7.6 POWER TRANSFORMERS – TOM LUNDQUIST, CHAIRMAN

The Power Transformers Subcommittee met on Wednesday, October 17th, 2007 with 51 members and 76 guests; with a total of 127 in attendance.

The minutes from the Dallas, Texas meeting were approved as written.

The chairman asked if anyone was aware of any patent conflicts, none were voiced.

7.6.1 WORKING GROUP AND TASK FORCE REPORTS

7.6.1.1 TASK FORCE FOR REVISION OF C57.17, REQUIREMENTS FOR ARC FURNACE TRANSFORMERS – Dominic Corsi, Chairman

No meeting.

7.6.1.2 WORKING GROUP FOR DEVELOPMENT OF PC57.143, GUIDE FOR APPLICATION OF MONITORING TO LIQUID IMMERSED TRANSFORMERS AND COMPONENTS – Donald Chu and Andre Lux, Co-Chairmen

The working group met on Monday, October 15 at 8 AM. Approximately 120 members and guests were in attendance.

The guide went through a survey in March 2007. Approximately 19 responses were received; 3 of them negative and 16 positive. Almost all of the comments and suggestions were incorporated during a working session of the WG during the spring Doble Client Conference. These comments were reviewed and discussed for membership concurrence.

Approximately 7 of the comments have not been implemented because they require further action. Volunteers came forward to work on these issues. The goal is to have these contributions back within 2-3 weeks. The new draft (#20) will be surveyed by the WG membership in late November.

The meeting adjourned at 8:45 AM.

7.6.1.3 WORKING GROUP FOR DEVELOPMENT OF PC57.148, STANDARD FOR CONTROL CABINETS FOR TRANSFORMERS – Joe Watson, Chairman

The Working Group for PC57.148 met on Monday, October 15, with 8 members and 16 guests attending (24 total). Four guests requested to be added to the

membership. Joe Watson was not able to attend the meeting and Greg Anderson facilitated. The meeting convened at 11:00 am with an introduction and review of the IEEE patent policy and request for any disclosures of conflicts.

Work continues on Draft #4, which was posted on the website in March 2007. Several drawings were also posted in March. Each drawing was briefly reviewed during the meeting. There is continued concern that some of the drawings are too detailed and cannot be bound in the standard document. We are still investigating whether these drawings can be posted somewhere on the Internet for download and review. The consensus of the group is that we should proceed with completing the document without the large detailed drawings and only include several generic figures (non-detailed schematics and wiring diagrams that can be inserted on an 8-1/2" x 11" sheet). Perhaps after the document is initially published, further investigation can continue on how to make the more-detailed drawings available as an "electronic annex" to the standard document.

The opinion of the group is that this document should continue with the "less is better" approach and only include the commonly accepted items that can be agreed by all Users. Several items were identified that seemed to mandate that a User accept something usual. An example was the discussion of "ring-type terminals". Although the majority of Users in North America specify ring-type terminals, some Users are moving towards allowing European-type, rail-mounted terminal blocks, because of the growing number of transformers being sourced from foreign manufacturers.

One worthwhile suggestion was that we develop a standard one-page "data sheet" that can be bound in the standard. The data sheet can allow a User to quickly check-off the items desired; i.e. either ring-type terminals or European-type terminals, NEMA 4 enclosure, etc. The use of a standard data sheet (acceptable by everyone) will allow a Manufacturer to easily determine the specified items. The consensus of the group was to continue the work on the standard in its present format and perhaps incorporate the data sheet as an annex in a future revision. Perhaps the data sheet can be also placed on the Committee's website in "active PDF" format which will allow the User to electronically check the desired items and incorporate the data sheet into their company specification.

With the time remaining, the document was quickly reviewed. Several items were suggested for incorporation:

-- view glass in door, for viewing an annunuciator without opening the door (C. Hurley),
-- add description of a NEMA 7 enclosure to Section 5 (K. Yule),
-- maximum/minimum mounting height of cabinet; i.e. maximum height to top of 72 inches, or consideration of mounting cabinet high enough to avoid snow or flood water,

-- duplex 120 volt, 15 or 20 amp GFI receptacle inside or outside control cabinet,
-- "cooling chimney" for cabinets containing devices that produce excessive heat (T. Lundquist),
-- reference for "SIS" wire (K. Yule).

The meeting adjourned at 12:15 p.m.

7.6.1.4 WORKING GROUP FOR DEVELOPMENT OF PC57.131, STANDARD REQUIREMENTS FOR TAP CHANGERS - William Henning, Chairman

The Working Group on Tap Changer Performance met on Monday, October 15, 2007 with 16 members and 46 guests present.

The working group chairman asked if anyone had information on patents related to the working group. It was noted that no one present at the meeting expressed knowledge of patents related to our document.

Next, the minutes of the previous meeting in Dallas were approved. The previous meeting in Dallas was primarily devoted to a discussion on temperature rise limits for contacts of load tap changers and de-energized tap changers. The discussion continued at the Dallas meeting. Finally, the following decision was made by a show of hands.

SHOW OF HANDS REGARDING TEMPERATURE RISE

15 votes to use the same temperature rise limits as in the IEC tap changer standard

0 votes to increase the temperature rise limits for de-energized tap changers to make them the same as for LTCs.

2 votes to decrease the temperature rise limits for LTCs to make them the same as for de-energized tap changers.

So the decision was made to use the IEC temperature rise limits.

A second subject discussed was the wording used to identify the contacts to be tested in the five dielectric tests.

For LTCs,

Test 1: (not changed) live part to ground

Test 2: (not changed) between phases, if applicable

Test 3: (changed to read) between the any two contacts that connect across the first and last taps of the tapped winding

Test 4: (changed to read) between any two contacts that connect across adjacent taps of the tapped winding, or any other contacts relevant to the LTC contact configuration

Test 5: (not changed) between diverter switch contacts in their final open position

For DETCs, the wording was not changed and is reproduced below for reference.

Test 1: live parts to ground

Test 2: between phases, if applicable

Test 3: between the first and last contacts of the DETC

Test 4: between any two adjacent contacts of the DETC

Test 5: any distance, that due to contact configuration will have a higher stress than the ones tested above

With these changes made, the working group now has a complete document ready for balloting. The working group chairman noted that the PAR for revision of C57.131 will expire in December, 2007 and will need an extension granted in order to complete the balloting.

7.6.1.5 WORKING GROUP FOR THE REVISION OF C57.93, INSTALLATION OF LIQUID-FILLED TRANSFORMERS - Michael Lau, Chairman

The document has been submitted to RevCom, waiting for response.

7.6.1.6 WORKING GROUP FOR DEVELOPMENT OF PC57.150, GUIDE FOR THE TRANSPORTATION OF TRANSFORMERS AND REACTORS RATED 10,000 KVA OR LARGER –Greg Anderson, Chairman

Greg Anderson, Chair of the Working Group for Transportation Issues Guide, PC57.150, called the meeting to order at 3:25 p.m., Tuesday, October 16, 2007. Also present were the Vice-Chair Ewald Schweiger, and Secretary Susan McNelly. There were 18 members present with 38 guests and 3 guests requesting membership in the WG.

The IEEE Patent disclosure requirements were discussed and a request was made for disclosure of any patents that may be related to the work of the WG. There were no responses to the request for disclosure.
Approval of minutes from the Spring 2007 Dallas meeting was requested. A motion was made and seconded. The motion was approved.
Greg brought up the list of participants and his desire to get this updated so that only those that have actually contributed are on the list that is put in the actual standard.

Participants/Contributors to date:

Gregory W. Anderson, Chair
Ewald Schweiger, Vice Chair
Susan J. McNelly, Secretary/Technical Editor

William Darovny	Marnie Roussell
Doug Filer	Craig Swinderman
James Garner	Robert Thompson
Tom Lundquist	Jane A. Verner
Jerry Murphy	David Wallach
Paul Pillitteri	Kipp Yule
Les Recksiedler	Ricardo Zarate

The WG is presently on draft 4 of the guide. Greg reviewed the various sections in the standard and thanked those that have already provided information that has been input into the guide to date.

Kipp Yule volunteered to help provide additional information for the overseas shipping section. Kipp indicated that placement, quantity, and trigger values of the impact recorders, position of the load on the ship, the size and age of the vessel, whether the unit is oil filled, and design impact requirements are all important factors that need to be considered.

The recent bridge collapse in Minneapolis has had far reaching ramifications on additional limitations and reduced bridge capacities across the US and in other countries. These reduced capacities are affecting shipping durations and permitting.

Bill Darovny and Jane Verner will provide some input for a receipt checklist.

There was a comment from Dave Wallach on the impact recorder section that 5G as an indication of rough handling needs to be thought out. Does it mean that 4G is OK?

John Progar had a comment that issues with shipping a unit that has failed and that even though some components may be damaged, care is still needed to protect parts that may still be in good condition. John Progar and Craig Steigemeier will provide information on issues related to transportation of repaired units. There are also issues related to relocation of units. In general, good progress is continuing to be made on the document. A revised draft with the latest input will be sent out in the next several weeks for review.

Meeting was adjourned at 4:22 p.m.

7.6.1.7 TASK FORCE FOR FUNCTIONAL LIFE TESTS OF DE-ENERGIZED TAP CHANGERS – Phil Hopkinson, Chairman

The Task Force on Life Tests, De-energized Tap Changers was called to order at 9:30 AM on October 16, 2007. There were 33 attendees, 13 members, and 20 guests with 2 requesting membership. Reviewed the agenda for the meeting, and the Minutes from the March 13, 2007, meeting in Dallas, Texas, were approved.

1. Mission – Develop Functional Life Test and Supporting Technical Paper for De-energized Tap-changers. Reminder that the goal is to develop the test and have a paper that supports the test. Test will ultimately be included in C57.131.

2. Mr. Hopkinson reviewed slides from the agenda posted on the Transformer Committee Website.
   a. Life considerations
   b. Tap changer Suitability for Synthetic Insulating Liquids
   c. Functional Life Tests Functional Life Tests-Issues
   d. Functional Life Tests-Connections
   e. Functional Life Tests-Issue of Oil Volume
      I. Large liquid volume important for test validity – modified slide Large liquid volume should speed up thermal runaway
      II. 130 C Liquid Temperature a good selection – there is a safety concern with this temperature.

3. Review Test data provided by Larry Dix, Quality Switch

   Silver-plated contacts and natural ester oil were used. The data looks stable.

   The volume of oil should be large and should not be changed. A thought is that there is a chemical reaction is going on with the contacts and too little oil depletes this chemical. Mr. Dix estimates using 10-15 gals in testing. Mr. Kraemer estimated using 500-600 liters in testing conducted at Reinhausen.
   Mr. Alan Johnson will look at defining the volume of oil to use in testing.

   Natural ester oil – very stable
   Mineral oil – moderate stability
   Silicone – very unstable

   Members are to consider other combinations of where to attach leads and thermal parameters. Additional testing to be conducted by Mr. Dix and Mr. Kraemer.

4. New Business

There was no new business.

The meeting adjourned at 10:45 AM.

7.6.1.8 WORKING GROUP FOR REVISION OF C57.135, GUIDE FOR THE APPLICATION, SPECIFICATION AND TESTING OF PHASE-SHIFTING TRANSFORMERS – Jin Sim, Chairman

The Working Group for revision of C57.12.135, the "IEEE Guide for the Application, Specification and Testing of Phase Shifting Transformers" met on Tuesday, October 16, 2007 at 11:00 am. There were 8 members and 20 guests attending the meeting. The Vice chair and the secretary could not attend the meeting and notes were taken by Jeff Foley.

After the introduction, patent disclosure was reviewed and previous meeting minutes were reviewed and approved.

The chairman briefly reviewed the activities between meetings. Several members and guests from users and manufacturers of PST contributed with written comments and suggestions to improve the document. All of them will be incorporated into the revision of this guide.

Some parts of the contribution were discussed at the meeting as noted below.

The overloading conditions for very large PST could exceed the switching capability of the LTC and various users handle the situation by utilizing the LTC controls to block the operation under these conditions. After full discussion of the subject, members felt that this should not be included in the guide since it should not be a design guide and virtually all cases of large PST procurement process includes specification and design reviews to address this issue.

Certain PST designs will cause the impedance changes with LTC position changes in non-linear fashion and a concern was raised if this will impact the power flow. Sanjay Patel reported via email that based on his discussions with users that the impedance changes do not impact the power flow as much as the phase angle. Most users utilize analytical tools to study the load flow and can handle the impedance changes.

System planners need information on loading PST and they rely on their technical people to provide guidance. There is not sufficient amount of technical papers or industry guides to address this. Jim McIver will summarize inputs from users and manufacturers on minimum information requirements for specifying a PST for inclusion in the revision of the guide.

A considerable discussion on PST with DETC took place. Several users indicated that they are used to switch connections to either phase shifting or voltage regulation, or to change a fixed angle of regulation. This subject belongs to the user specification, rather than a guide and will be treated as such.

7.6.1.9 WORKING GROUP FOR REVISION OF C57.12.10, STANDARD REQUIREMENTS FOR LIQUID IMMERSED POWER TRANSFORMERS - Javier Arteaga, Chairman

No minutes received.

7.6.1.10 TASK FORCE FOR THE REVISION OF IEEE STD 638-1992, IEEE STANDARD FOR QUALIFICATION OF CLASS 1E TRANSFORMERS FOR NUCLEAR POWER GENERATING STATIONS – Craig Swinderman, Chairman

The task force met on Tuesday, October 16, 2007.

Attendees: 3 members + 3 guests

The meeting began at 1:45 p.m.

The meeting minutes from March 2007 meeting were approved.

The IEEE patent policy slides were shown. An opportunity was provided for the attendees to identify or disclose patents that may be essential for the use of the standard. No responses were given by the attendees of the meeting.

Topics discussed:
In our last meeting in March 2007, it was decided that the group should proceed with applying for a PAR to revise the existing document, keeping the same scope as the original document, but updating the content as necessary. A PAR was recently submitted to IEEE in order to begin a working group for revising this document. The PAR was approved during the June 7, 2007 Standards Board meeting and will be valid until December 2011.

The working group has made good progress and has already prepared a complete draft #1 document of the revision to the standard. This draft #1 of the document will be posted to the transformers committee web-site shortly.

It was noted during our working group meeting that there were no users present in the working group meeting to provide input to the document revisions. During the course of this week, two nuclear plant-related users volunteered to review the draft#1 of the P638 document and provide comments and suggestions. In

addition, the working group will contact other users and ask for their input to this draft document. This input will be greatly appreciated by the working group.

The working group is now reviewing the latest versions of IEEE 323-2003 "Qualification of Class 1E Equipment for Nuclear Power Generating Stations" and IEEE 344-2004 Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations" in order to be sure that the latest requirements of these standards are covered in our revision of IEEE 638, or where the document should be modified to follow the updated standards IEEE 323 and 344. Two members have volunteered to review these documents and provide reports by the spring 2008 meeting.

In addition, the working group will review referenced standards C57.12.56, C57.12.60 and C57.100 that describe the thermal aging procedures discussed in Annex A. A member has volunteered to review these standards in order to update Annex A in accordance with the latest version, including updating the example calculations contained in the Annex. This work will also be completed prior to the spring 2008 meeting.

Also, during the meeting it was noted that some of the Normative Reference standards listed in the draft of the document are not actually referenced in the body of the document. The working group will review as to whether these references should be moved to informative references, included in a bibliography, or should be kept as normative references and mentioned in the body of the standard.

Any comments/suggestions received after review by the various users will also be incorporated into the draft of the document prior to the spring 2008 meeting.

The meeting adjourned at 3:00 p.m.

7.6.1.11 TASK FORCE FOR WIND FARM TRANSFORMERS – Joe Watson, Chairman

No meeting held, the work of this task force was concluded.

7.6.1.12 TASK FORCE FOR TRANSFORMER TANK RUPTURE AND MITIGATION – Peter Zhao, Chairman

The chair opened the meeting at 11:00AM, and welcomed the members and guests. There were 29 attendees in total, which included 14 members and 15 guests. One (1) guest requested the membership to the TF.

IEEE patent policy was addressed and no patent conflicts were reported.

Dallas meeting minutes was approved as written.

Two main subjects were covered during the mtg.:

Review and discuss the draft paper – “Transformer Tank Rupture and Mitigation – A Summary of Current State of Practice and Knowledge”, which resulted from 10 presentations during the past mtg.’s. The paper is going to be published on IEEE Transactions.

Prepare for Recommendations. Bill Darovby agreed to take on the job.

New Business

The TF was contacted by Cigre WG A2.33 – Transformer Fire Safety Practices. They were looking for opportunity for cooperation. It would be beneficial if two working groups are able to help each other.

The meeting adjourned at 12:15 PM.

7.6.1.13 TASK FORCE FOR EVALUATION OF PARALLELING TRANSFORMER CONTROLS AS RELATED TO UPDATING C57.12.10 – Tom Jauch, Chairman

After introductions and patent comments, an agenda to encourage discussion was followed. It included:

1) the present standards concerning transformer paralleling in C57.12.10,
2) the proposed additions and changes to those present standards, and finally
3) the proposed outline of the Paralleling Guide.

The first issue addressed was “what is paralleling”. It was agreed a definition (after checking previous definitions) would be included in the document, which needed to be broader than “transformers connected on both the high and low voltage busses”.

Comments included in the discussion:

1. Need to define paralleling methods, typical system configurations, limitations of the guide as well as special applications.
2. A section on “designing transformers for parallel operation” should be added.
3. Trying to incorporate all possible variations could delay the completion of the guide.

4. How do we incorporate system operating considerations? Or do we?
5. Are there any other standards or working groups we need to correspond with for this guide?
6. Guide needs to consider not only the transformer controls but also issues the transformer manufacturers need to consider.
7. When matching xfmr ratings and impedances - which transformer rating should be used?
    - If you only consider the top OFAF rating when paralleling transformers, you could unknowingly overload a transformer at its lower ratings when operating in parallel
8. The engineer specifying transformers at utilities is typically not the same person making the control decisions. We will probably need to solicit responses from "corresponding members" to make this a useful guide.
9. IEC standards discuss ohmic vs % impedance changes. These standards should be considered when preparing our guide.
10. Transformer manufacturers are hoping this guide will help answer many of the questions they run into and have trouble getting answers to. Mainly, when a customer specifies he will be paralleling the transformer with xyz, what does this mean? Often times the OEM's have trouble getting answers to their questions and they are hoping this guide will help address those issues?

It is obvious that some determined effort will be necessary to properly define and limit the scope and the purpose of this WG. The PAR application descriptions will be circulated among the members soon for comments.

The general assignment of reviewing the proposed outline and e-mailing the chair comments and suggested changes was made.

After the first meeting the membership stands at 19 members. We are soliciting additional members and users to the group, including corresponding members.

The meeting adjourned at 4:30 p.m.

7.6.1.14 TASK FORCE FOR EVALUATING THE NEEDS OF TRANSFORMERS USED WITH SVC – Peter Zhao, Chairman

This is to report the investigation results from the team and no actual TF mtg. was arranged during the mtg.

Team Members:

Loren Wagenaar, Dong Kim, Alan Darwin, Flavio Neuls, Christoph Ploetner, Michael Craven, Peter Zhao.

Summary of the Findings

Performance:

1. Load Condition: 100% inductive, or 100% capacitive, or any combination of both real power and reactive power with the total sum limited to the rated MVA of the transformer.
2. Large Voltage Variations on both LV and HV windings.
3. DC Component: transformer shall operate under normal operating conditions with DC current (amp range varies)
4. Harmonic Requirements
5. Both step up and step down operation
6. Frequent switching

Designs:

1. Low normal flux density design to allow an overflux condition. Core saturation to be achievable when transformer is subject to simultaneous AC and DC excitation currents.
2. Overexcitation and hot spot considerations
3. Harmonics from the electronics had to be taken into account for cooling.
4. Winging arrangements

Constructions:

In general, the same as other power transformers.

Tests:

In general, there is a minimal difference to the normal IEC/IEEE transformer test requirements.

Sometimes, if the nominal flux density is low, the magnetizing characteristics are measured over an extended voltage range. There maybe a requirement for impedance characteristics (LCR) and loss against frequency (high) if the manufacturer of the electronic switching/control equipment attached to the transformer needs such information.

There is sometimes extra calculated/estimated data requested compared with a normal transformer (data that is not easily measured, such as effect of DC in neutral and inrush current).

Actions before next meeting:

Draft the proposal based on the investigation results.

7.6.2 OLD BUSINESS

No old business.

7.6.3 NEW BUSINESS

The Power Transformers Sub Committee would like to offer the topic of “paralleling transformers” as a subject for one of the Monday and Tuesday afternoon technical presentations.