8.11 Performance Characteristics Subcommittee

8.11.1 Introduction/Attendance

The Performance Characteristics Subcommittee (PCS) met on Wednesday, October 27, 2004 with 67 members and 46 guests in attendance. 14 of those guests requested membership in PCS. See last page of these minutes for attendance summary.

8.11.2 Approval of Meeting Minutes

The minutes of the last meeting in San Diego were approved as written.

8.11.3 Chairman's Remarks

8.11.3.1 Administrative Subcommittee Notes

- Next Standards meeting dates and locations are as follows:
  Spring 2005: March 13 – 17, Jackson, MS
  Fall 2005: October 23 –27, Memphis, TN
- IEEE PES meeting future dates and locations are as follows:
  San Francisco, California: June 12 – 16, 2005.

8.11.4 Agenda Changes

None

8.11.5 Working Group and Task Force Reports

8.11.5.1 PCS WG for Continuous Revision to C57.12.90 – Bruce Forsyth, Chairman; Rowland James, Secretary

The PCS Working Group for Revisions to test code C57.12.90 met in Henderson, NV on October 25, 2004 at 9:30 A.M. There were 48 persons in attendance, 27 members and 21 guests. 11 guests requested membership in the working group. After introductions, the minutes from the last meeting were reviewed and approved.

Announcements
Bruce Forsyth urged working group members who haven't registered for the Association Management System to do so. This system will enhance our abilities to communicate with the Working Group.

Subhash Tuli announced that C57.12.90 will be re-balloted in December.

Bruce then reviewed with the Working Group IEEE's Patent Requirements for Standards Under Development. Two slides provided by the Transformers Committee related to the IEEE's Patent Policy were presented and an opportunity was provided for WG members to identify or disclose patents that may be essential for the use of this standard. No responses were received.

Old Business

1.0 There was a discussion of the proposed draft #5 of the WG Item #11 "Proposal for Single Phase Excitation Tests." The remaining outstanding issue was the number of exciting current test required to demonstrate proper performance of a transformer during factory tests.

1.1. It was agreed that performing the single-phase excitation test in four positions (maximum, rated, 1-step below rated, and minimum) is sufficient to demonstrate acceptable performance unless there are other tap positions that change the magnetic excitation circuit. Notes 2 and 3 were reviewed and it was agreed they provide sufficient information to address such cases.

1.2. A comment from the floor recommended adding the word "voltage" in Note 1. Note 1 now reads as follows:

"The de-energized tap-changer (DETC) shall be set to the maximum voltage tap position for these tests."

1.3. The title of table 1 was changed from "Measurements Required for Exciting Current and Loss Test" to "Measurements Required for Single-Phase Excitation Test."

1.4. A motion was made by Bob Hartgrove and seconded by Joe Melanson to accept these changes. The motion passed unanimously.

2.0 The next item discussed was draft #2 of WG Item #9 "Proposal for Operational Tests for Load Tap Changers."

2.1. The test requirements in draft 1 of this procedure included 4 basic tests: Motor Drive Mechanism Test, LTC Control Equipment Test, Load Current Test, and a Step Voltage Test. A comment submitted prior to this meeting noted that a separate test for the motor drive mechanism is not necessary since the subsequent tests require the motor to be operated, which should be sufficient to demonstrate acceptable operation. The Chair agreed and struck out that motor drive mechanism test in draft 2. During a discussion of this issue, Joe Foldi recommended testing the motor for minimum voltage operation. Bruce Forsyth noted that another WG member, Boyd Leuenberger, had submitted a similar comment prior to this meeting. This item was not resolved and remains open.

2.2. A discussion took place regarding the use of the term "cycle" in this document. After some discussion it was agreed the following statement would be included to define the term "cycle" as it related to LTC operating in this document:

"The LTC mechanism shall be considered to have operated one full cycle when it has operated through all LTC tap positions in both the raise and lower directions."

2.3. John Melanson stated that the LTC motor should be energized from a specific position in such a way that the control circuit is used to operate the motor as installed. Subhash Tuli stated that manufacturers should not be allowed to make any temporary connections in the control cabinet. After some discussion it was agreed that the current wording is sufficient to address these issues.

2.4. A short discussion was held on the need to test the control circuit at the minimum and maximum control voltage levels. This item remains open.

2.5. A question was raised on the need for a separate control circuit test since the control circuit is used for load and voltage tests.

2.6. Steve Beckman asked if LTC travel stops would be challenged? It was noted that the current wording of the LTC Control Equipment Test includes testing the mechanical limit switches.

2.7. A question from the floor was made on what are we trying to accomplish with these tests. Bruce Forsyth responded that the purpose of these test is to demonstrate that the LTC and controls are functioning properly as installed on the transformer.

2.8. In a follow up question it was asked if the LTC is controlled remotely how is this tested? Bruce responded that this procedure is not intended to cover equipment that is not directly installed on the transformer and that this test procedure would be limited to demonstrating the installed equipment performs as specified by the manufacturer.

2.9. Pierre Riffon stated that IEC requires only two steps above and below neutral. Joe Foldi stated that he would prefer to keep the ranges recommended in the proposed text. After some discussion, there was agreement that the proposed text be retained.

2.10. It was noted from the floor that the step voltage test states that no current will be flowing during this test. It was recommended and agreed that this be reworded to "load current".

2.11. As time was running out, Bruce Forsyth announce that the current comments will be incorporated into a new draft that will be sent to WG members before the end of this week for their review.

New Business

1.0 Vallamkonda Sankar raised two issues.

1.1. Clause 9.3.3.2 – recommended a statement be added that the equations only apply to concentric windings. Bruce Forsyth noted that this request has already been addressed by the WG in previous meetings and agreed to research the issue to determine the WG's previous resolution.

1.2. An issue regarding switching impulse polarity was raised, but it was noted that this WG only addresses issues falling under the scope of the Performance Characteristics SC and switching impulse issues should be directed to the Dielectric Test SC.

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

The Working Group met on Monday, October 25 at 1:45 PM. There were 27 members and 39 guests in attendance, with 1 person, Pritpal Singh, consultant, requesting membership. The chairman reported that the roster has been reviewed recently, resulting in 7 inactive members being removed. With the addition of the new member above, the Working Group membership now stands at 60 .

Following introductions, the minutes from the March 8, 2004 San Diego meeting were approved as submitted.

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

Subhash Tuli reported that the latest draft of standard C57.12.00 will be re-circulated in mid-December 2004.

The Working Group then began discussing the topics of old business, as follows :

WG Item 53, C57.12.00 Table 19, request to make the zero sequence impedance test a "Routine" test requirement for transformers with wye connected high-voltage and low-voltage grounded neutrals with a low side voltage greater than 600 volts and a rating greater than 2500 kva.

There was an exhaustive and lively discussion on this topic. Joe Foldi noted that zero sequence impedance tests are usually done at 10 to 15% of the rated current to avoid tank heating and core saturation effects, and that zero sequence impedance is not linear and may be quite different at full load and/or during a fault condition. It typically is less than the tested value due to the effects of saturation. Another comment was that sufficient measurements are needed to be able to calculate the resistive and reactive components correctly as required for the test report specified by C57.12.90. Some people voiced support for the proposal as many times users do not realize they need to request this test be performed. On the other hand, for multiple unit orders there is little value in conducting the test on identical units. Other statements were that single phase, shell form, and 5-legged core designs should be exempt from this requirement. The location of the delta winding (for tertiaries) also has an effect. Dennis Marlow noted that C57.12.90 already addresses most of these concerns, and any proposed changes to that document should be addressed by that working group. Ultimately the working group decided by a vote of 24 to 2 to make the following changes to C57.12.00 Table 19 :

1) In the column labeled "tests", the test listed as "Zero-phase sequence impedance voltage" will be changed to "Zero-phase sequence impedance voltage and load loss".
2) The columns will be marked to require this as a "Routine" test and a "Design" test, and the mark will be removed from the "Other" test column.
3) A new note 18 will be added which reads "Zero-phase sequence impedance shall be a routine test for Class 11 transformers, and a design test for Class 1 transformers, having a neutral brought out. This test is not applicable to single-phase, shell-form, or transformers with 5-legged cores."

WG Item 54, C57.12.00 Table 19 and Section 8.2, request to add winding DC resistance measurements as a requirement for buried tertiary windings.

The Working Group began this discussion by noting the difficulty of performing this test compared to the benefits received from it. There did not appear to be much support for this proposal, but as time was expiring, the chairman decided to continue the discussion at the next meeting.

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

- 12 members and 22 guests attended, with 2 guests requesting membership.
- Minutes from the San Diego meeting, Mar 9, 2004, were read and approved.
- 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 given.

- Eddie So is still recovering from his illness and thus the TF meeting for "Guide of Low Power Factor Power Measurements" was canceled. It was hoped that Eddie would be able to attend and hold the next meeting.
- Frequency Conversion Factors of Transformer Performance Parameters
- Revised wording in C57.12.90 Section 9.4.3 (Impedance voltage) – The WG agreed to and discussed the following:
  - The WG was presented x/r ratios for distribution transformers in the range of 5 to 20. Several members commented that in fact the x/r ratio could be as low as 1 for distribution transformers. It was agreed that the error for the frequency ratio for impedance voltage would be too high for distribution transformers (up to 5% error). Thus, for distribution transformers the emphasis for load loss measurement should be put on having the correct rated current.
  - The following revisions were agreed to in the third paragraph –first sentence the "should" should be a "shall", in the last sentence the "should" to "would".
  - The proposed wording with the above changes was approved by the WG.
- Revised wording in C57.12.90 Section 12.4.7 - Short Circuit Test – The WG reviewed and reaffirmed the wording with no changes.
- Revised wording in C57.12.90 Section 11.7 - Temperature Rise Test – The WG agreed to the following:
  - In the section on the fact that direct hot spot temperature measurements would not be valid, it was agreed that the following wording should be added "would need to be corrected for winding eddy losses at the rated frequency" instead of "would not be valid since the winding eddy loss will be not be correct"
  - There was discussion on the fact that the calculated heatrun current would only be valid for the initial estimate of the heatrun current. The Chairman agreed to develop revised wording for this and replace the second sentence.
- Revised wording in C57.12.90 Section 8.6 – No Load Loss and Exciting Current. The WG reviewed and reaffirmed the wording with no changes.
- Revised wording in C57.12.90 Section 13.3.7 – Audible Sound Emissions – The WG agreed and discussed the following:
  - The WG reviewed and agreed to a direct analytical method to convert the ONAF sound level from non rated to rated frequency. It was agreed that the manufacturer shall provide an adequate supply to operate the cooling equipment at the rated frequency.
  - Proposed wording to encompass the ONAF conversion was shown. The following changes were agreed to: remove LP_{Amb} from the list of the variables, add "corrected for ambient" to $LP_{ONAN-50}$ and $LP_{ONAN-60}$.
  - With the above changes, the wording was agreed to by the WG.
- Revised wording in C57.12.00 Table 19 Note – The WG agreed to the following:
  - Add "at the tender stage" to the end of the phrase: "then upon mutual agreement with the customer"
- The text additions to C57.12.90 and C57.12.00 for the 50 to 60 Hz frequency conversions is now complete for all performance parameters and will be sent for survey to the WG and PCS survey shortly
- Other Business from a previous meeting:
  - A point was raised at a previous meeting as to the limit of how much load loss should be corrected if not exactly rated current is applied. There is presently no limit in 12.90. It was agreed by the WG that even measured losses lower than 50% of rated current were accurate. In fact it can be more accurate since the windings would not heat up as quickly. The WG agreed that no changes to the wording are required in 12.90 or the loss guide on this matter.

- New Business – The WG suggested new discussion items for future meetings:
  - Investigate the errors in the temperature rise measured values due to corrections and assumptions.
  - Overload test at different frequencies
  - Zero sequence impedance and losses
  - Investigate the total error for load loss in all corrections due to temperature and other factors. There is a paper that discusses these matters that can be used as reference.

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

The Working Group was called to order at 8:04 AM on October 26, 2004. There were 63 attendees, 33 members, 3 requesting membership, and 27 guests. The agenda for the meeting was reviewed, and the Minutes from the March 9, 2004 meeting in San Diego California were approved. Copies of both the minutes and Draft 1.7 of the guide were distributed.

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

Draft 1.6 of the guide was sent to Performance Characteristics Subcommittee as well as members of the working group to request feedback. There were 12 responses, which could be categorized into four areas:

- Typos, and spelling errors
- Rewording and clarification of grammer
- Re-drafting of figures is needed
- Technical comments

Prior to discussing the technical comments Gustav Preininger made a presentation considering the assumptions that must be made to develop a typical ladder model of the transformer to study transformer breaker interactions. Of particular concern is the determination of the parallel capacitance in the model. If it is assumed the voltage distribution is linear across the winding, and working with the energy stored in each parallel capacitor, a value can readily be calculated. However it must be understood that such a model would only be appropriate up to 150-250 kHz, probably adequate for considering a standard lightning impulse or most of the interactions this guide describes. If higher frequencies are of interest all winding and turn-to-turn capacitances would have to be considered. It is important to recognize that the model selected has to be appropriate for study of the transient applied to the transformer terminal.

The committee then reviewed the technical comments received, and two areas were identified for discussion. First, there was a request for a simple rule of thumb that could be applied. The group has discussed this previously, and again concluded that there were too many variables to consider. However the group suggested instead that the circumstances surrounding such interactions could be listed so that a user may consider further study. It was suggested that the items to be considered by a user are:

- Lightly loaded transformers
- Breakers that are switched frequently
- That arrestors alone are not adequate to protect a transformer from interactions

- Application of snubbers can be a simple economic solution to interaction problems.

The rules of thumb identified, generated a discussion on arrestors and their impact on transformer breaker interactions. Several examples of failures were described and considered the location of the arrestors as well as the location of failures within a transformer. The salient points discussed were that arrestors may not provide protection for very fast transients or transformer breaker interactions, and that location and lead length for an arrestor are critical.

The second technical comment discussion area was the consideration to address additional topics in the guide. Suggestions were to consider phase-to-phase voltages generated by switching; a lack of phase-to-phase protection in delta or ungrounded windings; the effects of disconnects as well as breakers at transformer terminals; and part winding resonance. The consensus of the group was that these topics would be considered in future revisions of the guide.

Two figures were added to the guide to help display the statistical nature of breaker characteristics. The first illustrates breaker transient recovery voltage characteristics, and the second arcing time/breakdown time for two types of vacuum interrupters.

Next steps are to incorporate this meetings comment, to rework the figures to meet publishing requirements, a final review by IEEE editorial staff, and to send the guide out to ballot by years end.

Under old business, Ramsis Girgis, discussed another transformer interaction problem, the failure of GSU's under backfeed conditions. Approximately 42 of these failures have been reported in the last 30 years, and are generally the results of high voltage transients simulating a resonance in the transformer when little or no damping is present. It was suggested that this is an area that the working group should consider after the completion of this guide, as there is little guidance available in this area.

New business discussions indicated that CIGRE would be holding a Transformer Colloquium in June or July next year in Moscow.

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

The W.G. met in the Estancia D Meeting Room of the Green Valley Resort Hotel in Las Vegas, Nevada on Oct. 25, 2004 from 11:00 a.m. to 12:15 p.m. There were 8 members and 3 guests present. The following are highlights.

1. The minutes of the W.G. meeting in San Diego were approved.

   NOTE: The minutes of the Las Vegas W.G. meeting will not be formally approved until the W.G. meeting in Jackson Mississippi.

2. IEEE patent policy as related to standards development was reviewed; details in registration package. Attendees were asked if they knew of any patents that would impact the implementation of the revision of IEEE C57.21. None were noted.

3. The reaffirmation process for IEEE C57.21-1990 (R1995), the current version, is now complete. IEEE Standards Board approval was obtained at the June 24, 2004 meeting.

4. Draft #2 of the revision of C57.21, prepared by the Chairman was discussed. The following are the key points.

   (i) Input/comments provided by Sten Andersson will be included in Draft #3. A copy of his input will be provided by e-mail to W.G. members.

   (ii) Pierre Riffon lead off discussions re the audible sound test; Clause 10.6.3.3. The audible sound type test must be carried out at full operating temperature. This will reflect in-service operating conditions. If a temperature rise type test is conducted, the audible sound type test can be conducted at the end of the temperature rise type test as it will ensure the unit will be at full operating temperature. The temperature rise type test and audible sound type test must be conducted at maximum operating voltage. If no temperature rise type test is carried out (similar type test report available) but an audible sound type test is required, sound level measurements must be made with the unit at operating temperature. This can be demonstrated when the measured sound level stabilizes within $\pm$ 2 dBA. The other approach is to reach an agreement between purchaser and manufacturer as to when the unit is near operating temperature; multiple of the thermal time constant.

   (iii) The test values in Table 5 for 765 kV should be reviewed. The notes to Table 5 will also be reviewed for consistency. Duration, magnitude and methodology for the low frequency test will also be reviewed; 2 columns -69 kV and below and above 69 kV. Pierre Riffon will make the revisions.

   (iv) The proposal to extend the turn-to-turn test, as an alternate to the impulse test, to oil immersed shunt reactors was discussed. Sten Andersson will provide input before the next W.G. meeting re the suitability of the test methodology and equipment availability. It should be noted that in the current revision of the IEC reactor standard, the Turn-to-Turn Test is applicable to dry type shunt reactors and not oil-immersed shunt reactors. This is the practice in the current version of IEEE C57.21. Should this be maintained in the revision?

   (v) Fig. 3C should be clarified. The crest voltage value “read out” is different from that obtained from the “graph” waveshape. Is the recorded value based on “smoothed” waveshape. How should the observed oscillation be handled? The Chairman agreed to investigate and make appropriate changes.

   (vi) Table 4A was discussed. It was proposed to make the Vibration Test a type test and add an additional “walk around” sound test as a routine test for oil immersed shunt reactors. The “walk around” test is conducted using an integrating sound level meter. The tests are carried out with the shunt reactor “cold”. However, in order to provide a calibration point a “walk around” sound test should be carried out at the beginning of the audible sound type test; unit cold.

(vii) Should the audible sound type test methodology be changed to reflect the standard use of integrating sound levels which allow a "walk around" procedure? The answer seems to be YES. The Chairman will change the test code in Draft #3.

8.11.5.6 TF for Revision of C57.110 – IEEE Recommended Practice for Establishing Transformer Capability When Supplying Non-Sinusoidal Load Currents – Rick Marek, Chair; Kent Haggerty, Co-Chair

The meeting opened with introductions and Kent Haggerty was introduced as the Co-Chair. The Chairman indicated that this was the first meeting and that it would be a Task Force meeting, since there was no PAR. Signup sheets were then passed around requesting volunteers for membership on the Working Group.

The IEEE Patent presentation slides #1 and #2 were shown to the Task Force and they were advised that:

- The IEEE's Patent Policy is consistent with the ANSI patent policy and is described in Clause 6 of the *IEEE SA Standards Board Bylaws*;
- Early disclosure of patents which may be essential for the use of standards under development is encouraged;
- Disclosures made of such patents may not be exhaustive of all patents that may be essential for the use of standards under development, and that neither the IEEE, the WG nor the WG Chairman ensure the accuracy or completeness of any disclosure or whether any disclosure is of a patent that in fact may be essential for the use of standards under development.

An opportunity was provided for TF members to identify or disclose patents that the TF member believes may be essential for use of that standard. No responses were given.

The Chairman gave a brief historical background on the C57.110 document and a summary of the last revision. In the last revision, H_{FL} was defined and liquid-filled formulas and examples were added to the document. The definition of K-factor was also clarified in the context of the new definitions.

The Chairman noted that a PAR request had been submitted, but was rejected by NESCOM on the grounds that the word transformer in the title was not sufficiently descriptive. Since several appeals by Bill Chiu and Ken Hanus failed to convince NESCOM, it was agreed to change the title, rather than continue the debate. The new title will add the words "liquid-filled and dry-type power and distribution" before the word "transformer".

The Chairman noted that revision of the document is necessary as a resolution to a negative ballot received during the reaffirmation process. This ballot also resulted in an errata sheet. The Chairman will correct the errata sheet items.

Phil Hopkinson noted that one change over the years since the 1998 printing was that key learnings have been gained on transformer loading patterns. He also noted that reproducing test conditions in the lab is difficult. The Chairman agreed that there was no good test that accurately duplicated the harmonics. A guest commented that there is now a solid state AC source that is programmable and can provide a wide range of harmonics.

He and Chuck Johnson offered to provide information, which will then be passed on to all present. It was also suggested that this could be an interesting tutorial topic. The Chairman noted that this is one example illustrating the need to reevaluate and update the document.

All members were requested to provide the Chairman with information on papers and other technical information that should be added to the bibliography. A guest questioned whether the affects of current harmonics on core loss should be added to the document. He referred to a paper that indicated a very large increase in core loss due to current harmonics. The paper will be reviewed by several of the members to determine appropriate action.

The Chairman reviewed some of the many comments and editorial corrections that were submitted for the reaffirmation process. All were minor errors, which will be corrected by the Chairman. He also noted that he would review the whole document for consistency in the use of decimal places. Ramsis Girgis suggested limiting the numbers to just two decimal places, due to the approximate nature of the calculations.

Another comment from the reaffirmation process noted the weak coverage in the document on 3rd harmonics in general and specifically the need for additional treatment on excessive heating of neutral bus due to 3rd harmonics. Phil Hopkinson offered to provide information to the group from power quality experts. He will also review the section for improvement.

The Chairman will provide the discussed information to all present. The members will also receive a copy of the latest version of the C57.110 document. A number of volunteers were requested and assigned specific tasks that are due by mid-December.

- Ramsis Girgis volunteered to review the abstract and introduction and update if necessary.
- Sheldon Kennedy and the Chairman will compare and harmonize the symbols and key formulas in C57.110 and C57.18.10.
- John Crouse, Tim Lewis, Subhas Sarkar, Phil Hopkinson, Chuck Johnson, and Ramsis Girgis volunteered to review the whole document for upgrades.

15 requested membership in the Task Force and there were 13 guests.

8.11.5.7 Semi-Conductor Rectifier Transformers, C57.18.10, WG – Sheldon Kennedy, Chairman

The Task Force met on Monday, October 25, 2004 at 3:15 PM with 10 members and 4 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 2004 meeting in San Diego, California were approved.

Comments received during the 2003 reaffirmation of C57.18.10 required action to resolve the negative votes received. The Task Force decided to have a corrigenda revision of C57.18.10 to correct the errors and missing or undefined terms. Technical comments will

be worked on during a full revision process following the corrigenda revision. The proposed corrigenda PAR was reviewed and approved by the task force. This PAR will be submitted by the chair following the meeting.

Items from the comments for editorial corrections received during the reaffirmation were reviewed. Members were encouraged to review the standard for any editorial errors.

Technical comments received were also discussed, but these will be tabled until the full revision process. Clarifications of the routine, design and other tests were discussed. No table exists showing these concisely and it may be recommended to add this. Some of the standard language is confusing on some of the tests.

A statement was requested giving clarification of the differences between dedicated rectifier transformers covered by C57.18.10 and transformers serving distributed loads containing harmonic content covered by C57.110. The chair informed the working group that C57.110 was also beginning a revision process. The chair also pointed out that C57.18.10 states that it is for dedicated rectifier loads.

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

The working group met at 9:30 am on Tuesday, October 26, with 16 in attendance. There were 7 members and 9 guests. One of the guests requested membership and will be added.

Introductions were made and the group was asked if they had any knowledge of the possibility of any patents, which may be essential to the implementation of the Standard. The response was negative.

The roster was handed out, as well as copies of Draft 2 of the Standard, which had been previously emailed, and an IEC draft concerning arc suppression reactors. The new AM system was discussed, and attendees were requested to ensure that they are registered with this system in order to receive future emails concerning this Standard.

A list of major changes to Draft 2 was reviewed. These changes include: adding an introduction, table of contents, and reference standards; updating the definitions and moving them to the front of the guide; re-creating two tables that were not available electronically; formatting the equations in MathType; adding missing tables and a bibliography. Thanks were given to Devki Sharma, Peter Balma, Richard Dudley and Klaus Papp for help in these revisions.

The IEC draft on arc suppression reactors was briefly discussed. Richard Dudley volunteered to work with Klaus Papp to edit this section for inclusion in the next draft of PC57.32. It was pointed out that the symbols in the IEC draft would need to be aligned with IEEE symbols. The IEC reactor standard was discussed, and Richard mentioned that it does not contain information on resistors or neutral grounding devices. It was pointed out that we would need to add definitions to the Standard once the arc suppression reactors section is added.

The definitions were briefly discussed and it was agreed that any definitions already listed in C57.12.80 would be removed from the Standard.

Section 4 on Service Conditions was discussed. It was decided that Section 4.2 needs to point out that neutral grounding devices are often mounted on other equipment, resulting in higher effective ambient temperatures.

Section 5 on Operation at Altitudes in Excess of 3300 feet (1000m) was discussed. Table 2 was discussed and the group determined that it is an accurate table. Meters will be listed first in the next revision.

Section 6 on Basis for Rating was discussed. Table 4 lists the continuous duty rating of resistors as 0% for any rated time and the accuracy of this was questioned. It became evident in the discussions that we need input from manufacturers of neutral grounding resistors and capacitors. Peter Balma and Richard Dudley volunteered to make contact with them and solicit input. Steve Schappell volunteered to review the grounding transformer section.

It was pointed out and agreed that Table 1 "Limits of Temperature Rise for Neutral Grounding Devices at Rated Continuous Current" should be moved to Section 8 on Temperature Limitations and the definition for insulating materials deleted. Richard Dudley agreed to revise Table 1, using input from C57.16 and C57.21.

The group discussed how the test code should be handled for the Standard. The options are to have one test section, or a test section for each type of device. It was noted that Table 5 lists X/R and Table 11 lists R/X and they need to be aligned. Table 6 on Insulation Classes was briefly discussed. It was questioned whether 230kV class devices were used, and the response was affirmative.

The members and guests were asked to email further comments to the Chairman to incorporate into Draft 3 before the next meeting.

8.11.5.9 PC57.149 – Guide for the Application and Interpretation of Frequency Response Analysis for Oil Immersed Transformers – Chairman; Charles Sweetser

WG PC57.149 met for the development of a guide for Frequency Response Analysis (FRA) in Las Vegas, Nevada on October 26, 2004 at 3:15 P.M. There were 44 persons in attendance, 21 members and 23 guests of which 3 guests requested membership.

The FRA Working Group meeting was called to order at 3:15 PM.

The first order of business was to show the two slides regarding patents & inappropriate behavior. Larry Coffeen indicated that he has patents related to the subject of our work. Larry agreed to provide the WG Chair with the administrative details for the patents.

The minutes from the last meeting were presented and approved without comment.

It was announced that the IEEE Task Force became an official Working Group on June 24, 2004. The new title is: PC57.149 – "Guide for the Application and Interpretation of Frequency Response Analysis for Oil Immersed Transformers."

Charles Sweetser presented a brief report on what had been done in the last six months. The latest contributions were identified and discussed. The major contributors were Paulette Payne, Bertrand Poulin, and Subhash Tuli. Each section was then discussed.

- **Section 1:Scope and Application** – Progress has been made on this section. The definition section is not yet completed and roughly 20 definitions are still needed. Roger Verdolin offered to provide the first round of needed definitions, and Mark Perkins offered to review this work. Larry Coffeen asked about how the WG plans to define the "impulse method". It was recommend that the WG possibly redefine the "impulse method" as the "time domain method".

- **Section 2: Test Parameters** – The topic of measurement impedance dominated this discussion. The advantages and disadvantages of using measurement impedances, such as 0 Ohms, 10 Ohms, 50 Ohms, and 1 MOhm were presented. Other issues were also raised in Section 2, such as frequency range, specific standard for calibration, and types of co-axial cable, however these parameters will most likely be specified by the end user.

- **Section 3: Measurement Parameters (test plan)** - Charles Sweetser presented information related to various FRA test types and test connections to generate discussion. Issues such as recommended tap positions were also raised. Four test categories were also presented and defined; Open Circuit, Short Circuit, Inter-Winding, and Transfer Admittance. There was considerable discussion regarding phase convention and test order. Most of these issues do not appear to be resolved at this point. Bob Degeneff also brought to our attention that he wants any definitions in this Section and in Section 1 to be check with any existing IEEE definitions that may already exist.

- **Section 4: Test Records** – This section appears to be complete for the first draft. The WG agreed that the data format must remain open. Proprietary formats should be discouraged.

- **Section 5: Analysis and Interpretation** – The WG agreed that this section is in poor condition. In past revisions, this section has been filled with case studies that have often been misleading. The WG would like to see work done in the area of computer modeling analysis. This analysis should be applied to various transformer designs to see how the results compare to actual measurement. Mark Perkins requested that this section contain a realistic assessment of what FRA can do. Charles Sweetser, Larry Coffeen, and Richard Breytenbach will review and edit this section for the next meeting.

- **Section 6**: **Appendix I –** Bob Degeneff will continue to the lead contributor to this section. Roger Verdolin volunteered to review Section 6.

Charles Sweetser provided an update as to the status of the CIGRE FRA Working Group A2.26. The CIGRE and IEEE FRA Working Groups established a liaison relationship earlier this year. Charles stated that WG A2.26 plan to have their first draft completed by January 2005. This draft will be available to PC57.149 for our group to review. The WG A2.26 draft will consists of three primary sections; Introduction for New FRA Users, Techniques, and Interpretation.

Ramsis Girgis announced that Charles Sweetser will be the new WG Chair for WG PC57.149.

8.11.5.10 Core Overexcitation TF – Craig Steigemeier, Chairman

The meeting took place at 8:00am on October 26th, 2004. There were 70 total attendees, of which 44 were members and 26 guests. 22 new members requested membership and will be added to the Task Force roster. This was second meeting of the Core Over-excitation Task Force. This Task Force is charged with the identification of limits for core over-excitation and coming up with suggestions for modification of appropriate standards.

At the beginning of the meeting, the IEEE patent policy and the meeting room WiFi capabilities were reviewed. No one offered the chairman suggestions of patentable work or identified any inappropriate topics covered during the meeting.

Based on input from the spring San Diego meeting, suggested 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) were presented and discussed. Also, core hot spot temperature limits were reviewed.

Suggestions made during the meeting after review of the suggested changes include:

- instead of using 130°C, use the 90°C rise over the 40°C ambient for clarity
- address core hot spot when overexcitation occurs in lightly loaded situations
- consider the core formula in IEC standards
- consider setting induction limits, but must consider core material and construction
- refer to C57.116 for consistency – both in terminology and details like power factor
- consider using a curve for temperature/overexcitation (attendees will send Chairman examples/suggestions)
- in addition to the GSU and system tie transformers, consider adding a third category for "other" transformers that are designed only for step-down operation
- insure consistency in the use of rises versus absolute temperatures
- address boundary conditions - such as number of fans in operation and material
- develop and include a core hot spot calculation similar to the winding hot spot calculation

In general, most attending seemed to prefer to keep the modifications as simple as possible, while coming up with something adequate to address concerns over the adequate handling of overexcitation situations.
The Chairman will modify the changes based on the comments from the meeting and review it with a volunteer group including representatives from the following 3 manufacturers and 10 utility/consultants:

Peter Balma – PSE&G
Ed teNyenhuis - ABB
Donald Chu - ConEd
Ramsis Girgis - ABB
Peter Heinzig - Siemens
Harold Moore - Consultant
Rowland James - Entergy
Miguel Oliva - ABB
Bipin Patel – Southern Company
Stephen Beckman – Fort Pierce
Gustav Preininger - Consultant
Bob Tillman – Alabama Power Co
Subhash Tuli – Waukesha Elec Sys
Loren Wagenaar – AEP

Dieter Wagner – Hydro One Peter Zhao – Hydro One

8.11.6 Project Reports

8.11.6.1 Status of C57.133 - Guide for Short Circuit Testing - Nigel McQuin, Chairman

IEEE removed the PAR of this Guide and therefore the document has been withdrawn. Niguel was absent from this meeting. The PCS and Standards SC are in the process of deciding whether to send the manuscript as is to a reaffirmation ballot or revise the Guide with technical updates and improved clarity graphs / pictures before sending it for ballotting. The second proposal will require forming a TF to produce the revised document.

8.11.6.2 Measurment of "Zero Sequence Impedance" for transformers with interconnected windings – Ramsis Girgis

A group of six SC members met to review and confirm accuracy of the method suggested by Gerry Rosselli and to develop appropriate text to describe the test for implementation in C57.12.90. This text will be reviewed in the spring meeting of that WG. Bruce Forsyth was given the responsibility of chairing this group.

8.11.7 Tutorial Session on "Taps" – V. Sankar

Mr. Sankar gave this tutorial. He presented types of Taps, Tap windings, TCs, and design strategies. The main recommendations by Sankar were that Specifications should not restrict design options and that users should confirm the requirements of the specification and should work together with suppliers developing the specifications. He also suggested not requiring DETC.

8.11.8 Old Business

None

8.11.9 New Business

- A motion was made by Jerry Cockran to move the DGA Guide C57.104 from under jurisdiction of Insulating Fluids SC to PCS. A number of SC members commented on the proposal and it was agreed that Jerry will submit in writing the technical reasons for his request and that the Admin SC will study those reasons and make a decision.

- Another request was made to examine C57.12.00 clause 7.1.1 regarding the MVA reference for the temperature gradient testing of TV windings.

Attendance at this Las Vegas Meeting

MEMBERS

1. David Aho
2. Ray Ahuja
3. Dennis Allan
4. Stephen Antosz
5. Jim Antweiler
6. Peter Balma
7. Ronald Barker
8. David Barnard
9. Barry Beaster
10. Steve Beckman
11. Wallace Binder
12. William Boettger
13. Jeffrey Britton
14. Bill Chiu
15. Craig Colopy
16. Jerry Corkran
17. John Crouse
18. Alan Darwin
19. Ron Daubert
20. Robert Degeneff
21. Richard Dudley
22. Reto Fausch
23. Joe Foldi
24. Bruce Forsythe
25. Bob Ganser
26. Eduardo Garcia
27. A. Garnitschnig
28. Harry Gianakoros
29. Ramsis Girgis
30. Myron Gruber
31. Robert Grunert
32. Ernst Hanique
33. Bob Hartgrove
34. Peter Heinzig
35. Bill Henning
36. Thang Hochanh
37. Philip Hopkinson
38. Rowland James
39. M. Jaroszewski
40. Sheldon Kennedy
41. Vladimir Khalin
42. John Lackey
43. Richard Marek
44. Dennis Marlow
45. John Matthews
46. Van Nhi Nguyen
47. Samuel Oriti
48. Mark Perkins
49. Don Platts
50. Christoph Ploetner
51. Bertrand Poulin
52. Gustav Preininger
53. Mark Rivers
54. Marnie Roussell
55. Steven Schappel
56. Ewald Schweiger
57. Devki Sharma
58. H. Jin Sim
59. Steve Snyder
60. Andy Speegle
61. Andy Steineman
62. Craig Steigemeier
63. Bob Tillman
64. Subhash Tuli
65. Loren Wagenaar
66. Peter Zhao
67. Waldemar Ziomek

GUESTS

1. Roger Verdolin *
2. Pierre Riffon
3. Ramon Garcia
4. George Tolbert *
5. V. Sankar
6. Pritpal Singh
7. Saurabh Ghosh *
8. Bruce Fairris
9. Derek Foster *
10. Eberhard Lemke
11. Jesse Gill
12. Arnold Carlos
13. Eduardo Gomez*
14. Sam Mehta
15. Jerry Allen *
16. Jose Grijuela
17. Sangbong Park
18. Kent Haggerty *
19. Oleg Roizman
20. Ibrahim Shteyh *
21. Sten Andersson
22. Lars-Erik Juhlin
23. Jan Hajek
24. Martin Navarro
25. Don Russell *
26. Dan de la Cruz
27. Harold Moore *
28. R. Breytenbach
29. Robert Chang
30. Saulie Lee
31. Ernst Knoll
32. John Darby
33. Steve Northrup *
34. Dilip Shah
35. Benny Jeong
36. Girlamo Rosselli
37. Erwin Jauch
38. Alan Traut
39. Joseph Cheung *
40. Danny Bates *
41. John Haufler
42. John Herron
43. Hossein Rezaz
44. Rick Mucha
45. Frank Chmiel
46. Mahesh Sampat*

* Guests requesting Membership.