8.3 Dielectric Test Subcommittee – Loren B. Wagenaar, Chairman; Stephen Antosz, Secretary

The Dielectric Test Subcommittee (DTSC) met on Wednesday, March 16, 2005, in Jackson, MS with 61 members and 34 guests present. None of the guests requested membership in the Subcommittee. See the last page of these minutes for attendance list.

8.3.1 Chairman's Remarks

The Chair reviewed highlights of the Administrative Subcommittee meeting held on Sunday:

1) Everyone was encouraged to sign up and keep their profile information updated on the Association Management System, AMS. It will be the main method of communication. Working Group chairs and secretaries are authorized as administrators to AMS, and should be able to pull rosters, etc. from it.

2) Next meeting date and location is October 23-27, 2005 in Memphis, TN. Technical tours are planned for ABB Alamo, Reinhausen and Ermco.

3) The minutes of the Fall 2004 meeting in Las Vegas, NV were approved as written, and are available on the IEEE Transformers Committee Web Site.

4) It was pointed out that specific patent issues that have been raised at previous meetings do not have to be raised at future meetings. However, the chairs of working groups and task forces must continue to ask at the start of each meeting if there are additional patents that may be related to the work of the WG or TF, and results must be recorded in the minutes.

8.3.2 Working Group Reports

8.3.2.1 Working Group on Acoustic Partial Discharge Tests in Transformers - J.W. Harley, Chair

Attendance: 9 members and 5 guests attended the meeting. Attendees introduced themselves. The minutes from the October 25, 2004 Las Vegas NV meeting were approved. IEEE Patent disclosure requirements were discussed and a request was made for attendees to identify or disclose any patents that may be related to the work of the WG.

- Hem Shertukde stated the equipment of his company was covered by patent #6,178,386 and the software was protected by copyrights. We think the PC57.127 Draft Guide descriptions of workstation and on-line systems are general enough that there are no conflicts with the patent.
- A request for a Patent Letter of Assurance will be sent to the holder of patent #6,340,890, which covers the Three Sensor System and locator algorithm in Section 5.7 of the Guide.

The main Working Group activity is to expand and up-date IEEE PC57.127 Guide for the Detection and Location of Acoustic Emissions from Partial Discharges in Oil-Immersed Power Transformers and Reactors. The meeting activities included the following.

1. The Chair thanked members of the HVDC Working Group for their contributions to Section 9.6 HVDC transformers and reactors.

2. A new section will be added to the body of the Guide suggesting the situations in which acoustic PD tests are used.
3. Alan Darwin led a group discussion relating to (a) wording of Section 9.6 HVDC transformers and reactors, (b) changes to Annex A, the bibliography, and (c) questions from the last WG meeting about whether the Guide should recommend when to use conventional PD acoustic tests and when to use continuous on-line tests. With reference to the last item, the group decided to not make these recommendations in the Guide.
4. Dirk Russwurm's group reviewed Annex D, which has been added as a tutorial for the detection and location of acoustic emissions from partial discharges, and a number of other changes made as a result of the last WG meeting.
5. The WG approved the Guide being sent to the Dielectric Tests Subcommittee as a survey before balloting. This will be coordinated with Loren Wagenaar and Steve Antosz.

8.3.2.2 Working Group on Revision of Low Frequency Tests - Mark Perkins, Chair

The working group met Monday, March 14, 2005 at 11 am.
There were 16 members and 29 guests present. 6 guests requested membership.

After the introduction of members and guests, the chairman announced that he would no longer continue in the position, and that Bertrand Poulin would be the new chair. The IEEE patent policy was discussed as requested by the committee leadership. No one in attendance indicated any patents that were applicable. The minutes of the Las Vegas meeting were discussed, and Loren Wagenaar asked that we amend them to indicate that no one in the Las Vegas meeting indicated a patent was applicable. The minutes as amended were approved.

The report on the meeting of the task force on revision to C57.113 partial discharge guide was given by Dr. Eberhard Lemke. For specification of PD detectors measuring the apparent charge consideration must be given to PD test equipment in use today. For this purpose a Survey has been distributed before the meeting to all TF members.
The PD Survey was approved by the TF members and will be sent to all Dielectric Subcommittee Members prior to next meeting.

The comments submitted to the first draft have been incorporated in the second draft, which was distributed to all TF members. Draft 02 of C57.113 revision was reviewed and a number of changes were recommended. Harmonization with IEC 60270 is the ultimate goal, but consideration must be given to existing PD measuring systems for transformer testing, which may not meet completely the IEC requirements. The survey will help determine this. Results from the task force meeting along with the oral and written comments of the TF members will be incorporated in a third draft, which will be submitted to all TF members before the next meeting. The meeting adjourned at 9:30.

The next item of business in the working group was the special test procedures being used on single-phase distribution transformers with a permanently grounded high-voltage winding terminal be incorporated into C57.12.00. The following wording was approved: For single-phase transformers with a BIL of 150 kV or less that have only one high-voltage bushing, the high-voltage neutral terminal permanently connected to ground, and no secondary windings permanently grounded, no applied-voltage test is required. These transformers shall receive an induced-voltage test between the HV terminal and ground with duration of 7200 cycles but not less than 15 seconds. This voltage shall be 1000 volts plus 3.46 times the rated transformer winding

voltage, but in no case shall the line-to-ground voltage developed exceed 40 000 volts for 125 kV BIL or 50 000 volts for 150 kV BIL. An applied potential test shall be applied to all windings that are not permanently grounded. Coordination needs to be done with the group on 3 phase distribution transformers.

The group then discussed comments from the last 2 ballots of C57.12.00. The responses will be forwarded to Subhash Tuli so that the reviewers can be notified.

The working group then discussed a proposal by Subhash Tuli for low frequency dielectric testing of buried tertiary windings. The consensus of members was not reached, so the discussion was tabled.

8.3.2.3 Working Group on Revision of Impulse Tests – Pierre Riffon, Chair; Peter Heinzig, Vice-Chair

The WG met on March 15, 2005, from 3:15 pm to 4:30 pm. Twelve members and twenty-three guests attended the meeting. Four guests requested membership. The agenda was accepted as written. The minutes of the Las Vegas meeting were approved as written. The IEEE patent disclosure requirement policy was discussed. Reference to the package posted on the IEEE Transformers Committee Web site was made. None of the members and guests present during the meeting were aware of any patents related to the work of the WG.

1. The first technical subject on the agenda was to discuss the switching impulse test waveshape polarity. The actual clause 10.2.2.1 of IEEE C57.12.90 specifies that either negative or positive polarity switching impulses may be used for switching impulse tests. IEC 60076-3 specifies that negative impulses have to be normally used for switching impulse tests in order to avoid risks of erratic external flashover. IEC 60076-3 does also call for an additional switching impulse type test with positive polarity waves for demonstrating the dielectric withstand of air clearances for cases where the air clearances are shorter than prescribed.

For oil-paper insulation structures as used in power transformers, the waveshape polarity has more or less no influence on the dielectric withstand. Nevertheless, for air gaps, the positive polarity is the most onerous polarity and the dielectric withstand is significantly less than for negative polarity impulses. After discussion it has been agreed upon:

- Only negative polarity impulses shall be used for demonstrating the transformer voltage withstand during switching impulse tests. The wording of clause 10.2.2.1 of C57.12.90 will be modified as follows:
  "Negative polarity waves shall be used".
  It has been also decided that the wording of the Impulse Test Guide (C57.98) to be modified accordingly together with an explanation that this is for avoiding erratic external flashover. This request has been forwarded to the WG chair responsible of the revision of C57.98.
- It has been also decided that the voltage withstand of air clearances (phase-to-ground and phase-to-phase) does not need to be demonstrated by an additional switching impulse test using positive polarity waves because phase-to-ground and/or phase-to-phase clearances have not been a problem in service so far.

2. The second technical subject on the agenda was the review of the survey made on impulse test procedure for transformers having non-linear devices. The survey has been sent to the Dielectric Tests SC chair on October 27, 2004. Because of the difficulties experienced by transmitting attachments to Emails, the survey was never made. In order to overcome these difficulties, the proposal has been already posted on the IEEE Transformers Web site and the request for survey within the Dielectric Tests SC membership will be posted by using the AM system before the end of March 2005. Moreover, a reminder notice will also be sent to the Dielectric Tests SC membership a week prior to the deadline date also by using the AM system. With such a procedure, the WG feels that the problems experienced will be solved and that the survey procedure will be improved.

3. The third technical subject on the agenda was the review of the survey made within the WG membership on October 2004 concerning the revised proposal on lightning impulse test procedure for cases where the tail time of the impulse waveshape can not be obtained. Out of 51 survey requests sent, only 6 responses have been received. Here also, approximately half of the WG membership did not receive the attachment to the Email. Nevertheless, the number of responses received was quite disappointing and the WG chair pointed out that it is the responsibility of the WG members to respond to surveys. Out of the 6 responses received, 4 were affirmative and 2 negative. The responses received together with the two negative ballots were reviewed and it has been agreed upon that:

- The title of the table stating the minimum recommended impulse generator capacitance and energy will remain as stated in the document surveyed.
- The time frame where the notice to be given by the manufacturer in case where the tail time can not achieved has been lengthily discussed. Several counterproposals have been proposed and none of the proposal got significant acceptance. Among the counterproposals made, the notice may be given at the time of bidding, prior to contract or prior to final electrical design or design review if applicable. Because a clear lack of majority during the WG meeting and the lack of responses received on the survey, it is more likely that the same proposal as surveyed will be proposed once more.
- In order to overcome the difficulties experienced by sending attachments to Emails, the proposal will be also posted on the IEEE Transformers Web site and the request for survey within the WG membership will be sent by using the AM system before the end of March 2005. Moreover, as also decided for the impulse test procedure on transformer having non-linear devices, a reminder notice will be sent to the WG membership a week prior to the deadline date.

Because the WG meeting was running out of time, the remaining parts of the agenda were not discussed and will be added on the agenda for the Memphis meeting.

8.3.2.4 Working Group for Revision of the Impulse Test Guides C57.98 and C57.138 – Art Molden, Chair; Joe Melanson, Secretary

The WG met at 3:15PM on Monday March 14, with 39 attendees present of which 8 were members and 31 were guests. Chair Art Molden was unable to attend due to previous commitments, so Secretary Joe Melanson chaired in his place. Art sends his apologies.

The IEEE Patent Policy slides were reviewed with the group. The group was polled to see if there were any known patent issues to disclose relative to this standard. None were indicated by any of the attendees.

The Minutes of the last meeting in Las Vegas were approved.

Under Old Business, the group was shown the extensive revisions to the Guide put on the grouper for their review and comment by Art Molden. The group was encouraged to review the document and send any comments to Art Molden or Joe Melanson. NOTE: Subhash Tuli indicated after the meeting that he will forward some digital oscillograms for inclusion in the revised Guide.

Moving on to New Business, the group was asked to assist with the submittal of existing digital records of impulse tests that could be used to update the standard with current digitizer outputs. The manufacturers were asked to submit any records that they could in ASCII format so that they could be imported into EXCEL. They were informed that the records would be kept anonymous.

Joe Melanson discussed the use of Transfer Function by some of the test labs that have the software on their digitizers. The idea is to include information in the standard describing the operation and implementation of the software as a tool in the testing of transformers.

Thang Hochanh was introduced and presented a project on Transfer Function that he is coordinating with other test labs. The study will incorporate Transfer Function results submitted for evaluation from all of the participants. The information results will be presented to the Working Group at a later meeting for consideration and possible inclusion in the standard.

Bertrand Poulin commented on the development of the Transfer Function that he was personally involved with for more than 20 years. He provided slides and records of examples of Transfer Function analysis that he has made that show a need for further study and development of an "index" to support the reliability of existing software. He indicated that it is often difficult to judge the quality of the output waves. The transfer function is used by some test laboratories to determine whether the differences in the voltage and current waveshapes are due to problems inside or outside of the transformer. It would be helpful to have some type of indicator, and he has developed a rough tool that indicates whether or not there is sufficient magnitude of signal available at given frequencies. The tool is based on the resolution of the amplifier used. The criterion that Bertrand uses is for signals that are less than 1% of amplitude and yield an index of less than one. Several comparisons were shown including: 1) reduced and full waves showing a successful comparison, 2) reduced and full waves showing a failed comparison and therefore a problem within the transformer, and 3) full and chopped waves showing a successful comparison. In general, whenever the index is unity within the corresponding frequency region, and the transfer functions of two waveshapes agree, then the test is successful. Conversely, whenever the index is less than unity and the transfer functions do not agree within their frequency region, then the statistical test is not successful. Bertrand suggests that suppliers of digital impulse recorders may need to be contacted to develop systems to determine such an index.

Subhash Tuli proposed that a tutorial be presented to the group detailing the application and uses of the Transfer Function be made at the next meeting. Mr. Poulin was asked to participate and present the tutorial. He agreed, and asked that others with experience in the group also participate in the tutorial. NOTE: Ernst Hanique volunteered after the meeting to participate in the development of the tutorial. Others will be contacted for possible participation.

There were no more questions or comments and the meeting was adjourned.

8.3.2.5 Task Force on Liquid-Filled Transformers Dielectric Test Tables – Phil Hopkinson, Chair; Scott Choinski, Secretary

The working group met on March 15, 2005 at 1:45 PM with 43 participants present. The following comments received on Revision 9 of these tables were discussed and resolved:

- In response to the survey, it was decided not to indicate any preferred BIL ratings in these tables.
- It was agreed that Table 1 should be split into separate tables for Distribution and Class I and Class II transformers.
- Comments from Mr. Bipin Patel were discussed. It was decided that:
  - The test tables should show Class I transformers to include units of < = 69 kV rating.
  - The applied test levels for internally grounded neutrals were discussed. It was agreed that internally grounded neutrals should not be given applied tests as stated in Note 7 of Table 7.
  - The use of 150 kV BIL ratings for neutral terminals for windings >= 362 kV rating was discussed. It was agreed that the min BIL rating of 110 kV as shown in Table 1b will be acceptable.
- Mr. Pierre Riffon expressed satisfaction with the separated tables for Class I and Class II transformers. In response to his comments it was agreed that these Test tables express insulation levels for only effectively grounded neutral systems. Mr. Riffon will draft a note that addresses this issue.
- Mr. Gustav Preininger had pointed out that the ratio of System to Nominal voltage was not consistent. He also stated that 825kV BIL is too high for 161 kV system. He also questioned the need for Steep Front Tests.

  The WG decided that all these test values reflect historical practices and should not be changed. Steep Front tests as shown in Table 2 will also be kept in this table for reference by the use in special cases.
- Mr. Loren Wagenaar pointed out that in the present tables the applied tests cannot be directly related to BIL ratings. He also pointed out that the ratio of 2.5, as stated in Note 11 of Table 1b, between applied test and minimum neutral BIL is not consistently reflected in the present neutral BIL levels. The WG voted to remove Note 11 from the Table.

It was agreed that the test tables will be revised and sent out for WG comments. There was no new business. The meeting adjourned at 3:00 PM.

8.3.3 Liaison Reports

8.3.3.1 Surge Protection Devices – Bob Degeneff

The Working Group on Switching Transients Induced by Transformer/Breaker Interaction met at 8:00 AM on March 15, 2005. There were 69 attendees, with 32 members and 37 quests.

1. The Switching Transients Interaction Guide was sent to IEEE editors for review, and comments were received back on March 11, 2005.
2. The ballot pool will be established utilizing myBallot™ and the document will be in the hands of the balloters by mid to late April.
3. Bob Degeneff and Sam Mehta will make a presentation of this groups work to the CIGRE SC A2 Committee at the Colloquium to be held in Moscow in June.
4. The group was asked if it should continue its efforts, by investigating back-feed energization of transformers since there are many similarities to the work in C57-142. It was determined that the group should complete its current effort to ballot and publish this guide, and only then, to consider this activity.
5. Under new business Mel Smith of the Switchgear Committee asked the working group if any progress had been made in determining the typical resonant frequencies of transformers. The Switchgear Committee would like to utilize this information to determine transient recovery voltages (TRV), and would like to work with values representative of transformers currently in service. This will be a topic addressed at the next meeting. Ramsis Girgis suggested two presentations be made at a future meeting to facilitate understanding of the data required; the first by the Switchgear Committee detailing the data needed for the recovery voltage they are computing and the second, a tutorial of resonances within transformers by a member of the transformers committee.

8.3.3.2 High Voltage Test Techniques (HVTT), IEEE Standard 4 - Arthur Molden

Last meeting was Dec 20-21 in Brewster, NY. Art did not attend. There is no report.

8.3.4 Old Business

8.3.4.1 Results of Survey

A survey was conducted in January within the DTSC covering two ongoing issues:

- whether to apply impulse tests to <u>all</u> power transformers
- whether to extend the coverage of Class II transformers down to 69kV

On the first issue, there were 18 affirmative, 16 negative and 3 abstentions. On the second, there were 22 affirmative; 12 negatives; and 3 abstentions. Obviously the response was very low on both issues. The chair interpreted these results to be that neither resolution passed. Therefore both issues will be dropped.

8.3.4.2 Steep Front Test Levels

Subhash Tuli brought up the question of how to handle steep front testing when it is specified. at the Fall 2004 meeting. The test levels were removed from C57.12.00 in 1993. Should this be removed from the table as an “other” test, or not? Should the rise time and other waveshape characteristics be specified? In what form and where should this be done (in the main body or an Annex)?

This topic seems to come up again and again every few years. The collective memory was that this was voted on before and the levels have been removed and are left out on purpose. If they are in C57.12.00, it may imply promotion of this test, and that is not what the industry wants to do. However, people are still specifying the test anyway, so what guidelines are available in these

rare cases. People seem to go back to the old standards as a guide. If this is the case, then maybe they should be added back somewhere.

It was suggested that a Task Force will be formed to address this issue ("once and for all"), but no definitive decision was made on this issue. NOTE: The chair will circulate an e-mail asking for volunteers to serve on a task force to advise the proper location, if any, for specifying these tests.

8.3.5 New Business

8.3.5.1 Subhash Tuli reported that both main documents C57.12.00 and C57.12.90 will go out for ballot soon. The only changes from Draft 2 will be the editorial comments received in the previous ballot. The substantive changes are being or will be addressed by the appropriate subcommittee.

8.3.5.2 The chair will coordinate a tabulation of all the comments from the initial ballot of C57.12.00 and C57.12.90 and distribute to the appropriate WG's within the Dielectric Test SC for action.

Members Present

1. Aho, David
2. Ahuja, Raj
3. Antosz, Stephen
4. Arpino, Carlo
5. Artiega, Javier
6. Barnard, David
7. Britton, Jeffrey
8. Bush, Carl
9. Colopy, Craig
10. Corkran, Jerry
11. Crouse, John
12. Darwin, Alan
13. Daubert, Ron
14. Davis, Eric
15. Degeneff, Bob
16. Dudley, Richard
17. Elliott, Fred
18. Fallon, Donald
19. Forsythe, Bruce
20. Ganser, Robert
21. Garcia, Eduardo
22. Garnitschnig, Andreas
23. Gianakouros, Harry
24. Gomez-Hennig, Eduardo
25. Goodwin, David
26. Griesacker, Bill
27. Gruber, Myron
28. Hanique, Ernst
29. Hayes, Roger
30. Heinzig, Peter
31. Henning, Bill
32. Hochanh, Thang
33. Hopkinson, Philip
34. Kennedy, Sheldon
35. Lemke, Eberhard
36. Leuenberger, Boyd
37. Machado, Tamyres
38. Matthews, John
39. Melanson, Joe
40. Miller, Kent
41. Moore, Harold
42. Northrup, Steve
43. Perkins, Mark
44. Platts, Don
45. Poulin, Bertrand
46. Raymond, Tim
47. Riboud Jean-Christophe
48. Riffon, Pierre
49. Rossetti, John
50. Sampat, Mahesh
51. Sharma, Devki
52. Shteyh, Ibrahim
55. Speegle, Andy
56. Steineman, Andrew
57. Stiegemeier, Craig
58. Tuli, Subhash
59. Wagenaar, Loren
60. Walls, Albert
61. Ziomek, Waldemar

Guests Present

1. Sergiy Razuvayer
2. Dhiru Patel
3. Marcel Fortin
4. Jesse Patton
5. CP McShane
6. Dwight Parkinson
7. Marion Jaroszewski
8. Steven D. Brown
9. Sylvain Lapointe
10. Barry Beaster
11. Scott Digby
12. Clair Claiborne
13. Jeff Serzan
14. Miguel Oliva
15. Jose E. Grijuela
16. Craig Derouen
17. Gael R. Kennedy
18. David Dunlap
19. James Kilgore
20. Steve Jordan
21. Martin Navarro
22. Alan Wilks
23. Juan Castellanos
24. George Tolbert
25. Arturo Del Rio
26. Virendra Jhonsa
27. Christoph Schuette
28. David W. Scaquetti
29. Sten Andersson
30. Dan Dorris
31. Christoph Ploetner
32. Josh Herz
33. Oleg Roizman
34. Hossein Rezai

* Requested Membership. (None)

53. Sim, H. Jin
54. Snyder, Steve