7.11 **Performance Characteristics Subcommittee – Ramsis Girgis, Chairman; Stephen Antosz, Secretary**

7.11.1 Introduction/Attendance

The Performance Characteristics Subcommittee (PCS) met on Wednesday, October 25, 2006 with 62 members and 43 guests in attendance. 7 of those guests requested membership in PCS. See last page of these minutes for attendance summary.

7.11.2 Approval of Meeting Minutes

The minutes of the last meeting in Costa Mesa, CA were approved as written.

7.11.3 Chairman's Remarks

7.11.3.1 Administrative Subcommittee Notes

- Future Standards meeting dates and locations are as follows:
  - Spring 2007: March 11–15, Dallas, TX
  - Fall 2007: October 14 - 18, Minneapolis, MN
  - Spring 2008: To Be Determined
  - Fall 2008: Most probably Portugal
- IEEE PES Meeting: June 19 – 22, 2007 inTampa, Florida. Deadline for submission papers is December 11, 2006 and decision to be made by February 12, 2007.
- Starting with the next Standards meeting in Dallas, no paper registration will be available
- The “Loss measurement and tolerances” Guide C57.123 will be submitted for dual IEEE / IEC Logo
- Those who are not members of the committee need to get membership

7.11.4 Working Groups and Task Force Reports

7.11.4.1 PCS WG for Continuous Revision to C57.12.90 – Mark Perkins, Chairman; Rowland James, Secretary

There were 66 persons in attendance, 30 members and 36 guests. After introductions, the chairman asked if there were any patent issues relating to this standard. Being none, this discussion was closed. The minutes from the last meeting were then reviewed and approved as written.

<u>Task Force Reports</u>

1. Marcel Fortin’s report on Short-circuit test revision was not given at the meeting.

2. Gerry Rosselli reported on the progress of the section on measuring Zero – Sequence Impedance of multi-winding transformers. He reported that a survey was

conducted of the PCS subcommittee on draft 2b. There were sixteen responses, nine approved with no comments, six approved with comments, and one disapproved. In his response to the survey, Bipin Patel provided a suggested re-write of the Draft 2b that simplified the presentation. The task force chair preferred this simplified version and recommended that this be accepted. The group voted to accept this version. Subhash Tuli suggested changing the term E in Figure 24 to Eav so as not to confuse the term with E used in the previous equation. His proposal was accepted. The group also discussed what measurement would be reported, and it was agreed to report the test results on each individual phase along with the average. Finally, Ramsis suggested surveying the Subcommittee one final time with a revised draft incorporating these changes. This survey is to be completed immediately after the meeting.

3. Mark Perkins reported that the task force on resistance measurements (section 5 of C57.12.90) sent a survey with the proposed changes to the Performance Characteristics Subcommittee and the working group. The survey results were 11 approved, 4 approved with comments, and one negative by Marcel Fortin. The Chair then reviewed the final draft of revisions to section 5 and discussed the changes from the negative and comments that were implemented into the latest draft. Subhash Tuli requested that we specify a current that could be applied during the 3-hour stabilization time in clause 5.1.2 a), for example doing an excitation test. The group decided to say that the windings should have no significant current for 3 hours and that what constituted significant current could be left to the discretion of test personnel. The group then agreed on a vote of 38 to 2 that this final draft of revisions to section 5 should be sent to the standards committee for inclusion in the next draft of C57.12.90.

7.11.4.2 PCS WG for Continuous Revision to C57.12.00 - Steve Snyder, Chairman; Dennis Marlow, Secretary

The Working Group met on Monday, October 23 at 1:45 PM. There were 22 members and 37 guests present, with the following 2 people requesting membership:

Joe Foldi --- Consultant Devki Sharma --- Consultant / Entergy

The addition of the 2 new members brings the Working Group membership to 69.

Following introductions, the minutes of the March 20, 2006 Costa Mesa meeting were approved as submitted. Working group members were then asked about any applicable patents pertaining to our work. No patents were disclosed by anyone.

The chairman reported that C57.12.00/D3 has been successfully balloted and is ready for publication.

Old Business:

WG Item 70 clause 6.5.1: Tank Pressure Requirements: The request was to change the language in this section and delete the reference to the ASME Boiler Code. This proposal was discussed at the last meeting and there was not much support in the WG to make a change. The chairman has contacted the balloter and discussed the matter further with him, and he does not object to the position of the WG. No changes will be made to this section.

WG Item 79 Clause 5.7.1: Polarity of Single-Phase Transformers: The balloter questioned whether the "200 kVA" limit was in error, since this is not a standard rating. The chairman requested a survey of the Distribution Transformers committee to obtain their input, and the feedback indicated the standard has been this way since at least 1968 and there is no interest in changing it now. The issue has been discussed with the balloter and he has no objections to the findings of the WG. No changes will be made to this section.

During this discussion, a question about whether the polarity requirements apply to tertiary windings was raised by Don Platts. He made a suggestion about adding tertiary windings to the standard, and will send a proposed clarification to be discussed in a future meeting.

New Business:

The chairman introduced a new C57.12.00 Table 21 (Routine, design, and other tests for liquid-immersed transformers) that incorporates 8 changes already agreed to by this WG dating back to April 2002. The most obvious change is the addition of another set of columns specifically for Class II Power Transformers, with the intent of clarifying the test requirements for all transformers while reducing the number of table notes. The most significant change in the test requirements is to make load loss testing a routine test for distribution transformers. Much of the meeting time was devoted to carefully looking through each test and determining if the requirements for each category were correct. Several additions and revisions were identified, and it was suggested that perhaps the table would be better if restructured strictly along the lines of Distribution, Class I Power, and Class II Power. The chairman agreed to do this, and will send the new table to the WG members for their review and feedback prior to the next meeting.

7.11.4.3 WG on Loss Tolerance and Measurement - Ed teNyenhuis, Chairman; Andy Steineman, Secretary

- 13 members and 11 guests attended
- IEEE Patent Policy - The policy was reviewed by the WG and an opportunity was provided for WG members to identify or disclose patents that the WG member believes may be essential for the use of that standard. No responses were received.
- Minutes from the Costa Mesa Meeting held on Mar 21st, were read and approved.
- Report from TF for "Guide for Low Power Factor Power Measurements": This meeting was chaired by Eddy So who had been absent for 3 years due to illness. There were 9 people present. The Guide is still being worked on. The expression and evaluation of uncertainty of measurement results were discussed.
- Frequency Conversion Factors of Transformer Performance Parameters - The final wording for C57.12.00 and C57.12.90 will have the below items included. With the below changes, the wording will be sent on to Dong Kim (C57.12.00) and Steve Antosz (C57.12.90):
    - Editorial change to the no-load loss example
    - Added Equation numbers

- Changes will be made to sound level by the Audible Noise WG, which will meet later on Oct 24th, 2006. The items below will be added / removed:
  - Added conversions for Load Noise
  - Added conversions for the frequency spectrum of Core noise
  - Added winding resonance to the types of resonance a transformer can have
  - Removed the part on resonance under rated frequency and added a sentence for resolution of that situation
- Ramsis Girgis will present and discuss these in the Audible Noise WG meeting and will finalize the wording of this part of the document
- Wording will then be sent to be put in 12.00 & 12.90
- Chairman to prepare introduction on the frequency conversion factors to send along with the wording

- C57.123-2002 – Guide for Transformer Loss Measurement – This Guide needs to be reaffirmed by Dec 2007. The chairman will edit the revised version of the guide and send to the WG for review. The chairman will also obtain a PAR, ballot pool and submit for ballot. The below are the agreed upon changes:
  - 3.2.3 – error in equation
  - 3.2.4 – revised wording to add shell and wound type.
  - 3.2.x – Joint type – Proposed wording agreed upon with some editorial changes (insert between 3.2.4 and 3.2.5)
  - 3.2.x – Core size – Proposed wording agreed upon with some editorial changes (insert between 3.2.4 and 3.2.5)
  - 3.2.6 & 4.4.5 – The WG agreed to add reference to the frequency conversion factors in the C57.12.90 annex.
  - Equation 7, 8 – error – the "=" should be "+"
  - Remove 3.7.2 & 4.5.2 on two wattmeter method – Both sections will be replaced with wording saying that it is not recommended. The WG agreed to the proposed wording with some editorial changes.
  - 3.7.3 – It was agreed to leave as is. The figure 12 will be revised to remove the "30" and "60".
  - 4.4.1 – It was agreed to remove Example 3 since the %pf is outside of the scope of equation 13.
  - Section 9.3.3.4 from C57.12.90 will be put into section 4.5.3. The WG agreed to add this with the below changes in Figure 23:
    - Add H3, H0
    - Remove CT on H2
    - VT should be connected to H2 (not ground)
    - V connected to ground (remove N, B)
  - Section 6 – reviewed by Ed teNyenhuis and was OK
  - Section 8 – reviewed by Vladimir Khalin and was OK
  - Bibliography – the B13 is not published but will be by 2007 so can be left as is

7.11.4.4 WG on Switching Transients Induced by Transformer / Breaker Interaction, PC57.142,WG - Robert Degeneff, Chairman; Peter Balma, Secretary

The Working Group on Switching Transients Induced by Transformer/Breaker Interaction was called to order at 8:05 AM on October 24, 2006. There were 49 attendees, 23 members, 2 requesting membership, and 24 guests. The Minutes from the March 21, 2006 meeting in Costa Mesa, California were approved, and copies of the minutes,

minutes of two conference calls with the Switchgear Committee, and Draft 2.0 of the guide were distributed.

1) IEEE patent policy was reviewed and the group was asked if there were any disclosures. There were none.

2) Next, Bob acknowledged the contributions of several members of the working group, Phil Hopkinson & Scott Choinski for chairing the last meeting; Pierre Riffon for rewriting draft 1.7; and Donald Fallon, Ramsis Girgis, and Peter Balma for their assistance with several conference calls with the Switchgear Committee.

3) A brief history of the working group was reviewed, as listed below:
   a) Original topic was considered in 1996
   b) Working Group was formed in 1997
   c) Task force agreed to write Guide in 1997
   d) PAR written and C57.142 assigned in 2001
   e) Asked for assistance of Switchgear Committee, as they had formed separate WG
   f) Joint tutorial presented in Raleigh, NC - 3/18/03 by Tobin/Hopkinson/Degeneff
   g) PAR extension requested and approved
   h) Draft circulated in 2004 – asked for input/guidance from subcommittee
   i) Ballot held August 2005

4) Results of the ballot, open from 8/9/05 to 9/9/05, were reviewed and are as follows:
   a) 145 eligible members in ballot pool
   b) 115 votes received (79% returned)
   c) 85 affirmative votes
   d) 22 negative votes with comments
   e) 2 negative votes without comment
   f) 6 abstentions
   g) 107 countable votes
   h) 85/107=79% affirmative

5) Two joint conference calls were made with the Switchgear Committee, and minutes from those calls were distributed at this meeting. Bob Degeneff reviewed highlights from both calls, which are briefly summarized in the following:
   a) In the first call, the following items were discussed:
      i) Pierre Riffon's, et. al., major revisions to the document which is now draft 2.0.
      ii) Guide should contain a list of steps that a user could go through in investigating an operational issue
      iii) Need to provide guidance on how to recognize potential for problem in either a new installation or in an application where failure is thought to have been caused by this situation
      iv) The need to change the title of the guide to "A Guide to Describe the Occurrence and Mitigation of Switching Transients Induced by Transformer, Switching Device, and System Interaction"
      v) Additional information on current chopping is needed (Kirk Smith to provide)
      vi) Several references to C37, IEEE 1313, and IEC-71 are needed (Bill Bergman agreed to supply)
      vii) The formation of a joint task force, to be led by Pierre Riffon with members from both committees, is to be formed.

b) The second conference call considered seven key technical concerns for discussion:

(i) Current Chopping
(ii) Multiple Re-ignitions vs. Restrikes
(iii) Transformers are considered as pure inductance, losses need to be added
(iv) Description of winding resonance
(v) Practical guidance to situation
(vi) Snubber design
(vii) Expand explanation on aspects of system design that could contribute to this problem
- Electronic Loads
- Backfeed energization
- Feeder Cable Length,

6) Marcel Fortin indicated that the Switchgear Committee in their main meeting voted to work on this document as a joint document with the Transformer Committee.

7) Don Fallon indicated we initially tried to include input from others, but really did not get constructive comments until the ballot. However, now that input is coming in collaboration with the Switchgear Committee. The two conference calls held, show the willingness of the members from both the Switchgear and Transformer Committees to work together to prepare the next version of this guide. Don did not foresee any reason why such a collaborative effort could not take place.

8) Angela Ortiz of IEEE indicated that continued teamwork with the Switchgear Committee was the best possible way to proceed, and that the mechanics of doing so would not be a problem.

9) The question of how we can better publicize this issue was raised. Bob indicated that CIGRE had published a document approximately a year and a half ago, and that was one source of this information. The group had no other suggestions and concluded that completing this guide was probably the best way to publicize this issue.

10) The issue of what steps can an engineer take to avoid this problem in advance was raised once again. And again, the conclusion is that the installation of a snubber is the most cost efficient way to mitigate this problem. Unfortunately, the studies to confirm the potential for an interaction problem are far more expensive. An example of this situation was raised relative to furnace transformers 30 years ago. Essentially, the interaction problem existed then, but there were very limited tools to even study the issue. The solution was to add snubbers, which has been done since that point in time, and the problem has been since.

11) Bob Degeneff proposed the following next steps for this work effort:

a) To revise the title of the guide to “A Guide to Describe the Occurrence and Mitigation of Switching Transients Induced by Transformer, Switching Device, and System Interaction.” This will require a new PAR.
b) To revise the scope to reflect the title change and add clarifications, but not to increase the overall scope of the document.
c) To form a joint task force with the Switchgear committee to revise this document and be ready to ballot in 2007

12) Peter Balma made a motion that these "next steps" be accepted by the group. The motion was seconded, and a vote of working group was unanimous, no opposing votes were cast.

13) Jim McBride made a brief presentation to the group describing his work efforts on developing on-line FRA measurements. As a result of his research, Jim has made some high quality measurements of system transients, and wanted to share these with the group because of its effort to understand system transients and their impact with transformers. His efforts indicate that the frequency content of these transients is quite high, and that a 40 kV rise in voltage with a 5 usec rise-time had been seen. Key to these efforts. It should be understood that such measurements can be misleading unless made with equipment specifically capable of reproducing these higher frequencies.

14) There was no new or old business brought before the group.

7.11.4.5 WG on Revision of C57.21- Standard Requirements, Terminology, and Test Code for Shunt Reactors over 500 KVA – Richard Dudley, Chairman

The W.G. met in the Cartier-A Meeting Room of the Delta Centre-Ville Hotel in Montreal, P.Q. on Oct. 23, 2006 from 11:00 a.m. to 12:15 p.m. There were 12 members and 11 guests present. The following are the highlights.

1. Introductions were made.

2. The minutes of the meeting in Costa Mesa were approved.

   Note: The minutes of the Montreal meeting will not be formally approved until the W.G. meets in Dallas, Texas.

3. IEEE patent policy was highlighted by the Chairman and no patent issues wee noted that could impact the revision of IEEE C57.21.

4. Draft # 6 of the revision of IEEE C57.21, prepared by the Chairman, was discussed. Revision of the document is largely complete. Discussion was focused on a small number of outstanding issues, most of which were identified and partially discussed via e-mail prior to the meeting. The following are the highlights.

   (i) Based on discussions the Chairman had with Jeff Nelson, Chairman of the IEEE Switchgear Committee, Annex B should be acceptable to the IEEE Switchgear Committee. The focus of the informative annex is on transients seen by shunt reactors during switching and is a basis for the elimination of reduced BILs from Table 5.

   (ii) Christoph Ploetner made a presentation on the issue of whether losses should be referred to rated current, as is current practice, or rated voltage. Christoph's presentation which was prepared based on his discussions with Bertrand Poulin, are attached to these minutes. The tolerance on impedance and the actual achieved impedance creates the issue. In service, the actual current is determined by the actual achieved impedance. The actual achieved

impedance determines the actual in service MVAR of the shunt reactor. Utilities "buy" MVARs but guaranteed losses are important for commercial reasons; especially in the case of loss evaluations. It was finally the consensus of the W.G. to reduce the tolerance on impedance from ± 5% to ± 2.5% and reference losses to rated current as has been the practice in the current version of IEEE C57.21.

(iii) The hi-pot levels in Table 5 for the applied voltage test were discussed. The hi-pot levels for dry type SRs in the current version of IEEE C57.21 are based on those for insulators. They are higher than those for oil immersed SRs of the same voltage class. One W.G. member pointed out that insulators are components and therefore have higher hi-pot levels. However, insulators as applied to dry type SRs should have hi-pot values based on the application. Therefore, Pierre Riffon proposed that the hi-pot value for oil immersed and dry type SRs should be the same and that the values for oil immersed SRs should be used. Hi-pot values for oil immersed SRs are based on insulation co-ordination practices. Table 5 will be modified accordingly. It was also noted that hi-pot levels for oil immersed & dry type transformers are the same.

(iv) For shunt reactors, reduced BILs are not utilized due to the frequent switching. For power transformers, LA protection practice is different and therefore there are different BILs for the same voltage class.

(v) The recommended impulse level for 550 kV System Voltage should be; lightning 1550 kV, chopped wave 1705, and switching 1290.

The Chairman agreed to produce Draft #7 and circulate it to W.G. members prior to submitting to IEEE for formal ballot. The meeting adjourned at 12:15 p.m.

7.11.4.6 WG on Revision of C57.110 – IEEE Recommended Practice for Establishing Liquid-Filled & Dry-Type Power & Distribution Transformer Capability When Supplying Non-Sinusoidal Load Currents – Rick Marek, Chair; Kent Haggerty, Co-Chair

The meeting opened on Tuesday at 1:45 PM with 12 members and 12 guests present. Following introductions, the minutes from the March 21, 2006 meeting in Costa Mesa, California were approved as submitted with a correction to the date.

The chairman reviewed the IEEE patent disclosure requirements. No guests or members indicated knowledge of patent activity applicable to the work at this meeting.

With no comments concerning old business, Draft 3 was reviewed. This draft incorporated all the results from the working group review of Draft 2, including revisions to the abstract, key words, and introduction. Additional wording was added to the section concerning transformer heating due to third harmonics. The rigorous test method in Annex C was replaced with a brief mention of testing using electronic power supplies. The proposed section on loading above nameplate rating was removed, since the whole document was related to loading.

Hasse Nordman suggested adding several electromagnetic field figures from IEC 61378-3 to replace the single figure D1. These figures would better demonstrate the effects of

harmonics on the field, since Annex D is a tutorial section. He will send information on the specific figures suggested.

The WG members were requested to carefully review the draft, since the next step will be to ballot the document.

7.11.4.7 TF on Semi-Conductor Rectifier Transformers, C57.18.10 – Sheldon Kennedy, Chairman

The Working Group met on Tuesday, March 21, 2006 at 3:15 PM with 12 members and 6 guests present. Sheldon Kennedy chaired the meeting.

The IEEE disclosure statement was read. There were no patents pertaining to this standards work for which any members had awareness.

The minutes of the March 21, 2006 meeting in Costa Mesa, California were approved.

The Chair announced that the Amendment, C57.18.10a/D1, had been put out for a survey in the working group. Only 6 votes were received to date. They were all positive, but one contained a comment that there was an additional error in the Circuit 50 diagram that should be corrected. It showed three neutrals coming to one side of the interphase transformer and only one coming to the other side of the interphase transformer. There should be two on either side. We are correcting the errors and missing or undefined terms. So it was felt that this should be corrected immediately. Since we don't have enough votes back on the survey yet, the Chair will circulate Draft 2 for survey in the Working Group, with the Circuit 50 correction, immediately following the meeting.

The Chair reminded the Working Group that IEEE had published an Errata in January 2006, correcting some of the problems that occurred when the Word copy was converted to a PDF file.

If the working group survey is successful, the Performance Characteristics Subcommittee will be surveyed, if desired by the Subcommittee. If that is successful, Amendment C57.18.10a/D2 will be submitted to Revcom.

7.11.4.8 WG on Neutral Grounding Devices, PC57.32 – Steve Schappell, Chairman

The working group met at 9:30 a.m. on Tuesday, October 24, with 13 in attendance; 5 members and 8 guests. One of the guests requested membership and will be added. The roster was handed out and introductions made.

The current status of the document was discussed and it was noted that the PAR expires in December 2006. A two year extension is needed, but the filing date has been missed, so special approval from IEEE will be required.

The group began by reviewing Draft 2 of the Standard. Peter Balma agreed to review the definitions in the guide and report back in one month. Richard Dudley agreed to review Equation 1 (current crest) as it does not seem to agree with the C57.16 Standard.

While reviewing Table 8 (Limiting Temperature Rises for Current Carrying Parts – Neutral Devices) it became apparent that a previous topic of discussion was never resolved.

Richard Dudley presented a two page document, and stated that he would look at incorporating some of the information into Table 8.

The section on Ground Fault Neutralizers was discussed. Richard Dudley would request input from Klaus Papp. If Klaus is unable to help, Richard will create a new draft.

The section on Grounding Transformers was discussed, and Steve Schappell volunteered to create a new draft.

The section on Resistors was discussed. Doug McCullough presented a two-page draft, which is much appreciated. The group made comment that seismic tests should be listed as an "Other" test, and that "Design" tests do not have to be made at an independent test laboratory. Also, "Dielectric Test" could be stricken from the test table, as specific dielectric tests are already listed.

The section on Capacitors was discussed. Several manufacturers of these devices were provided: GE, ABB, and Cooper. It was agreed that we would request input from these manufacturers on this section.

7.11.4.9 WG on the Guide for the Application and Interpretation of Frequency Response Analysis for Oil Immersed Transformers, PC57.149 — Chairman; Charles Sweetser

There were 41 persons in attendance, 12 members and 29 guests of which 6 guests requested membership. The first order of business was to show the two slides regarding patents and inappropriate behavior. The minutes from the last meeting were presented and approved without comment.

The Working Group Chair presented a brief report on what had been done in the last six months. It was estimated that the document is over 90% complete. The latest contributions were identified and discussed.

Edits to Section 3: Making an FRA Measurement
Section 3 consists of 6 connection tables covering single phase, two-winding, three-winding, and auto-transformer configurations. The tables were edited in accordance with IEEE Std C57.12.70-2000 "IEEE Standard Terminal Markings and Connections for Distribution and Power Transformers." A reference note to this standard was also added.

First Draft Completion of Section 5: Analysis and Interpretation
Section 5, considered to be the most difficult, was submitted for the first time. This first attempt is relatively simple and consists of various analysis strategies: Trace Characteristic, Trace Comparison, and Relation to Other Diagnostic Tests. Subjects such as Modeling and Failures Modes still need to be addressed.

The rest of the meeting focused on reviewing the work required to finish each section.

Section 1: Scope and Application - The 20 definitions in place are too descriptive. These definitions will be reviewed and edited for length and content. George Frimpong volunteered for this task.

Section 2: Scope and Application - Complete, editorial work only.

Section 3: Making a FRA Measurement - This section dominated the discussions. Richard Breytenbach, Larry Coffeen, Jim McBride, and Mark Perkins expressed concern regarding the terminal marking convention used in Section 3, which presently references IEEE Std C57.12.70-2000 for establishing the test polarity and sequence. They recommended that second or alternate convention be established. This second or alternate convention addresses only delta connected windings. They want the test polarity and sequence H1-H2, H2-H3, and H3-H1 regardless of group type or phase orientation; the same considerations should also be given to X and Y marked delta terminals. The basis of their argument is that it is easier for less knowledgeable field personnel to remember. Richard Breytenbach agreed to provide the alternate connection instructions, including a purpose, description, and terminal connection table. The FRA Working Group will review this contribution at the next meeting.

Section 3 offers 4 test types: Open Circuit, Short Circuit, Inter-Winding, and Transfer Voltage. Section 3 will be edited showing the Open Circuit and Short Circuit tests as the minimum recommended tests. The others, Inter-Winding, and Transfer Voltage, will be labeled as additional and investigative.

Bob Degeneff recommended we consider discussing test types that can be used for transient system modeling. We will address this subject as more information is collected.

- Section 4: Test Records - All of the information is present, however it needs better presentation.

- Section 5: Analysis and Interpretation – The group agreed on the basic components for this section, however, additional figures need to be added.

- Section 6: Appendix FRA Theory – Alan Darwin made a short presentation regarding modeling. This presentation focused on the modeling work done by Dr. Zhongdong Wang from the University of Manchester. We are hoping to include some of this work in our modeling section. Alan Darwin agreed to review and edit this section for length and content. Some of this work may also be incorporated in Section 5.

Patrick Picher presented a CIGRE Update. Patrick is the CIGRE Working Group Chair for A2.26. The PC57.149 FRA Working Group plans to have an updated draft D3 at next meeting.

7.11.4.10 TF on Core Overexcitation – Craig Steigemeier, Chairman

The sixth meeting of the Core Over-Excitation Task Force authorized by the Performance Characteristics Subcommittee took place at 3:15 pm on October 23, 2006. This Task Force is charged with the identification of limits for core over-excitation and coming up with suggestions for modification of appropriate standards. There were 64 total attendees, of which 20 were members and 44 were guests. Nineteen (19) of the 64 attendees were first time attendees to this task force meeting. Two (2) attendees requested membership and will be added to the Task Force membership roster.

The following agenda for the meeting was reviewed with the attendees:

- Participant introductions – sign attendance roster
- Patent reminder
- Approve Minutes of Costa Mesa Meeting
- Task Force Charter & Scope:
- Charter – Performance Characteristics Subcommittee
- Scope – The impact of excitation overvoltage on the transformer core
- Review Suggested Modifications to Standards based on discussion at the Costa Mesa meeting
- Discuss suggested text for Surface Temperature Limit
- Action item review

At the beginning of the meeting, attendees were reminded of the need to adhere to the IEEE patent policy was stressed and the chair asked for anyone aware of patentable situations to bring it before the group. No one offered the chairman suggestions during or after the meeting of patentable work or identified any inappropriate topics covered during the meeting.

A discussion was opened to review the minutes from the Costa Mesa meeting published on the Committee website. A vote was taken and the Costa Mesa meeting minutes were approved as reported.

The changes to C57.12.00 (IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers), Section 4.1.6 (Operation above rated voltage or below rated frequency) suggested at the Memphis (Fall 2005) meeting and discussed again at the Costa Mesa meeting were reviewed in detail. The following suggestion was made for the re-write of C57.12.00, with the text in blue being the additions to the standard suggested at the Memphis meeting:

4.1.6 Operation above rated voltage or below rated frequency
4.1.6.1 Capability

Transformers shall be capable of:

a) Operating continuously above rated voltage or below rated frequency, at maximum rated kVA for any tap, without exceeding the limits of observable temperature rise in accordance with 5.11.1 when all of the following conditions prevail:

1) For distribution transformers:

1a) Secondary voltage and volts per hertz do not exceed 105% of rated values.

1b) Load power factor is 80% or higher.

2) For generator step-up transformers, the primary voltage is equal to the highest generator voltage at full load as specified by the user.

3) For system tie transformers, the primary and secondary voltages are equal to the highest levels specified by the user.

4) Frequency is at least 95% of rated value.

b) Operating continuously above rated voltage or below rated frequency, on any tap at no load, without exceeding limits of observable temperature rise in accordance with 5.11.1, when neither the voltage nor volts per hertz exceed 110% of rated values.

In the case of multiwinding transformers or autotransformers, 4.1.6.1 applies only to the specific loading conditions used as the basis of design. These loading conditions involve simultaneous coordination of kVA input and output, load power factors, and winding voltage combinations [see item j) of 4.3.3]. Differences in loading and voltage

regulation for various output windings may prevent simultaneous achievement of 105% voltage on all output terminals. In no case shall the kVA outputs specified for any loading condition require continuous loading of any input winding in excess of its rating.

4.1.6.2 Maximum continuous transformer operating voltage (unchanged)

4.1.6.3 Core hotspot temperature limit
To avoid the generation of gasses in the core, the core hot spot temperature should be limited to 130ºC for the condition of highest core over-excitation, full load, and the highest ambient temperature for transformers filled with mineral oil. It should be noted that the calculation for the hotspot is unique and different from the core surface temperature. The location of the core hotspot is typically in the center, or between cooling ducts, of the upper part of the core. Gas generation in this area is caused by overheating of a thin film of mineral oil.

The following comments were made during general discussions of the suggested text:

- (Pete Balma) For GSUs, are we specifying that the highest generator voltage at full load is the overexcitation voltage requirement?
  Craig indicated yes. Additional comments along same line.
- (Dan Perco) Discussion of core hotspot vs. surface hotspot. Leakage flux could result in core hotspot temperatures on the surface vs. in the center.
- (Harold Moore) Should discuss capability of core (and adjacent) materials at elevated temperatures.
- (Ramsis Girgis) Core hot spot limit is related to oil thin film gassing. Other materials would be more related to surface temperatures.
- (Harold Moore) Spacers made of materials such as pressboard are only good for 95°C, and therefore are a valid concern.
- (Hasse Nordman) Same temperature limits for metallic hot spots adjacent to insulation materials would apply.

The following comments were made during the discussion of the suggested Surface Temperature Limit text:

- (Tim Raymond) What are we trying to say? If we are trying to put a requirement on the core surface temperature limit, this should be clarified by stating that the 130°C core temperature limit applies to internal temperatures and that the core surface temperature should be limited to the maximum allowable temperature for metallic hot spots in contact with solid insulation.
- Several participants further discussed the 125°C surface temperature limit. The origin of the limit and appropriateness were discussed.
- Harold suggested wording it such that any materials in contact with the core surface must be compatible with the maximum expected temperatures, such as 95°C for pressboard.
- Craig was asked to summarize the comments, noting that the specific surface temperature limits should be removed and text included to reflect the limitation based on the core insulation material. He agreed to come up with suggested text, which follows:

- Core surface temperatures, including interior cooling ducts, shall be limited by the temperature capability of the insulation materials in contact with the core surface. For non-thermally upgraded pressboard, this limit would be 95°C.

Craig will communicate the information that has been compiled to date to the appropriate Working Groups that have responsibility of revising standards that are impacted by the suggestions of this task force. A summary of those communication follow:

- Performance Characteristics SC (Ramsis Girgis, Chair)
  - WG revising C57.12.00 (Steve Snyder, Chair)
    - Recommend that the wording for 4.1.6.1 be modified and an addition (4.1.6.3) is included that aids in the clarification of overvoltage capability and hotspot limits.
    - The inclusion of a specific temperature should note that the limit applies only to mineral oil insulated transformers.
    - Capacity limits or capabilities should be included on the nameplate that makes the transformer design unique.
- Insulation Life SC (Don Platts, Chair)
  - WG revising C57.91 (Tim Raymond, chair)
    - Suggest inclusion of core hotspot temperature limit in C57.91.
    - Provide the suggested addition of 4.1.6.3 for consideration,
- Insulating Fluids SC (Rick Ladroga, Chair)
  - WG revising C57.104 Gas Guide (Rick Ladroga, Chair)
    - Suggest that text should be included to note that moderate core overheating doesn't place the transformer at risk.
    - A guideline for low levels of gas generation with a H_2/CH_4 ratio in the range of 6-8 should be considered for incorporation into a future revision of C57.104.

If meaningful responses to these communications are received prior to the Dallas meeting next spring, a session will be scheduled to review those comments. It is expected that the individual working groups will need some time to consider the comments, so it is likely that the work of this task force is over until such time as a response to questions or modification suggestions are received.

7.11.4.11 TF on Revisions of S.C. Test Guide C57.133 & PCS 57.12.90 Section 12, Marcel Fortin, Chairman

This The Task force met from 11h00 to 12h20. 46 persons attended the meeting; 18 signed to become members of the WG, the other 28 signed as guests and will be on the mailing list. The chairman particularly welcomed the 7 guests from local Utility and manufacturers.

The IEEE patent slides were presented. The attendees did not have patent issues to report.

Section 12 of C57.12.90: Short-circuit test code

A summary of comments from previous ballot have been presented by the chairman.

The chairman presented the proposed modifications to the document. The 2 major ones are:

- Change the preferred method from post-set to pre-set
- Remove LVI.

Those changes have been accepted by the WG.

The LVI is replaced by DGA (more details will be needed to explain how to do it and that the gas of concern is acetylene). An informative note will refer to FRA as a recommended tool. Reference will also be made to FRSL (Frequency Response of Stray Losses).

The acceptable impedance variation for class IV transformers is reduced from 2 to 1%.

The acceptable minimum temperature for doing test will be kept as it is now (top oil > 0°C).

It was decided to make routine tests compulsory for all transformers.

There were discussions about the need for test procedure and guide. It was proposed to survey north american laboratories on: short-circuit test trend, failure rate at test, diagnostic tool (DGA, FRA, FRSL, …), short circuit method (pre-set vs. post-set)

Pierre Riffon raised a question about axial split coils.

Course of action

- Patrick Piché will provide the chair with reference papers on FRSL
- Marcel Fortin will review the draft to include comments made at the meeting and circulate it for review at the WG level in early 2007.
- Marcel Fortin and Jacques Côté will perform the survey of North American Laboratories and report for the spring 2007 meeting.
- Pierre Riffon will provide the chair, in early 2007, a text to cover tests on axial split coils.

PC57.133 Short-circuit test guide

Marcel Fortin's report on PAR status: The document has to be completely reformatted and the bulk of it (LVI) has to be removed. Some additions may be needed about FRA, DGA, and FRSL. Time did not permit to discuss this topic.

Course of action
Marcel Fortin will continue reformatting and rewriting this guide and report at the spring 2007 meeting.

Spring 2007 meeting
2 consecutives periods will be needed in order to properly cover the test code and the guide.WG has been formed to revise section 12 of C57.12.90 and also the SC Guide C57.133.

7.11.5 Old Business

None

7.11.6 New Business

7.11.6.1 The question was raised that Coupling Transformers are not covered in C57.12.00. There are some unique features with regard to VAR loading, filters, and low poer factor. It was decided to send this request to the Power Transformers Subcommittee for consideration.

Attendance at this Meeting

MEMBERS

1. David Aho
2. Raj Ahuja
3. Dennis Allan
4. Stephen Antosz
5. Jim Antweiler
6. Peter Balma
7. EnriqueBetancourt
8. William Boettger
9. Arnaldo Carlos
10. Bill Chiu
11. Donald Chu
12. Larry Coffeen
13. Craig Colopy
14. John Crouse
15. Alan Darwin
16. Dan de la Cruz
17. Dieter Dohnal
18. Richard Dudley
19. Fred Elliott
20. Don Fallon
21. Joe Foldi
22. Marcel Fortin
23. Eduardo Garcia
24. Ramsis Girgis
25. E. Gomez-Hennig
26. Myron Gruber
27. Robert Grunert
28. Roger Hayes
29. Peter Heinzig
30. Bill Henning
31. Thang Hochanh
32. Philip Hopkinson
33. Marion Jaroszewski
34. Sheldon Kennedy
35. Vladimir Khalin
36. Michael Lamb
37. T. Machado Junior
38. Richard Marek
39. John Matthews
40. James McIver
41. Van Nhi Nguyen
42. Miguel Olivia
43. Klaus Papp
44. Mark Perkins
45. Don Platts
46. Christoph Ploetner
47. Jean-Chris Riboud
48. Marnie Roussell
49. Steven Schappell
50. Ewald Schweiger
51. Devki Sharma
52. Jin Sim
53. Steve Snyder
54. Andy Steineman
55. Craig Stiegemeier
56. Charles Sweetser
57. Ed teNyenhius
58. Robert Thompson
59. Subhash Tuli
60. Loren Wagenaar
61. Jim Zhang
62. Peter Zhao

GUESTS

1. Juergen Gerth
2. Tom Bassett
3. Randall Kyle
4. Charles Garner **
5. Mike Craven
6. Mike Thomas
7. Jim McBride **
8. Axel Kraemer
9. Jane Ann Verner
10. Steve Jordan
11. Tony Reiss
12. Mary Foster
13. Patrick Picher
14. Steve Wolter
15. Brett Todd
16. Greg Virelli
17. Valeriu Tatu **
18. Ulf Radbrandt
19. Michael Spurlock
20. Clarence Bell
21. JuanLuisThierry **
22. Alvaro Cancino **
23. Jermel Miller
24. Vallamkonda Sankar
25. James Borowitz
26. Pavel Iohita
27. Radoslaw Szewczyk
28. Jim Templeton
29. Jim Graham **
30. Flavio Neuls
31. Bob Dunkin
32. Dwight Parkinson
33. Kevin delahoussage
34. Pierre Riffon
35. Florence Tridon
36. Robert Veitch
37. Sergiy Razuvayer
38. Kipp Yule
39. Bruce Fairris
40. Rudy Ogajanov
41. Richard Graham
42. Carlo Arpino
43. Donald Ayers **

** Guests requesting Membership.