation value. When one capacitor can flashed it causes a voltage doubling across the entire rack. Normally this design can withstand this; however, due to the amount of contamination they had a cascading failure over the whole rack. The capacitor bank main breaker has a 362kV rated interrupter in a 25kV vessel. It is an ABB PMI breaker with 63kA interrupting capability.

Conclusion:

This was the first catastrophic capacitor bank failure they have had. They had 24 hour security on site during the investigation due to the severity of the failure. The main breaker was repaired and the gang breaker was replaced. Thirty percent of the capacitor bank was damaged. Some findings were, the fuseless bank design is susceptible to cascading failure, de-graded insulation (salt contamination from nearby highways/weather transitions/ice-bridging) and the process was too fast to be prevented by P&C methods. They also found the rate of rise of recovery voltage (RRRV) far exceeded the breakers capabilities; the breakers did not have a chance. Some changes they are making are, modifying their protection schemes, re-evaluating the use of the main and backup breakers and they've installed surge capacitors on all possible installations.

Do we have this type breaker? Plan to replace the grading capacitors.

Chris Brown, Louisville Gas & Electric Company provided discussion of a grading capacitor failure on an ITE Type 362-GA Multi Contact, Dead Tank SF6 Circuit Breaker. Mr. Brown was recently testing an ITE Type 362-GA breaker that was previously tested in 2003. Their test results indicated a problem on the A phase. They had high power factor results for both the grounded and ungrounded tests. They performed an internal inspection of the breaker and found a grading capacitor had failed and tossed its fluid all over the inside of the breaker pole and floor of the tank. They replaced the capacitor, cleaned all internal components and retested the breaker. The final test results compare well with the previous results from 2003.

Check the bolt type and torque values for the nozzle attachment to the moveable contacts for this type breaker

Mr. Marc Schneider, American Transmission Company is presenting this material to alert others of a problem he has found with the HVB 362 circuit breaker. On 8/28/2007, at the Point Beach Nuclear Plant,

the 345kV line number L111, POB L111 breaker, while closed and carrying approximately 1000 amps of load current experienced a 19,430 amp A-G fault that was cleared in 3.5 cycles. The fault on A phase was cleared not by the breaker L111 tripping, because the A phase interrupter was heavily damaged and was incapable of extinguishing the arc but by the bus tie breaker tripping at POB and the distant end L111 line breaker locked out after attempting to re-close into the on-going arcing fault inside the POB L111 A Phase pole unit.

An internal inspection of the A phase of the POB L111 breaker was performed. The fault arc was between where the interrupter moveable and stationary contacts would have been in contact in the closed position and directly below the closed contacts to the interrupter tank. The Teflon nozzle was detached from the moveable assembly and found stuck inside the stationary assembly birdcage. The interrupter had to be completely replaced and the damage to the tank fixed by filling in the arc crater with welding rod material. The root cause of the interrupter failure was that the bolts that fastened the nozzle assembly to the moveable contact had backed out of their tapped threaded hole in the movable contact assembly to the point that instead of the current path being copper the loosen hardened steel bolts became the current path. Apparently one or more of the bolts melted and a droplet of molten steel bridged the gap between the energized interrupter and the tank at ground potential. The fault arc was established to ground by following the steel droplet to the tank. The other two pole assemblies, B and C phase, were inspected and loose bolts and interrupter parts were observed on those interrupters as well.

What they discovered was, the bolts that attach the nozzle assembly to the moveable contact were MA-20 and they should be MA-18. The breaker was manufactured in the U.S. and they substituted the wrong bolts when they could not get the proper bolts. Another possible issue was with the torque value used when installing these bolts. The 10 ft-lbs torque value used was marginal and HVB changed this to 18 ft-lbs. HVB also recommends putting blue lock tight on these bolts when installing. At this time there is no service advisory from HVB. Mr. Schneider commented that HVB has been very helpful in this investigation.

Mr. Schneider commented that he has 29 of this type of breaker. This particular breaker was manufactured in 2000. The breakers at highest risk were built between 1998 and 2002, however, these issues with hardware and torque is generic to all of them. If you have any breakers that were shipped up to October or November 2007 may need to be inspected for this problem. To his knowledge there is no test to detect this problem.

Make sure we don't damage the low pressure interlock on this type breaker.

Paul Dinges, Lincoln Electric System provided discussion about a low pressure interlock issue on ABB 362PMI4030 breakers that has a HMB8 operator. They are in the process of building a new 345kV substation and commissioned (3) 362kV ABB PMI breakers and found a situation that could develop under the right conditions. They were commissioning these breakers with the help of an ABB field engineer. The wiring was not yet available at the breakers so they were using mobile batteries to operate the breaker. They found out later that they damaged the low pressure interlock.

ABB has a warning label that indicates "deactivate the close-position interlock device on any horizontally mounted mechanism. To do this, remove the spring clip. The close position interlock facility is engaged by reinserting the clip". As the springs discharge the plate engages with the interlock and the interlock blocks the drive ram in the closed position. The purpose of this interlock is when pressure is lost on the mechanism due to loss of power to the pump, and there remains SF6 pressure in the interrupter, the pressure could force the contacts back open, so the hydraulic pressure must be maintained. This is why ABB has the interlock. When they commissioned the breaker they left two of them in the closed position.

Check if we have these type breakers.

Mike Skidmore, American Electric Power, had a number of ABB type 72PM breakers that have high moisture readings. The first couple of inspections they were low and then on the last one the moisture had increased on 20 out of 50 breakers. There was a discussion during another meeting that mentioned that the SF6 molecule is larger than a water molecule. There are no gas leaks on these units except for possibly one. They are concerned that maybe the moisture is leaking in through the casting or some other way. They have 800ppm in one case and the others have increased significantly. They are currently opening up the breaker, pulling vacuum and putting in new desiccant. They are interested if anyone else is experiencing this problem. The breakers are manufactured between 1993 to the early 2000's.

Alex Salinas, Southern California Edison Company, commented that ABB had casting issues early on in this breakers design. They corrected the problem in the late 1990's and started making ASME standard vessels. There is a way to detect casting leaks during the vacuum process. If you do vacuum rise tests and extend it past 15 or 30 minutes you will be able to find a leak. They used laser leak detection to find their casting leaks. Mr. Skidmore mentioned that they have not had to add gas to these breakers so he doesn't think they have a leak. They just wanted to know if the moisture can be pulled through the casting without letting SF6 out. Mr. Salinas believes they do have a leak somewhere. Mr. Skidmore has a laser camera and they plan to use them on these breakers.

Bill Fernihough, Doble Engineering Company, recalled some discussions years ago that water molecules can get trapped in the aluminum structure and then once you fill the vessel with SF6 the water molecules could migrate back out.

Check if we have these ABB type PRMI breakers.

Randy Leinen, Black Hills Power, at the last meeting, reported two internal operating rod failures for ABB type PRMI breakers. Since then they had another failure and ABB came in and replaced all of their operating rods on all of their breakers of this model and vintage. ABB did all of this with their own service people at no cost for parts or labor to the utility. Last year Mr. Leinen reported that the rods that are failing are made by Axicon in Switzerland. Mr. Leinen wants to make people aware and if they have this problem please contact ABB.

Action Item: Provide this information to our maintenance crews.

Tony Picagli, United Illuminating, mentioned a presentation by Gene Finner from Dow Corning at the last Finpoint conference. He recommended the use of Molycote Gn paste in lieu of 321 Dry film lubricant for all applications. This should be updated in our lubrication guide. Mr. Picagli sent the correct information following the conference.

Check if we are having these problems.

Dave Lemmerman, PECO Energy, mentioned earlier the breaker problem they had with switching a fault on a reactor feeding a distribution circuit. He wanted to survey the group to see how many people have current limiting reactors in their distribution circuits? Approximately 30 people responded. He wanted to know if anyone has had any problems with faults on the load side of the reactors with breakers failing to interrupt.

Bill Fernihough, Doble Engineering Company, recalled at BC Hydro that they lost an OCB every year due to faults like Mr. Lemmerman is mentioning. They ran some tests and found TRV created from these reactors. They added capacitors and the problem went away.

PACC Committee

A steering committee was formed in PACC. They need a member from Generation and Industrial side of the relay business for that subcommittee. Can our protection people support this?

In order to make PACC more effective, it was decided to form a PACC Steering Committee with representatives from each of the following disciplines:

- Transmission
- Distribution
- Generation
- Industrial such as Petrochemicals or Railways

The Steering Committee will be an internal group within PACC and will be represented by the current officers of the committee and one representative from each of the above listed disciplines. PACC representation at the Advisory Committee will be limited to the Chair and the Vice Chair.

The following officers were elected to represent each of the disciplines with John Lacenere from Orange and Rockland Utilities representing the transmission area and Glen Lyford of National Grid representing the Distribution area. Both these gentlemen have extensive experience with utility operations and relay maintenance supervision. The Committee is seeking additional steering committee officers for the remaining disciplines.

These are useful NERC references for relays.

Dan Anderson, who is Chair of PACC, brought some very useful information regarding the various NERC documents that outline the maintenance requirements of protection assets at various utilities. Dan mentioned the following NERC documents that are of interest to protection engineers and technicians:

- PRC -005-0 Transmission Protection System Maintenance and Testing
- PRC -005-1 Transmission and Generation Protection System Maintenance and Testing
- PRC-007 Under-Frequency Schemes
- PRC-0011 Under-Voltage Load shedding Schemes.

Essentially, the NERC wants utilities to come up with a testing plan, explain the basis for the plan and then prove to the regulator that the plans are being implemented. Fred Morris and Jane Heineman joined Dan Anderson in the discussion and provided very useful insight and highlighted the various challenges these requirements are going to place on the testing engineers and technicians. Some of the major challenges are reduced work force and reduced number of highly experienced testing personnel.

Arc flash protection concerns

The presentation on Arc Flash Protection was very well received and timely. Jane Heineman expressed the view that the presentation was very useful and timely. Fred Morris described to the audience a staged fault that was set up at his former utility and appreciated the energy that is released during a fault. Since he has seen a fault from so near, he appreciates the new arc resistant switchgear that is designed to protect and save lives.

How are we dealing with testing multi-function relays?

There was good paper given on Commissioning and Maintenance Testing of Multi-Functional Digital Relays that was found very timely, extremely informative and appropriate. Several PACC members had comments on issues that are being faced by engineers and technicians in managing the new multi-function relays.

Is there an issue in our company with transmitting protection and non-protection signals in the same communication channels?

The third topic on SCADA revealed some important aspects related to the security of power system network. Doug Holland of Sask Power, Fred Thomas of Seattle Power and Light and Dan Anderson expressed concern at the security issues related to having one communication channel for transfer of protection and non protection information. They indicated that separate channels are being worked on to enhance security at several utilities. This they believed will enhance the security.

Action Item: Get a copy of this Maintenance Practice Survey

Donna Williams, the vice chair of PACC, presented the results of the Maintenance Practice Survey that was conducted by PACC. This survey was extremely successful and the result of the survey has prompted several questions related to maintenance practices in various quarters of the industry. Engineers and technicians at various utilities are now looking at their utility maintenance practices with respect to others especially with regards to maintenance intervals, types of tests performed, etc.

Action Item: Look into these NPCC Standards

Continuing the discussion on new NERC requirements pertaining to maintenance of protection assets, Dan Anderson presented in detail the maintenance standards developed by NPCC. These NPCC standards are based on NERC standards PRC 005,007 and 011 mentioned earlier.

Action Item: Log into Doble's protection portal

Ed Khan, Secretary of PACC presented the members with an update on the Doble Protection portal. He indicated that the site is being updated and requires more work to be become completely functional. Mr. Khan indicated that the portal will be totally functional within three

months. He mentioned that the site has service advisories and trouble and reporting section in addition to other pages. David Roop of Dominion was of the view that PACC should provide a venue whereby the service advisories and trouble reports can be accessed. Ed Khan and Dan Anderson responded that PACC is ready to post any advisories or trouble and reporting items that are submitted by the members.

Action Item. Review these papers

The technical session held during the April 2008 conference consisted of the following presentation:

- Making Arc Flash Protection Work
- Commissioning and Maintenance Testing of Multi-Function Digital Relays
- Evolution of SCADA systems to Today
- High Impedance Fault Detection in Feeders
- Upgrading Power Transformer Protection From Power Fuses To Circuit Switchers At Substations Which Do Not Have A Control House
- Under Voltage Load Shedding

The papers/presentations for the above listed topics may be accessed by going to <http://www.doble.com/> and logging in to the Proceedings of the 2008 International Conference of Doble Clients or the Protection Resource Center. A user name and password is required to login and obtain access to the Conference Proceedings. This can be obtained by sending a request to Help@doble.com. Please send all Protection Resource Center posting requests to Ed Khan at edkhan@doble.com

Support the PTUG

2008 PTUG Conference Program and 2009 March Conference Program

Please submit ideas or topics for presentations at the 2008 September PTUG conference by contacting the Secretary of PACC at edkhan@doble.com. You can also submit a paper or discussion topic to be presented at this conference for consideration by going to <http://www.doble.com/topics/>

We believe, early groundwork on topics of concern to the client group will result in more timely and informative conference presentations.

Rotating Machinery Committee

Action Item: I need to send this to our generation group. It looks like Doble is going to add subjects in RM that would be of interest to the power plant maintenance guys.

The Secretary of the Committee followed up on a discussion that took place during the September meeting in regards to expanding the scope of the RM Committee to include the day to day activities in a power plant, which involves much more than attending to rotating machinery issues. For example, problems with equipment such as UPS equipment, cables, batteries, and station service, etc. The Committee would like to expand its scope to include other power plant information in order to better serve the power plant industry.

The Committee voted 15 to 2 in favor of expanding the scope. The Secretary asked for volunteers to form a subcommittee to define the new scope and a subcommittee was formed. The Advisory Committee voted unanimously for the expansion of the Rotating Machinery Committee scope.

Action Item: I need to distribute these services advisories to those with a need to know in our company.

The Secretary received two Manufacturer Service Advisories which are described below.

1. TIL #1588, GE Energy, September 30, 2007, Potential for Explosive Gas Mixture in Stator Water Storage Tank

This Technical Information Letter pertains to H2 cooled generators with water-cooled stator windings. This water-cooled stator design first went into service in 1960. The purpose of this advisory is to alert users that an explosive gas mixture of greater than 4% hydrogen in air may occur in the stator cooling water storage tank if excessive hydrogen enters the stator cooling water from a leak path in the stator winding flow circuit inside the generator. Recommendations are provided to mitigate high levels of dissolved hydrogen in the stator cooling water circuit.

2. Product Advisory 9252090005, Basler Electric, November 6, 2006, BE1-50/51 Relay may Fail to Maintain the Required Trip Signal

This advisory notifies BE1-50/51 Overcurrent Relay users of a potential problem that may result in the time overcurrent (51) and instantaneous (50) trip elements failing to maintain an output closure and thus resulting in a failure to trip. Affected products are BE1-50/51 Overcurrent Relays shipped between the period of January 2001 and February 2006. Relays shipped before January 1, 2001 or after March 1, 2006 are not affected by this advisory. It has been determined that when the BE1-50/51 timed or instantaneous trip output contacts close, with a trip circuit potential greater than approximately 100 volts, a false reset transient pulse is sometimes noted within the microprocessor circuitry. The occurrence and repeatability of this transient reset pulse have been found to be intermittent and not consistent among units.

According to Glenn Griffin, TransCanada Hydro Northeast who was affected by this advisory, Basler Electric does supply suppression kits for free to retrofit these relays and eliminate the problem.

Do we have shaft insulation issues?

Mr. Glenn Griffin, TransCanada Hydro discussed a re-powering of a hydroelectric power plant that involved installation of 4 new 5 MW generators. The manufacturer is from Croatia and a question arose about the bearing insulation integrity. An insulation resistance test was performed on the thrust bearing housing and the results were not as expected. This measurement was difficult to perform because the units were assembled. Therefore, shaft voltage measurements were made to determine if currents were flowing through the bearings. The manufacturer has never measured a voltage below 300 mV and Mr. Griffin's results were 62 mV between the shaft and the bearing casing. Additional testing was performed by placing a Rogowski coil on the shaft to detect shaft currents, and no current was measured. (A Rogowski coil is a type of CT that can be made open-ended and flexible, allowing it to be wrapped around a live conductor without disturbing it. It has an air core rather than an iron core, and it has a low inductance that can respond to fast-changing currents.) Even though shaft currents were not measured, the manufacturer measured 1/5th of the typical voltage seen when shaft voltage measurements are performed. Therefore Mr. Griffin became concerned. Since there are no industry standards on what type of voltage level should be measured, and since the manufacturer is fairly new in the industry, Mr. Griffin wanted to know what others are doing to verify the integrity of their bushing insulation.

Dan Stolp, Douglas County PUD had a similar problem on an older unit that was being re-assembled. The Insulation Resistance measurement on the bearing insulation was very low. During start-up shaft voltages were measured, but they were unsure what the results meant. Therefore, they installed a shaft grounding brush on the shaft near the bearing to measure shaft currents, which they did not detect. According to Mr. Griffin, going forward they will be monitoring with a shaft grounding brush.

What is our policy for rotor pole replacement?

Joseph Brown, Doble Engineering offered a discussion item on behalf of Ricardo Singh, Suriname Aluminum Company. After having more frequent problems with internal winding shorts and ground faults in generator rotor poles, Mr. Singh would like to ask if it is a good idea to refurbish the pole insulation after 40 or so years of service. What are others doing?

Jim Duffus, U. S. Army Corps of Engineers commented that the 60 MVA units at the Bonneville project average about 50 years of service and they are installing new turbines and windings. They did not feel a need to refurbish the rotor poles. However, they tested and inspected the poles, and in some cases cleaned and repainted them.

Do we want to add the use of the corona camera to our inspections?

Glen Griffin, TransCanada Hydro stated that he was interested in knowing how people were using corona cameras. Are corona cameras used to provide corroborating evidence when on-line partial discharge (PD) detects a problem? Are there cases where the corona camera inspection may identify problems that may not be detected during on-line PD testing? He stated that his company does not own a corona camera, but that they have had them brought in (by contractors) when they have done rewinds or refurbishments in order to verify that the end-windings were free of corona discharges. He indicated that their past experience with this technology involved looking for varying levels of corona, which may indicate discharge activity, and that during these tests the windings were energized via a Doble M4000 and a resonating inductor to bring the voltage up to 120% of the line-to-ground voltage.

Don Campbell, US Army Corps of Engineers replied that they currently do not perform corona camera inspections on all of their rewinds. He said that he was also evaluating the use of the corona cameras

because he was aware that Hydro-Quebec uses this equipment. Hydro-Quebec suggested that the Corps of Engineers may want to include corona camera inspections in their rewind specifications; Hydro-Quebec suggested a particular manufacturer/model of corona camera, and they provided suggested readings. He said that manufacturers may not prefer the use of this technology because the readings are quantifiable, and there is no guess-work. The black-out test, which is currently utilized by the Corps of Engineers, is more subjective, and it gives the manufacturer the ability to argue about the severity of a problem.

How do we remove insulation from VPI machines?

Alan Wilson, Doble Engineering, discussed some of the techniques that have been used to remove windings from globally VPI'd machines. He mentioned a paper that was presented at the Doble conference where the author discussed the use of high pressure water jets to blast away the insulation, thereby allowing the windings to be pulled out. He provided photographs from another example where the windings were pulled out using hydraulic jacks that applied extreme pressure to the tooth tips during the extraction process. He pointed that these methods were extremely difficult, time consuming, costly, and that they were possibly very damaging to the core iron. Mr. Wilson's purpose of providing these examples was to emphasize a key point: that globally VPI'd machines may be less expensive to purchase, but they are probably not the best option when lifetime costs (repair costs) are considered. He asked the attendance if they agreed that global VPI is a bad option, especially for long stator machines, and if we should discourage the purchasing agents (accountants) from considering them. He concluded his opening discussion by pointing out that some of the more reputable manufacturers are now providing globally VPI'd machines in order to compete in the world market.

Action Item: Review our specifications... Are our specifications tight enough to discourage the vendors from trying to have us accept cutting out coils of new windings?

Eric Eastment, US Bureau of Reclamation described a situation they have encountered during a recent rewind. They were able to identify strand shorts in the slot section of a winding, and as a result, they had to cut a coil out of a brand new winding. They were able to negotiate for monetary compensation and an extended warranty for this winding. He asked if any of the other attendees were ever in a similar situation with a contractor, or whether they ever had to accept a new winding with a coil cut out.

Frank Novak, New York Power said they had a situation where the contractor was using RTV type material for side filler instead of the required side packing ripple springs because they did not use the right dimensions for the slots. The winding coils were pressed into the slots using 700-800 lbs of force. In this case, New York Power made the contractor pull the coils back out (1/2 stator) and correct the problem.

Don Campbell, US Army Corps of Engineers said that they have never accepted a new winding with a coil cut out. He added that he believes they would have insisted that the coil be replaced. However, they are in a current situation where they are getting ready to accept two different windings on the same project. Midway through the manufacturing process, the manufacturer changed the design and manufacturing facilities and they did not inform the Corps of Engineers. They had expected to get four units with the same coils and same losses, but the newer machines were different. This situation also includes different core steel.

Do we want to look into using this type of packing systems?

Frank Novak, New York Power asked the attendance about the use of new materials such as RTV or epoxy for side filler. He wanted to know if there are some systems and/or manufacturers that should be avoided. He also wanted the opinion of others on whether RTV or the epoxy system as a side-pack filler is a good or a bad idea. Mr. Novak wanted to know of any difficulties encountered with either of these systems.

Eric Eastment, US Bureau of Reclamation indicated that he has had good short-term experiences with the G.E. style conductive room temperature vulcanizing silicone (CRTV) system. He added that there have been some prior issues with these systems when they were in the development stages, but now if applied correctly (proper quantities and mixtures), these systems seem to work well.

Can we use this technique of swapping the line and neutral ends of the stator to increase the lifetime of our units?

Robert Brummond, US Bureau of Reclamation explained that they have a 48 MVA, epoxy insulated, bar wound generator that was rewound in 1988, and it has started producing ozone. One of the options they are considering is to swap the main and neutral terminals in order to reverse the areas of high and low voltage stress. He asked the attendance to provide comments on their experiences with reversing windings. He wanted to know if it provides additional useful life or whether it causes additional problems. He added that he has heard stories where reversing the leads could make the PD problems worse.

Dave Snyder, US Army Corps of Engineers stated that they recently had two machines rewound, and during this process they elected to swap the main and neutral terminals. They also installed partial discharge detectors which were not included prior to this project. These machines have only been on line for a brief amount of time, so they do not have enough data to make conclusive remarks about the effectiveness of these changes. He stated that there were no immediate, dramatic changes in the PD readings.

A committee attendee pointed out that it is possible that the neutral end windings could have significant mechanical damage due to vibration. Such damage may not have been noticeable prior to swapping the leads because these windings were in an area of low voltage stress. Under these circumstances, reversing the leads may result in an immediate failure. Mr. Brummond stated that he has been performing ramp and power factor testing, which stresses the line and neutral end windings, every three years, and the unit has passed these tests. Therefore, he has at least some confidence in the integrity of the neutral end winding's insulation.

James Timperly, Doble Engineering stated that reversing windings is an old technique. He said that TVA has done this on combustion and hydro generators, and that some companies purchase machines with provisions for reversing leads built into the design. He said that he has considered this option on some combustion machines that had indications of deterioration that was voltage sensitive. Mr. Timperly pointed out that you do not double the life of the winding because the winding has been exposed to vibration for many years and it may have mechanical damage. He concluded by saying that this approach "generally" extends the life of the unit, perhaps adding another four to five years in a unit that already has a lot of PD and ozone. However, if you already have a bad bar on the neutral end, then the unit could fail immediately.

Dan Stolp, Douglas County PUD indicated that they are just finishing a project to reverse the windings on nine different generators. He said that this approach is not something that he would normally recommend as a method of extending the life of the machine. However, in this case they had one unit fail, and they found the deterioration in the others to be voltage sensitive. They plan to rewind all of these units, and they reversed the leads in an effort to buy some time until the rewinds could be completed. All of these units have PD couplers, and reversing the leads on some of the units resulted in an increase in measured PD, while the PD is significantly lower on some others. In Mr. Stolp's opinion, the success of reversing the leads on reducing PD depends upon the location and the nature of the degradation.

Are our control cabinets with 480 volt circuits properly identified for arc flash hazards?

At one company during pre-work safety briefings the participants are told not to open the control cabinet for the transformers without the use of proper arc flash protective equipment because of the energized 480 volt circuits in the cabinet. Is this practice extreme?

Frank Novak, New York Power stated that this requirement was not unusual. Depending upon the opening time of the circuit breaker, a category 3 or 4 hazard could be reached in 480 volt equipment. They have similar practices in place, and each cabinet is identified with a sticker showing the arc flash potential (calories/cm²) available within the enclosure.

Joe Kisela, PPL Electric Utilities stated that they have gone through the process of identifying arc flash hazards at his nuclear plant. What they found is some of the worst hazards were in the 480 volt switchgear, not the 4 kV or 13 kV equipment. In fact, some of the calorie ratings were off the chart, which means the ability to properly suit-up for the hazard is non-existent.

Transformers Committee

We need to get involved in this type LTC diagnostic testing because it seems to work.

Load Tap Changer Dissolved Gas Analysis

The Load Tap Changer Dissolved Gas Analysis Subcommittee met on Thursday, April 10, 2008 with approximately 56 attendees present. There are about 90 members on the subcommittee. The highlights of the progress for the project are provided here but more details are given in the subcommittee meeting report.

Guide Revision Progress

This subcommittee's work is maturing and a reissue of the guide is anticipated. The Secretary of the committee noted that a small working group meeting will be planned during the week of the next September Conference in Atlanta Georgia. Historically, the subcommittee has been able to obtain the most progress on the guide at these type working group meetings. If you wish to participate in the working group please advise the Secretary at: ngilbert@doble.com. The members are also requested to review the document and provide comments to the Secretary at any time. The committee did NOT have a small group meeting at the April 2008 Conference.

Study of Moloney MA/MB Load Tap Changers

Larry Christodoulou, Electric Power Systems, provided documents for viewing that explained his findings in studying the Moloney type MA/MB load tap changers. He advised that he is obtaining dissolved gas data that he feels is more representative of the Moloney LTC's that he is studying. He was able to calculate preliminary norms for different ratios of gasses from 337 dissolved gas sample results. First he identified that the gassing levels tend to follow a log normal probability distribution. Larry Christodoulou feels that by the September meetings he will be able to provide ratio limits for this type load tap changer. Gilbert Lemos of Southern California Edison provided his company's test data on Moloney MA and MH load tap changers to Larry Christodoulou for his analysis.

Federal Pacific Electric Load Tap Changers

Harry Ruggles, American Electric Power, advised that his company will soon be going into three Federal Pacific Electric (FPE) load tap changers and that he will provide an update on what was found at the subcommittee in the September meeting. Rick Youngblood, American Electrical Testing Company, has been tracking about 82 FPE load tap changers and has obtained over 3,200 samples over 10 years. He is very confident that he will be able to provide some guidelines for this manufacturer of load tap changers.

DTAWeb and Collection of DGA of LTC Results

Norbert Gilbert, Doble Engineering Company went through a summary of how a client's dissolved gas-in-oil data for load tap changers can be placed into Doble's DTAWeb system.

Reinhausen Load Tap Changer Gassing Trends

A presentation was given by Marcus Stank, of Reinhausen Manufacturing that described the complications of using dissolved gas analysis of load tap changers manufactured by Reinhausen. For

some load tap changer types the dissolved gas technique was NOT recommended but for others types the gassing signature would provide a significant diagnostic tool. The presentation included a preliminary “MR Special Triangle”. This proposed triangle charted the relationships of ratios of combustible gasses similar to the technique of the Duval Triangle but the sides of the triangle are the percentages of the gas ratios and not the percent of gas levels.

Action Item: Get a copy of this survey.

Transformer Manufacturers Survey

It was noted that the project has fulfilled its purpose by creating the document and discussion was held to determine the subcommittee’s disposition. It was voted that the project will be removed from the list of active projects but the document shall be issued periodically for additional input. It was suggested that having the survey as a line item in the meeting agenda, possibly in the technical questionnaire section would inform the group of the recent changes to the document. The document will be made accessible through the Doble website in the near future.

How does our LTC Maintenance compare with these questionnaire results?

Load Tap Changer Maintenance Technical Questionnaire

The Transformers Committee developed a Technical Questionnaire in 2007 that had a goal to measure the effect of LTC maintenance on transformer performance. It contained 11 questions that collectively pertained to the types, frequency, and effectiveness of load tap changer maintenance. This TQ had been sent to all Doble clients who were not manufacturers or insurers, and the responses reviewed and analyzed by the Assistant Secretary, Jill Duplessis. The survey findings have been detailed in the Transformers Committee Report in detail

Here is a summary of the Conference presentations.

2008 Doble Client Conference Program

The technical session included a symposium concerning mobile transformers by four Doble clients. There were also 10 paper presentations provided as well as general discussion from the floor. These papers contained techniques and benefits of investigation of hydrogen gassing, power flow regulation, the solution of a generator step transformer tank heating problem, drying transformers using low frequency heating, a report on damage of a transformer due to an earthquake, test result analysis of transformers and a teardown of a large transformer. These papers may be accessed through the Doble Portal.

This year the Transformers Committee is provided a list topics of interest that may be developed into presentations for the Conference. Do we have some experiences on the following subjects?

This is a relatively new agenda item that is anticipated to become part of the March-April meetings to encourage early preparation for the planning meetings that ensue in September. The intent was to initiate discussion of a few topics during this meeting so that the members of the committee can start looking into how he/she or others in their company can contribute to a subject. For example: The topic of transformer transportation has been discussed frequently in the last few years and would be of interest to most in the Committee. One client has had issues where a mishap on a railroad shipment has caused winding

movement. Another Client had a negative experience with ocean shipment. Has your company had bad experiences to share? Has your company changed specifications to reduce the chance of damage? Do you use GPS's during the transport?

To start the process of generating ideas, the Chairman introduced the following list of subjects during the meeting:

- Transformer Transportation Experiences
- Fiber Optics use in Transformers
- Natural Ester Fluid use in Transformers

All members should begin channeling ideas to Doble for incorporation into the September Conference agenda.

This looks serious. We need to add a filter on our type M load tap changers.

Tom Kydd, Hydro One, wanted to make other utilities aware of the requirement for an "obligatory" filter cartridge installation on type 'M' Reinhausen tap changers per a clause in a 'MR' Operating Instruction manual. The clause, see A Portion of Reinhuasen's Operating Instruction Manual Figure 1, is located in the 'MR' manual identified as 037/04/01/0 on page 26.

If the number of operations per year is 15,000 or higher, we recommend the use of our stationary oil filter unit type 51 with a paper filter insert (see Operating Instructions No. 18). If the operating voltage between phases of an M III 350 D / M III 600 D tap changer exceeds 92 kV, or if the highest voltage for equipment U_m of any tap changer type M is ≥ 245 kV, the use of a stationary oil filter unit type 51 with a combined filter cartridge is obligatory.

**A Portion of Reinhuasen's Operating Instruction Manual
Figure 1**

Mr. Kydd's main reason for bringing this issue to the Transformer Committee is the "apparent" change in the instruction manuals. Hydro One purchased a number of this series of tapchangers that were not equipped with cartridge filters. Unfortunately, Hydro-One experienced the failure of one M I - 1500 series tapchanger when a flashover occurred between the shielding electrodes across the insulating drive shaft. The tapchanger failure resulted in a catastrophic fire and complete loss of a 750 MVA 500 kV connected autotransformer.

During the post failure investigation, they recognized the change in the instruction manual. They contacted Reinhausen and through discussion with them, are retrofitting their 30 remaining units with filters. As the result of their investigation they have also initiated a number of recommendations to address areas of oil sampling and processes.

We need to look at the pictures in the report and identify if we have these reactors in our units.

Mike Bocovich of Xcel Energy described an event that occurred in his company. A large autotransformer experienced a significant through fault when a surge arrester failed. This 672 maximum MVA North American Transformer unit was built in California and has current limiting reactors that have been designed into the tertiary winding. A shelf has been designed into the tank of the autotransformer to support the reactors. During the fault the reactor's magnetic flux shunt pack steel became dislodged.

Is this why we are having nuisance trips?

Rick Asche, Portland General Electric, brought up his experience nuisance trips of General Electric vacuum integrity switches. The vacuum bottle integrity circuit on a General Electric type LRT200 load tap changer was causing the unit to lock-out for unknown reasons. This provided nuisance trips for a six month period after major work on the unit. They replaced the integrity circuit, installed transient monitors and did everything that they could think of, short of going into the oil filled compartment, but could not resolve the problem.

When they did investigate in the load tap changer tank they found that one of the vacuum bottle integrity current transformers was installed backwards but this was not the reason for the problem. It was found that the current transformer shorting switch was providing intermittent operation which was causing the trips. It was determined that there was RTV on the contacts that was increasing the resistance. The RTV was used for sealing the wiring going into the switch and the RTV was migrating to the contacts causing the problem. These switches provided more recently have wires going into the switch that are potted and do not include the RTV.

Action Item: This unit failed because of high temperature that went undetected until it was too late. Are our alarming systems correctly set up?

Rick Asche of Portland General Electric provided, to those that were interested, a DVD of a transformer fire on their system that was caused by loss of cooling. This loss of cooling incident was previously reported in the March 2007 Transformers Committee Report in section: XIII. COMMITTEE FORUM, Item: A. Transformer Alarm System for Cooling Equipment.

Doble SFRA User Group

At this year's April SFRA User Group, the topics presented concerned the most recent Doble SFRA Products, user application discussions and two user case studies.

Action Item: Upgrade to version 5.0.

Doble has released version 5.0 of Doble's SFRA Software. This new version includes new features such as improved communications and impedance sweeps. Complete installation and the M5x00 upgrade instructions were discussed. Doble also announced, the soon to be released, M5400 test set and version 5.1 of the SFRA software. The new M5400 will be replacing the M5200 in Doble's line of SFRA test sets. The new test set is in a smaller fully enclosed case and provides a true USB interface. Version 5.1 of the software will incorporate communication protocols for the existing M5x00s as well as the M5400. It will also include an improved report generator.

Action Item: Add SFRA testing of transformers prior to shipping in our procurement specification?

Practical application discussion included the following key points:

- 1) A “how-to” discussion on recognizing a magnetized winding in SFRA traces and how it effects both wye and delta configured windings.
- 2) Lead length was also discussed, explaining how to properly select either 18 m or 30 m length cables for testing transformers.
- 3) Update on Doble’s activities on two IEEE committees for SFRA application and transformer transportation.
- 4) A case study was presented on behalf of Electrical Power Systems that illustrated the effects of oil saturated windings in an empty transformer. This case study was especially important as this can effect the analysis of transformers when they are being transported and needs to be taken into consideration upon acceptance.
- 5) A case study was shown on a 3-phase transformer that experienced a 3-phase fault after an ice storm. This case showed that the windings had experienced damage and assisted in making the decision to replace the unit.

Circuit Breaker Timing User Group

Action Item: Update our TDR900 to the USB over Serial method.

TDR900 Communication Options

The three options to communicate with the TDR900 were discussed, Legacy LAN, USB over Ethernet and USB over Serial. The USB over Serial is the preferred and more stable method and if anyone is experiencing communication issues with their TDR900, they are encouraged to contact the Product Manager to arrange a conversion to USB over Serial at our facilities in Watertown, MA.

It was explained that some of the issues associated with communication errors are related to the level of authority that the users may have over their computers used to control the TDR900, being “Administrator” the least restricted level and “User” the most restricted level and the one that practically makes it impossible to attain communications.

Action Item: Download the new software.

T-Doble V1.3c is Released

Doble Engineering Company announced the release of T-Doble V1.3c, Build 493. T-Doble V1.3c provides new features and general maintenance updates for the latest circuit breaker timing instrument, the TDR900. Disks with the software were distributed to all present at the meeting, and instructions on how to download it from Doble’s website were also discussed.

It was reported that T-Doble is compatible with Windows Vista. A minor problem has been encountered if the function “User Account Control” is activated, but entering the Control Panel and turning off this function has proven to solve the problem.

T-Doble V2.0 was Announced

Doble Engineering Company announced that the next version of the T-Doble software will be 2.0 and a brief demonstration of its capabilities and enhancements was performed. Suggestions for changes and enhancements from the audience were obtained.

T-Doble Integration to the TDR9000

Doble Engineering Company announced the T-Doble software platform will be applied to the TDR9000 instrument. This change will eliminate TRX, TRX Field, and the dependency on SyBase. The user will only have to manage one software platform, simplifying training requirement and data management. A demonstration of T-Doble controlling a TDR9000 and a TDR900 instrument was performed.

T-Doble Test Results Integration into DTAWeb.

Doble Engineering Company announced that test results obtained with the T-Doble software or converted into the T-Doble form will be now allowed to be uploaded into the DTAWeb software, where further analysis of the data will be possible. This will also serve as a safe depository of the Client's test data.

Doble Test Assistant and DTAWeb User Group

Action Item: Get our company using DTAWeb.

A review of DTAWeb was conducted, with new features being demonstrated. The new features were:

- Drag and Drop of multiple attachments to an apparatus in a query
- Merging of subsystems
- New reports
- Scoring apparatus

Discussions were also held regarding DTAWeb integrations with other database applications, such as TOA and Cascade.