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

The Dielectric Test Subcommittee (DTSC) met on Wednesday, March 14, 2007, in Dallas, TX with 67 of 118 members, and 71 guests present. 9 of the guests requested membership and are welcomed into the Subcommittee. See the last page of these minutes for attendance list.

8.3.1 Chairman's Remarks

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

   a) The next meetings:
      1) Fall 2007, October 14-18, Minneapolis, MN
      2) Spring 2008, March 16-20: Westin Hotel Charlotte, NC
      3) Fall 2008, October 5-9: Sheraton Hotel Porto,Portugal
      4) Spring 2009, April 19 -23, Southern US location

   b) It was noted that Steve Snyder's PCS WG on Revision to C57.12.00 is revising Table 21 Required Tests. Since some of these are dielectric tests, then this Dielectric Test Subcommittee must be involved.

   c) The very low response rate on several recent surveys of the Dielectric Test Subcommittee is cause for concern. The Chair reminded all present that it is a professional obligation of SC membership to participate in these surveys. The survey will remain open for the next several weeks to give members an extended opportunity to respond.

2) The minutes of the Fall 2006 meeting in Montreal, Canada were approved as written, and are available on the IEEE Transformers Committee Web Site.

8.3.2 Working Group Reports

8.3.2.1 Working Group on Acoustic Partial Discharge Tests in Transformers - Jack W. Harley, Chair; Alan Darwin, Secretary

Attendance: 20 members and 45 guests. Attendees introduced themselves.

The minutes from the 23 October 2006 Montreal, Canada 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. There were no responses.

The results were given for the Recirculation Ballot of PC57.127 Draft Guide for the Detection and Location of Acoustic Emissions from Partial Discharges in Oil-Immersed Power Transformers and Reactors.

1. The Recirculation Ballot was open from January 31, 2007 to February 10, 2007. There were 95 eligible people in the ballot group, 73 affirmative votes, 0 negative votes and 5 abstention votes. This gave us an 82% return, which exceeded the 75% requirement, and 100% affirmation.

2. The Guide has been submitted to RevCom and is scheduled for review at its March 21 meeting.

3. One of the figures in a Case Study in Annex D does not print well. The possibility of enhancing the figure is being discussed with a member of the WG and the IEEE editor. If the figure cannot be improved, the WG has agreed that the Case Study should be deleted so that the approval process can continue.

Bob Langan made a presentation and led a WG discussion about trends in acoustic monitoring. It was noted during the discussion that signal processing methods have improved substantially. This is sometimes allowing detection of signals deep within windings that previously was not possible. Also, acoustic emissions have been used to identify non-PD problems such as bubbles from overloading and structural movement caused by loose bolts.

SC Chair's note: WG Chair Jack Harley received notice that the revision of PC57.127/D10.0, Guide for the Detection and Location of Acoustic Emissions from Partial Discharges in Oil-Immersed Power Transformers and Reactors, was approved by the IEEE SA Standards Board on March 22. The document will be sent for publication.

Unless something new arises with this document, this WG will not meet at the Minneapolis meeting. The Chair wishes to thank Jack Harley and his WG for their persistent efforts on this document.

8.3.2.2 Working Group on Revision of Low Frequency Tests – Bertrand Poulin, Chair; Bill Griesacker, Secretary

The meeting was held on Monday March 12th at 11h00 am. After the usual introduction and display of IEEE's Patent policy, the minutes of the previous meeting were approved as written. A new secretary for the WG was appointed – Bill Griesacker

Next, Dr. Lemke presented his report on the task force meeting for the revision of C57.113 (IEEE Recommended Practice for Electrical Measurements of Partial Discharges in Transformers). The minutes of this meeting are found in Appendix 1. The main topics are:

I. The process of revision of the guide is going well. Comments and suggestions after draft 5 were incorporated in draft 6, circulated in the last several weeks and reviewed at the meeting.
II. The document will be circulated at the subcommittee level before a formal ballot according to IEEE's procedures.
III. The PAR has been submitted to IEEE and should be approved before the next meeting.

The rest of the meeting was devoted to the review and discuss a proposal for modifications to C57.12.90, sections 10.5 to 10.11 related to low frequency dielectric testing. The proposed new sections have been circulated within the WG in the last several weeks. No comment of technical content was received - only editorial.

The proposed revisions were based on Draft 3 of the last revision of C57.12.90 because the 2006 revision was not published until very recently. Proposed sections 10.5.to 10.11 will be reviewed once more based on the 2006 revision and if necessary, the numbering will be adapted to reflect the current status of C57.12.90-2006. One more circulation will take place at the subcommittee level before the next meeting.

Several meetings ago, it had been agreed to add a section to the standard concerning transformers with a neutral terminal permanently connected to ground internally. These transformers cannot receive an applied test. This request was accidentally forgotten. It has been added now to section 10.5.

Once more, the issue of lowering the acceptance criteria for pd level was discussed. One suggestion was made at 300 pC. 250 pC was also proposed. It was finally proposed to give a chance to the newly published standard a chance with the current levels. There was no resolution of this topic at the meeting.

Finally, a proposal from Joe Foldi concerning the addition of a criteria for PD at level voltage for class II transformers. He will submit his proposal to the chairman before the next meeting.

Appendix 1
Unapproved Minutes of the Task Force Meeting
Electrical Partial Discharge Measurement
Chairman – Eberhard Lemke

1. Introduction - The Chairman opened the meeting at 8:00 a.m. and welcomed the members and guests. There were 57 attendees present, 22 of them TF members and 35 guests; 4 requested for membership.

2. IEEE Patent Policy - The IEEE Patent Policy was discussed based on the submitted transparencies. There were no patent issues to be discussed.

3. Approval of Agenda - The tentative agenda was approved as submitted.

4. Approval of Minutes of the previous Meeting - The minutes of the previous TF meeting in Montreal were approved as written.

5. Recent Activities for revision the IEEE Guide C57.113

1. The comments and suggestions submitted to Draft 05B were incorporated in the Draft 06, which was circulated prior this meeting and reviewed today.
2. Few parts of sub-section “4.4 PD Calibrator” were moved to section “7.0 Appendices”, were a new sub-section “7.3 Fundamentals of the PD calibration procedure“ was added.
3. The former sub-section “7.5 Evaluation of the virtual test object capacitance was incorporated in sub-section “7.4 Basic sensitivity check”
4. A new sub-section “5.7 Maintaining the PD measuring characteristics” was added to section “5.0 Specification of PD measuring circuits“.

6. Future work - The comments and suggestions submitted during the TF meeting will be incorporated in the Draft 06A. A PAR was requested. It is expected that this document expires at the end of this year. The PAR activities will concentrate on writing the final draft according to the IEEE Templates. A pre-ballot editorial review of the Study Committee is recommended before starting the official balloting process.

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

The WG met on March 13, 2007, from 3:15 pm to 4:30 pm. Eighteen members and thirty-one guests attended the meeting. Nine guests requested membership.

The agenda was accepted as written. The Montreal minutes 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 this WG.

1. The first item of business was the status of the proposal related to the lightning impulse test procedure (tail time). The latest proposal surveyed within the WG was sent to Stephen Antosz on February 17,2007 for implementation in the next C57.12.90 draft for ballot. For the time being, the proposal is put on hold and we are waiting if we need to survey it once more within the SubCommittee.

2. The second item of business was the results of the survey made on a proposal modifying Clause 10.2.2.1 "Switching impulse waves". The proposal was surveyed within the WG and within the Dielectric Tests SC membership. The return rates were 32% in the SC and 29% in the WG. Out of these returned surveys, 95% were affirmative within the SC membership and 100% affirmative within the WG. No negative surveys were received. Two abstained within the SC. Two comments were received, one was mainly editorial in nature and the other one was from Bertrand Poulin who did want to not invalidate positive polarity switching impulses. After discussion it has been decided that the proposal will be modified as follows:

- The main text will consist of only one sentence requesting negative polarity waveshapes to be used.
- A first note will be added and will explain that reverse polarity impulses up to 70% of the full test level are needed in between full-wave tests for the purpose of biasing the core in order to avoid saturation.
- A second note will be added and will explain that negative polarity impulses are specified for avoiding the risk of erratic external flashovers. This note will also say that positive polarity impulses are also valid for the demonstration of the internal insulation voltage withstand capability.

A revised proposal taking into account the decisions made during the meeting will be surveyed once more within the WG and SC prior to the next meeting.

3. The third technical subject on the agenda was the results of the survey made on a proposal modifying Clause10.3.1.3 "Chopped-wave Test". The proposal was surveyed within the WG and within the Dielectric Tests SC membership. The return rates were 34% in the SC and 26% in the WG. Out of these returned surveys, 88% were affirmative within the SC membership and 92% affirmative within the WG. One negative survey was received. Four abstained within the SC and one within the WG. Thirteen (13) comments were received. Several of the technical comments were related to the minimum limit of overswing in opposite polarity when a resistor is added to limit the overswing amplitude. The negative ballot was also related to the level of the overswing in opposite polarity. An other important technical comment was from Joe Foldi and was related to the maximum allowed time interval of the first voltage zero after chopping instant (e.g. rate of voltage collapse after chopping). After discussion, it has been decided:

- to keep the minimum limit of overswing in opposite polarity to 30% when a resistor is added in the chopping circuit;
- to specify that the time interval from chopping instant to the first voltage zero shall be as short as possible and shall not exceed 1,0 µs when the position of the chopping gap is as described in the proposal. A note will be added that for some winding

designs, it is possible that the circuit response after chopping is not oscillatory but over-damped and for such cases, the time interval to the first voltage zero after chopping may be significantly greater than 1.0 µs.

Because the WG meeting was running out of time, the remaining comments received on the survey on Chopped-wave tests were not discussed. A revised proposal taking into account the decisions made during the meeting will be surveyed once more within the WG and SC prior to the next 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 meeting opened at 3:15PM on Monday March 12, 2007 with 36 attendees present, of which 9 were members and 27 were guests.

In keeping with the IEEE patent policy the members were asked if they were aware of any patent or copyright infringement issues in the present draft of the Impulse Guide. No issues were identified and the meeting proceeded with group introductions.

A motion to approve the fall 2006 minutes was made by Pierre Riffon and seconded by Bob Ganser. The 2006 fall minutes were approved.

The members were asked for comments on the latest draft of the Impulse Guide and the following comments were made:

- Pierre Riffon indicated the he had a comment about the impulse test sequence coordination between the Impulse Guide and the WG for Revision of the Impulse Tests. Pierre noted that the sequence of impulse tests on transformers with non-linear devices, as listed in the present draft of the Guide was not in agreement with the sequence included in the Revision of Impulse Tests. He indicated that his WG had agreed to include a full wave before the chopped waves. Art agreed to update the procedure included in the Impulse Guide so as to comply.
- Pierre Riffon also mentioned that the present undershoot for chopped waves was being reviewed and a possible tolerance of 3% was being proposed. The present 30% may become 27% to 30%. Art agreed to note that fact and await the outcome of the next meeting of the Revision to Impulse Test WG before making changes to the Impulse Test Guide.
- Pierre Riffon and Art Molden had some discussion about the need for a table of Minimum Energy Requirements in the Guide. Chairman Art postulated that a calculation of the minimum capacitance required to produce an appropriate tail duration should be determined on the basis of a given transformer parameters; whereas, Chairman Pierre postulated that a table provided a guide to the minimum energy required to produce the tail duration for a range of transformers. Both Chairs agreed on the addition of a table, and that a table would provide an informative addition to the Guide but, that the object of the table should be to provide what we can call typical IG “nameplate” parameters, that is, rated voltage and energy per stage, rather than a minimum energy based on test voltage levels. Chairs Pierre and Art will table a new table format for the Impulse Guide.
- With the inclusion of the above mentioned table and the Bibliography, the Guide will be ready to ballot within the Dielectric Test SC, hopefully before the next meeting
- An anticipated section on Transfer Function and additional, more appropriate digital impulse records have not been included in this revision of the Impulse Guide and will

require more cooperative input from the members if such information is to be included in the future.
- The Minutes of the fall, 2006 meeting and the present draft 2 of the Guide have been included on our grouper site.

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

The WG was called to order at 1:45 PM. There were 54 attendees, 20 members, and 34 guests with 6 requesting membership. Reviewed the agenda for the meeting. The Minutes from the October 24, 2006, meeting in Montreal, Canada were approved.

Comments to the revised tables were received from Bipin Patel, and were reviewed. WG members reviewed the tables and recommended the following changes:

Class I Table:
- Delete note 9
- Add the following to note 1: "Minimum Phase-to-Phase Induced test levels for 3 phase Distribution Transformers shall be not less than 2.0 times nominal system voltage."
- Add the following to note 5: "Induced tests shall be conducted at twice rated voltage."
- Induced test column, values 17 and above were rounded to the nearest whole number.
- Removed text "Applied test from C57.12.00 table 7
- Delta changed to Delta/fully insulated
- Delete note 7
- Change Basic Insulation Level to BIL
- Change V to U

Class II Table:
- Remove * from body of table
- Headings should match those in the Class I table as much as possible

<u>Proposed Dielectric Test Tables</u>
- Delete "Hopkinson" from the table
- Change units to µs
- Change "X" to "/" for BIL kV Crest
- Change "*" to "X" for Chopped wave and Switching Impulse kV Crest

Old material on Steep Front to be moved to the Appendix for reference purposes

<u>Proposed Test Levels For Repaired Unit</u>

The following is from an e-mail from Mark Perkins dated February 20, 2007, was discussed:
In my minutes of the working group October 2001, I have the following note on this subject:

"Item 3 on the tests for repaired or rebuilt transformers, the survey results were 25 yes, 4 no, and 2 abstained. Based on negative votes, it was proposed to change the recommended test levels from "a range of 75 to 85%" to "85%". It was also agreed to place this section in an annex rather than in the body of the standard since it is more of a guide than a standard."

We did a survey that included changes on the wording of C57.12.90 for tests on repaired or rebuilt transformers and this was the response from the survey. Subhash voted negative on this proposal, indicating that it should be in the main body of the standard. The new proposed text was as follows:

Annex__ Factory dielectric tests on repaired or rebuilt transformers:

Factory dielectric tests on transformers that have been repaired or rebuilt are dependent on the nature of the repair and the amount, age, and condition of original insulation that was used in the repaired or rebuilt transformer. The tests are also dependent on the original design of the transformer and the applicable test standards at the time of the transformer design. As such, this section only gives general guidelines for selecting tests and test levels, and the actual tests and test levels should be mutually determined by the manufacturer and the purchaser.

Agreement of the WG: Transformers with all new insulation should be tested at 100% test levels. When all or a portion of the insulation is re-used, the recommended test level is 85% of the full dielectric test levels.

Not discussed but proposed: In some instances, the purchaser may wish to test the transformer at 100% test levels even though the original insulation was used in the repair or rebuilding. In this instance the manufacturer and purchaser should carefully consider the higher risk of insulation failure in what might otherwise be an acceptable transformer versus the benefits of testing at the higher level.

Hopefully this gives you a better starting point to get something added to the standard. But you can see from the voting response, you might have some difficulty getting consensus.

8.3.3 Liaison Reports

8.3.3.1 Status of C57.12.00 – Dong Kim; and C57.12.90 – Stephen Antosz

Both documents have been published in mid February 2007, with a 2006 approval date. The next cycle of continuous revision will begin immediately, since there are already new clauses ready to go. There will be a short time in 2007 for any additional approved work that is ready to be added to the next official ballots. Send this information to Dong Kim or Stephen Antosz.

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

Editorial work on the new revision of High Voltage Testing Techniques, IEEE Standard 4 continues. We had a meeting in November of 2006 in Lake Placid, NY during which our Chairman and various members drove our Vice-chair Jeff Britton to distraction, force-feeding him on nothing more than clause amendments and editorial comment over a period of three long days. Jeff probably knows more about the new IEEE MS Word Template now than does the IEEE or Bill Gates himself. It is hoped that the first draft of this revision will be ready later this year.

8.3.4 Old Business

8.3.4.1 Phase-to-Phase and Phase-to-Ground Clearances

Prior to the meeting, the Chair issued a memo explaining the historical aspects of how the values in Table 14 of C57.12.00-2006 were established about 25 years ago. The Chair asked if a Task Force

should be established to evaluate the existing table and/or develop new tables for C57.12.00 setting minimum clearances. It was agreed that there is much discrepancy between various sources; IEEE, IEC, CSA, etc. A hand survey was taken of those present; 5 in favor, 1 opposed. This was a very poor response considering the room contained 67 members and 71 guests. The Chair will consider the next step.

8.3.5 New Business

8.3.5.1.1 Electrical PD – Vladimir Khalin

Vladimir asked the question whether it is helpful for this group to develop a document discussing electrical PD in CT's and bushings. Discussion established that instrumentation for measuring PD in these apparatus is somewhat different than for transformers and shunt reactors. This aspect is actually an extension of the TF on Electrical Partial Discharge Measurement, and the Chair will speak to Dr. Lemke and Bertrand Poulin about continuation of the TF on these topics after the current work on transformer measurement is completed.

Attendance at this Meeting of the Dielectric Test Subcommittee:

MEMBERS

1. Stephen Antosz
2. Carlo Arpino
3. Javier Arteaga
4. Roberto Asano
5. Barry Beaster
6. Oscar Bello
7. EnriqueBetancourt
8. William Boettger
9. Jeffrey Britton
10. Carl Bush
11. Scott Choinski
12. Donald Chu
13. Craig Colopy
14. John Crouse
15. Alan Darwin
16. Eric Davis
17. Robert Degeneff
18. Fred Elliott
19. Don Fallon
20. Reto Fausch
21. Joseph Foldi
22. Bruce Forsythe
23. George Frimpong
24. Robert Ganser
25. Ramon Garcia
26. Charles Garner
27. E. Gomez-Hennig
28. David Goodwin
29. Bill Griesacker
30. John Harley
31. Roger Hayes
32. Bill Henning
33. Thang Hochanh
34. Phillip Hopkinson
35. Vladimir Khalin
36. Dong Kim
37. Eberhard Lemke
38. Richard Marek
39. John Matthews
40. Susan McNelly
41. Joseph Melanson
42. Kent Miller
43. Arthur Molden
44. Gylfi Olafsson
45. Sanjay Patel
46. Mark Perkins
47. Don Platts
48. Bertrand Poulin
49. Jean-Chris Riboud
50. Pierre Riffon
51. Mahesh Sampat
52. Devki Sharma
53. H. Shertukde
54. H. Jin Sim
55. Steven Snyder
56. Andy Speegle
57. Michael Spurlock
58. Andy Steineman
59. Craig Stiegemeier
60. Valeriu Tatu
61. Juan Luis Thierry
62. Robert Thompson
63. George Tolbert
64. Subhash Tuli
65. Loren Wagenaar
66. Jim Zhang
67. Peter Zhao

GUESTS

1. Ed teNyenhuis
2. Kipp Yule
3. Larry Davis
4. Andre Shor
5. Gary King
6. David Wallach
7. David Bandow **
8. Chungduck Ko
9. Mike Goaltieri
10. Larry Coffeen
11. Rowland James
12. Wilington Ayala
13. Mark Ashford
14. Luke von der Zel
15. Mark Gromlovits **
16. Robert Perlichek
17. Alvaro Cancino
18. C. J. Kalra
19. Terry Rennich
20. Paulette Powell
21. Colin Clark
22. Arnold Carlos
23. Shawn Patterson
24. John Stein
25. Samuel Oriti
26. Mark Meyer
27. Ray Bartnikas **
28. Clarence Bell
29. Mike Craven
30. Gerry Rosselli
31. Catherine Hurley
32. Francis Raveneau
33. Kent Haggerty
34. Rick Ryman
35. Francesco Rebordao
36. Alexander Kraetge **
37. Marcel Fortin
38. Juan Castellanos
39. Shuzhen Xu
40. Jim Graham **
41. Stan Linsenbardt
42. Bob Ganser Jr.
43. Don Dorris
44. Jerry Harlan
45. Sergiy Razuvayev
46. Jermel Miller
47. Virendra Jhonsa
48. Jane Ann Verner
49. James Gardner
50. Dharam Vir **
51. Charles Drexler
52. Greg Anderson **
53. Lin Tong
54. Dale Corel
55. David Buset
56. Les Recksieder **
57. Dwight Parkinson
58. Paul Mushill
59. Jerry Allen
60. Brian Leslie
61. Jeewan Puri
62. Kent Brown
63. Wayne Johnson
64. Gael Kennedy
65. Edgar Trummer
66. Gary McCulla
67. Dan de la Cruz
68. Tom Lundquist **
69. Barry Ward
70. Jim Thompson
71. Juergen Gerth

** Guests Requesting Membership