

## **7.6 POWER TRANSFORMERS – TOM LUNDQUIST, CHAIRMAN**

The Power Transformers Subcommittee met on Wednesday, October 8th, 2008 with attendance of 115; comprised of 34 members and 81 guests.

The minutes from the Charlotte, North Carolina meeting were approved with no changes or corrections.

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 – Dominico Corsi, Chairman**

Minutes will be provided later.

#### **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**

No meeting. Working to get document out for ballot.

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

The Working Group for the Standard for Control Cabinets for Power Transformers met on Monday at 12:00 pm with 11 members and 5 guests.

The Scope and Purpose sections of the document were discussed and it was agreed that we should request a change to the wording of both sections on the PAR to align with the wording of those sections in the document.

The WG also agreed to limit the Scope of the document and PAR from Class I and Class II transformers to Class I and Class II transformers 10MVA and greater. The Standard is intended to cover all transformers 10MVA and greater as a default when control cabinet specifications are not specified by the user.

Padlock details will be specified as done in C57.12.10 where the hole size for the padlock is specified to be 3/8" (9.53mm), rather than the dimensions of the padlock.

DC relay voltage was revised from 120 Vdc to 125 Vdc.

The default auxiliary power AC voltage was revised from 120V single-phase to 208/120V AC. An option will also be added to permit the specifier to require two separate AC circuits – one for the heaters, lights and power receptacle and another for the cooling and other auxiliary loads.

The Standard will recommend that the specifier specify the type of wiring terminals required by the User, but the default wiring terminals will be rated to 15A or greater, for ring terminal wire lugs and the default current transformer (CT) wiring terminals will be shorting type terminal strips.

An Annunciator is optional, but when required a “reflash” logic will be the default standard.

The default wiring terminal numbering codes were agreed as follows:

- All wiring terminal strips other than CT wiring terminals shall be numbered “TB-1,” “TB-2,” “TB-3,” etc.
- All CT wiring terminal strips shall be numbered as:  
“CT-(Winding)-(Phase)-(CT position)” where the winding notation is H, X and Y to indicate the HV, XV or YV windings, where the Phase notation is 1, 2, and 3 to match H1, H2, H3, etc., and the CT position notation is 1, 2, 3, 4, etc., with one being the inner-most CT and the highest number being the outer-most CT. For example, the terminal strip for the inner-most CT on the B-phase (2-phase) XV winding would be numbered “CT-X-2-1.”

The document will be revised and Draft 7 will be presented to the WG as a straw ballot within the next month.

The meeting adjourned at 1:15.

#### **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 6, 2008 with 7 members and 8 guests present.

The working group chairman asked if anyone in the room had information on patents that may be essential for the implementation of C57.131, Standard Requirements for Tap Changers. It was noted that no one present at the meeting expressed knowledge of essential patents.

The working group chairman asked if there were any additions or corrections to the meeting minutes of March 18, 2008. It was noted that no changes were required to the minutes.

The status of the draft of C57.131 revision was discussed. We have a complete document, but its format fits the IEEE style manual in effect when the original document was approved. The results of the editorial review lead to two items:

1. The scope does not agree with the PAR.
2. The format does not adhere to the latest style manual.

Item 1: The document scope does not match the PAR.

The WG did not change the scope but added to it some clarifying text that made the scope statement more specific. The new text did not conflict with or alter the meaning of the scope statement as written on the PAR. But it used different words and elaborated some.

To fix this without applying for a PAR revision and without losing the clarifying text, the text in question was moved to the Abstract clause at the beginning of the document. The only text that remains in the scope clause is the exact wording on the PAR. In this way the IEEE requirements were met, and the desired text was retained.

Item 2: The format does not adhere to the latest style manual.

The entire document will be typed into the latest IEEE template. Then a ballot group can be formed.

The meeting was adjourned at 3:30 pm.

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

No minutes received.

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

Attendance: 15 members + 8 guests for a total attendance of 23 persons.

- Last Meeting Minutes discussed. It was pointed out the Silicone Oil promotes most contact corrosion by carrying oxygen and turning into sand. Ester fluid is most stable. Even Tin-Copper contact combination passed thermal life in Natural ester (FR3) when it failed in mineral oil.
- Minutes of the last meeting were approved with one change.
- Central Moloney had tested Tin plated copper- Tin plated copper contact combination. They found it to be stable. They did not record voltage drop across the contacts. Instead they measured at the bushings thus losing some sensitivity. Tin plating increased the contact resistance. The overall resistance should be approximately 60 micro-ohm versus 25 micro ohm for silver-silver. The stability of this combination should be verified. Larry Dix will do it at Quality Switch. It was

agreed that the contacts should be preconditioned by moving the moving contact stop to stop twice before testing.

- Contact voltage raises the super temperature – Phil Hopkinson had proposed 130 C oil temperature for thermal life testing and 2 XN current. Deter Donal showed data that had been prepared by Dr. Axel Kraemer where lower oil temperature (115 C) and higher current (4XN vs. 2 XN) for Silver – copper contacts was not acceptable. However, experience showed that it should have been. Axel Kraemer of MR had proposed lower Oil temperature (115 deg. C) and higher current (4X normal) for this test to stay well below the flash point of oil. Phil Hopkinson's Calculations showed that at 3X normal current the super temperature increment over top oil should have been 30 Deg.C but at 4X normal current it would be 84 C higher. This gave an acceleration factor that is too high. Phil will send his analysis to Axel for his review. The correct super temp should have been 155C. This has worked in the past. It was pointed out that 130c oil is dangerously close to the flash point of the oil. Acceleration factor should be 1000 to simulate 30 year life.

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

The Working Group (WG) for revision of the Phase Shifting Transformers Guide, C57.135, met Tuesday at 9:00 am with 13 members and 7 guests.

The WG was asked about any possible Patent issues and none were known. The minutes from the previous meeting were approved with no changes.

The PAR is in-effect until the end of 2011 and the Guide is intended to remain as a dual-logo IEEE/IEC document.

VSN Sankar had submitted a list of factors to be considered in the evaluation of tenders, to be included in Section 4.5.1, and this list was discussed by the WG. Mr. Sankar had attached comments to each of the items on his list that were not intended to be added to the Guide. All of these comments were deleted and the list was divided into two sections;

- Factors specific to the Phase-Shifting Transformer (PST) design
- Factors specific to the project

After discussion, the list of factors was finalized as follows:

#### **For PST**

1. Phase-shifter purchasing price or the first cost
2. Cost of capitalization of losses
3. Impedance variation across the tap range
4. Angle at full load
5. Electrical arrangement of on-load tap changers
6. On-load tap changers margins on step voltage, rated current, fault current and switching capacity and duty of changeover selector\
7. Test capability

### **For Project**

1. Foundations and the space requirement in the substation
2. Oil spill containment volume
3. Shipping weights and shipping dimensions
4. Protection and relay costs

Suggested changes to Section 4.5.2 from Mathieu Sazau were also discussed by the Group. After much discussion, the following text was agreed for this section to clarify design considerations for single core designs:

#### Clause 4.5.2

The single core design is less complex and has fewer winding segments than two-core designs but has some disadvantages as follows:

The LTC and the tapped winding are in the line end of the windings and are directly exposed to the system overvoltages.

The short circuit impedance of the single core design PST is very low at tap positions near zero degrees phase shift. Therefore the ratio between external fault currents passing through the PST and rated current may become very high, especially in systems with low fault current impedance. This has to be taken into account when selecting the tap changers and when calculating the forces in the windings.

Comments on Section 10.1.1.4 regarding test windings were also discussed and modified by the WG. The section will be modified to state that an auxiliary winding may be installed for shielding and/or testing purposes and that the presence of these windings should be indicated in the tender documents and shown on the nameplate.

The Guide's References will be updated to include IEC documents.

The revised Guide will be posted on the Transformer Committee website.

The meeting adjourned at 10:15.

**7.6.1.8 WORKING GROUP FOR REVISION OF C57.12.10, STANDARD REQUIREMENTS FOR LIQUID IMMERSSED POWER TRANSFORMERS - Javier Arteaga, Chairman**

No meeting held. The ballot pool is open. A one (1) year extension for the PAR has been requested. Intend to hold ballot immediately after the ballot pool is closed.

**7.6.1.9 WORKING GROUP FOR THE REVISION OF IEEE STD 638-1992, IEEE STANDARD FOR QUALIFICATION OF CLASS 1E TRANSFORMERS FOR NUCLEAR POWER GENERATING STATIONS – Craig Swinderman, Chairman**

Attendees: 2 members + 2 guests

The meeting began at 2:45 pm.

The meeting minutes from March 2008 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:

Since the last meeting in March, 2008, the P638 document has been updated and is now Draft #3. This latest draft was reviewed during the meeting. This draft #3 of the document will be posted to the transformers committee website shortly. The majority of the document is nearly complete, but a few remaining items need to be addressed.

During the review of the information contained in the updated Annex A of the draft document that describe the thermal aging procedures and calculations, it has been discovered that some of the figures and graphs included in the annex, which are updated figures pulled from another referenced standard C57.96-1999, are actually incorrect. The updated figure is intended to replace a similar, but outdated figure from the original document. A member has volunteered and has already contacted the working group chair of this other standard in order to try and correct these figures in our document. We will try and obtain the original formulas for the curves and have the curves re-plotted correctly. This work will be completed prior to the end of this year.

In addition, a new section has been added to the document to address concerns raised during the re-affirmation ballot regarding transformers subjected to non-sinusoidal loads, referencing C57.110. However, during the working group meeting, some members questioned whether this really applied to class 1E applications, as this standard applies to a very specific transformer application, and these applications may

not necessarily be subject to non-sinusoidal loads in service. We will contact the person initiating the re-affirmation comment, and will poll additional users for more information on the validity of the non-sinusoidal load concerns for this particular application.

The current planned schedule for the working group is to have draft #4 of the document completed by this December 2008. We will then send the document out for a straw vote in early 2009, and then submit the document for the Mandatory Editorial Review and balloting shortly thereafter.

The meeting adjourned at 4:00 pm.

#### **7.6.1.10 WORKING GROUP FOR DEVELOPMENT OF PC57.153, GUIDE FOR PARALLELING TRANSFORMERS – Tom Jauch, Chairman**

\* The working group met with 8 members and 9 guests in attendance. The minutes from the last meeting were approved and no patent issues were identified.

\* The group reviewed the Scope and Purpose as shown in the newly approved PAR. BASICALLY, this paralleling guide describes and compares **control** methods of paralleling power transformers **equipped with load tap changers (LTC) or series regulators.**

\* The group reviewed the 3 major premises of transformer paralleling: (1) maintaining the basic function of voltage control, (2) to minimize circulating or difference currents, and (3) automatically operate correctly regardless of system configuration changes.

\* We discussed a definition of “Paralleled Transformers”. 3 options were discussed with the preferred one being:

**“Two or more transformers connected in such a manner that they share in supplying power to a common load bus.”**

\* The group reviewed and discussed the automatic operations of several substation and system configurations. Discussions included how these varied conditions create different control configurations which need to be made automatically.

\* The several names given to paralleling control methods were discussed and proposed “preferred” names were listed.

\* Two possible system questions to determine the need for paralleling equipment or this guide were discussed.

1) Will **ANY** system condition cause this transformer to be in parallel with another? (IF YES)

2) Will **ALL** system conditions cause “tap difference” **control** voltages to create paralleling self correction? (IF NO)

**THEN:** It will require parallel equipment (master follower, circulating current, negative reactance, var balancing or power factor – other?)

\* We reviewed the CEMA paralleling standards which included master/follower and circulating current. More information from CIGRE standards will be discussed at the next meeting.

\* The Guide's general outline and the section outlines were briefly reviewed with a call for members to choose a subsection to discuss and do so. We will hopefully have sections sent to members and guests for comments in the coming months. The meeting was adjourned at 5:30pm.

#### **7.6.1.11 TASK FORCE FOR TRANSFORMER TANK RUPTURE AND MITIGATION – Peter Zhao, Chairman**

Meeting of the Task Force for Tank Rupture & Mitigation convened Monday morning at 10:30am. Substitute chair for the meeting was Robert Thompson, standing for Peter Zhao who was not able to attend.

Knowledge of patent concerns was requested, with none cited.

Attendance was 42 (11 members, 31 guests). Six guests requested membership (for Guide if WG approved). It should be noted that this task force was created several years ago with participation of only three or four persons, but strong and growing attendance since suggests a significant interest in development of a standard or guide covering tank issues.

The status of the White Paper that this task force has been working on was reported by Terry Lee. The White Paper, which was submitted for approval in early February, 2008, was well received by reviewers and is expected to be approved for publishing in IEEE Transactions – Power Delivery once certain changes are incorporated into the document. The primary revision of substance is to remove an appearance of promoting a particular supplier of a pressure suppression system. Terry asked the attendees for feedback on resolving the issue by insertion of a disclaimer of preference for any particular method for mitigation, along with editorial rewording of some objectionable sections. Feedback from attendees was supportive of this solution and the paper revision and re-submission will proceed.

It should be noted that, with the publishing of the White Paper and encouragement of the reviewers, the work of this task force is essentially complete. A remaining task is to request permission to issue a PAR for formation of a Working Group for generation of an application guide relating to tank designs. With the Chairman's stated expectation that the PAR scope will be for "Tank Design Issues" the meeting moved into discussion of topics that should be included in such an Application Guide. Progress was being made toward this list when a recommendation was made from the floor that the issues of tank rupture and mitigation was worthy of a stand-alone application guide. Development of the list was interrupted to get a show of hands (members and guests) for interest in pursuit of a guide based on tank rupture and mitigation only. The support for the narrower scope (for tank rupture) was three to one, with 29 hands up.

A second show of hands was requested for support of the formation of a Task Force to pursue another application guide for tank issues in general, based on the types of issues already discussed earlier in the meeting. Pursuing a guide with this more general scope (in addition to the tank rupture guide) was supported unanimously (by a

show of hands of members and guests). The tank-related issues that had been discussed were:

1. Design for withstand of shipping stresses.
2. Design for withstand of vacuum pulled for filling.
3. Design for withstand of seismic stresses.
4. Sound abatement.
5. Tank design for vibration control.

Jin Sim agreed to provide Craig Swinderman a draft of IEC 600-76-1 and to prepare a report to be presented at the next meeting of this task force (in Miami), concerning tank-related contents of that document.

Conclusions from this meeting are as follows:

1. Task force chairman should request permission to submit a PAR (with scope and purpose) confined to tank rupture and mitigation issues.
2. The Tank Rupture and Mitigation task force recommends that a new Task Force be established to consider the value of a second guide relating to general issues with transformer tank design, such as those listed above.

Item 2 will be raised under new business at SC Power Transformers meeting on Wednesday, October 8.

After much interesting and informative discussion, the meeting was adjourned at 11:45am.

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

No meeting was held.

#### **7.6.2 OLD BUSINESS**

None.

#### **7.6.3 NEW BUSINESS**

- Suggest to form a task force to decide if there should be a guide written to cover PV generators impact on power transformers. The transformer size fits more into distribution class however, these transformers should in many ways be considered GSU so there is a question regarding which subcommittee this TF if created would fit into.
- Tank Rupture TF has requested to submit for a PAR. The chairman has requested a draft title and scope description be submitted for Subcommittee approval and then AdCom acceptance.

#### **7.6.4 STATUS OF “INACTIVE” GROUPS**

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

This group is not meeting; major work on this document is complete, waiting for publishing.

##### **TASK FORCE FOR WIND FARM TRANSFORMERS – Joe Watson, Chairman**

Work of this group is complete; the task force is inactive.