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

The Dielectric Test Subcommittee (DTSC) met on Wednesday, March 10, 2004, at 1:30 p.m., in San Diego, CA with 69 members and 53 guests present. 15 of the guests requested membership on the Subcommittee. See the last page of these minutes for attendance list.

7.9.1 Chairman's Remarks

After introduction of the attendees, the Chair reviewed some of the highlights of the Administrative Subcommittee meeting held on March 7, 2004.

1) Minutes due to Tom Prevost and Sue McNelly by April 30.

2) Next meeting date and location is October 24-28 2004 in Las Vegas, NV. Spring 2005 will be in Jackson, MS.

3) The minutes of the Fall 2003 meeting in Pittsburgh, PA were approved as written, and are available the IEEE TransformersCommittee Web Site.

4) There has been much discussion regarding changes to the present 3.5 day length and the format of the Thursday Main Committee meeting, however no decisions have been made. A task Force within the Administrative Subcommittee has been formed to study the issue in more detail and make recommendations.

7.9.2 Working Group Reports

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

Attendance: 23 members and 29 guests attended the meeting. Attendees introduced themselves. The activities of the October 6, 2003 Pittsburgh PA meeting were reviewed.

The Working Group conducted a pre-ballot survey of PC57.127/D2.0 Draft Guide for the Detection and Location of Acoustic Emissions from Partial Discharges in Oil-Immersed Power Transformers and Reactors. The intent was to determine which parts of the Guide could bring negative ballots or requests for technical or editorial changes.

1. Hem Shertukde led the group discussion of Sections 1 through 4, which included the overview of the guide, definitions, introduction to systems and signal transmission characteristics. It was suggested that the type of document be changed from "Guide" to "Recommended Practice." Revisions were largely editorial.

2. Allan Darwin's group focused on Sections 5 and 6 that cover equipment specifications and field and factory tests differences and Annex A Bibliography. Editorial changes were suggested.

3. Ron Daubert led the discussion on Sections 7 and 8 about test procedures in the field and factory and Annex B signal processing. A suggested technical change was to use the term gas rather than nitrogen above the oil in order to encompass free-breathing units. Several editorial changes were suggested.

4. Barry Ward's group reviewed Section 9 characteristics of signals and Section 10 integrating AE results with data from oil analysis. A number of suggestions were made to improve the document, which would have been negatives, as well as editorial and technical comments. Several of the suggested changes were:
   - The terms repetition rate and synchronous will be added to definitions
   - Figure 13 PD waveforms needs more explanation
   - Figure 7 showing an attenuated AE burst should also show a non-attenuated waveform for comparison

5. Ernst Hanique's group covered Section 11 Acoustic Activity Interpretation and Annexes D and E calibration. Editorial changes will be made to Section 11 and Annexes D and E will be re-written to be more general.

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

The WG met on Monday with 18 members and 17 guests present. Mark Perkins did not attend so Loren Wagenaar chaired this meeting. The Pittsburgh minutes were approved as corrected; the correction was regarding an issue raised by Subhash at the Pittsburgh meeting concerning not measuring terminals rated less than 115 kV on Class II transformers.

Dr. Lemke made a report on the initial meeting of the TF on Electrical PD Measurements (complete minutes will follow here) There was discussion whether to keep the old document or develop a new one, and it was decided to use the old document only as background material but develop a completely new document and format.

Under WG business, Subhash stated that several users have been specifying that buried tertiary windings be subjected to applied and impulse tests. This requires that temporary bushings be bought. C57.12.90 does not cover these situations, so a small group consisting of Mark Perkins, Subhash Tuli, and Bertrand Poulin was established to study this situation and make recommendations.

Due to the absence of the Chair, the meeting was then adjourned.

7.9.2.2.1 Task Force on Electrical PD Measurement - Eberhard Lemke, Chair

1. Introduction and Attendance
The Chairman opened the meeting at 9:30 am and welcomed the member and guests. There were 50 attendees present, 22 of them will join the TF as volunteers.

2. Approval of Agenda
The submitted tentative agenda was approved as it was

3. Chairman's Remarks
First it has been pointed out that the main goal of the new document to be submitted is the harmonization of the existing IEEE Guide C53.113 (1991) with the third edition of IEC 60270 (2000-12). After that some background knowledge was presented dealing with the fundamentals on measuring the PD quantity "apparent charge". In this context it was stressed that the reading of commercially available PD measuring instruments is mainly governed by the measuring frequency characteristics and the pulse train response as well. Hence, the efforts will mainly focus on the specification of these parameters.

4. Discussion

In the discussion it was agreed that for the incorporation of the actual IEC recommendations a new document is required, which bases on the technical background of the existing guide. A first draft will be submitted by the chairman before the next meeting in Las Vegas.

The discussion went also on the aspect whether the term “Guide” should be substituted by “Recommended Practice” or not. This matter, however, should be discussed further during the next TF meeting.

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

The WG met on March 9, 2004, from 3:15 pm to 4:30 pm. Eighteen members and fourteen guests attended the meeting. The minutes of Pittsburgh meeting were approved as written. No changes were required on the agenda.

The first subject on the agenda was to review the results of the survey done within the Dielectric Tests Subcommittee on the revision of clause 10.3.1.1 of C57.12.90 related to impulse testing and regarding the recommended minimum impulse generator energy level to be met during lightning impulse tests for cases where the 50% tail time is shorter than the minimum allowable value of 40 µs. The survey has been sent on February 20, 2004, to approximately 140 members. Twenty-five surveys were returned (18% returned). Out of these 25 responses, 9 were affirmative without comments (36%), 10 affirmative with comments (40%) and 6 negative (24%). The details of the negative responses were not discussed. The WG chair and vice-chair will contact each individual who provides comments for trying to resolve the negative comments as well as the affirmative responses with comments. The essence of the negative comments is as follows:

- some of the recommendations and/or information given need to be move to the impulse test guide;
- the recommended energy levels seem to be too low;
- use of resistor should be agreed upon ahead of time;
- the recommended energy levels for class IVb and IVc are too high;
- the paragraph regarding the statement to be given by the manufacturer during bidding stage seems to be inappropriate in a Test Code;
- justification of a change in the Test Code without field problems is difficult to justify;
- change the concept of minimum energy levels to minimum capacitance values;
- may force manufacturers to invest considerable amount of money for improving their impulse generator.

The WG chair & vice-chair will try to get counter proposals from individuals who cast negative surveys and will issue a revised proposal based on the outcome of the resolutions. This revised proposal will be surveyed within the Dielectric Test Subcommittee prior to next meeting.

A quick survey within manufacturer representatives present during the meeting showed that the majority are able to cope with the recommended minimum energy levels given in the proposal.

After discussion, it has been agreed upon that a note giving the impacts of the recommended minimum energy levels will be added. This may help people to see the impacts of such proposal with their respective testing capabilities. Moreover the wording will be improved for stating clearly that these recommended levels are not mandatory but only recommended.

The second subject on the agenda was related to the revision of clause 10.3.1.3 of C57.12.90 dealing with Chopped-wave tests. The changes proposed are:

- the gap shall be located at a distance from the test object not exceeding the height of the transformer for insuring a fast chopping time;
- tolerances have been added to the time-to-chop;
- rules for using resistors limiting to 30% the overswing in reversed polarity are now given;
- details regarding the type of chopping gap and their effect on the waveshape (sphere gap and rod-rod gap) are given in a note. The use of rod-rod gap is permitted since this is representing more accurately a flashover within an air insulated substation.

After discussion, it has been agreed upon that:

- the tolerances given on the time-to-chop will be investigated. If not mentioned in IEEE C57.12.00 nor in IEEE C57.12.90, the IEC tolerances will be proposed;
- A maximum chopping time of 1,0 µs will be given as an upper limit. Details regarding how to reduce the chopping time will be introduced in C57.98;
- A general reference to IEEE Std.4 will be added in clause 10.1.1 of C57.12.90.

A revised proposal will be worked out according to the decisions made and will be surveyed within the Dielectric Tests Subcommittee.

Since the meeting was running out-of-time, the third subject on the agenda related to impulse tests on windings protected by non-linear voltage limiting devices has not been discussed. This subject will be reported on the next meeting agenda.

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

The meeting started promptly at 3:15PM on Monday March 8th, with 38 attendees present of which 11 were members and 6 were guests requesting membership.

After the formal introductions Mr. Loren Wagenaar was called upon to report to the working group on the outcome of the recent ballot for reaffirmation of C57.138, the Guide for Routine Impulse Testing of Distribution Transformers. Loren reported that the ballot returns were 100 percent in favor of the reaffirmation of this standard, but that comments obtained from the ballot would require that the Guide be reviewed and updated before the next review cycle, 5 years from now. Loren also reported that the revision of the C57.138 guide will now be included in the scope of our working group such that this working group will now become "The WG for Revision of Impulse Test Guides" A new PAR application will be made for the revision of this guide and electronic copies of the guide and the comments from the recent ballot will be made available to our WG.

The meeting then continued with approval of the Minutes of the Pittsburgh meeting and the following items of old business were discussed:

1) Minimum Energy Proposal. This proposal relates the kVA rating of a transformer to the available energy of an impulse generator and the ability to obtain the required impulse tail duration. A table included in the proposal was copied and modified by Art Molden for the purpose of our discussions, so as to indicate the number of IG stages that would be required for a particular BIL level. The intent here was to provide the members with

practical examples of the implications of this proposal. Various comments and questions were discussed including a proposal by Ramsis Girgis where, for those cases where tail duration was a problem two impulse tests could be performed; one test would be applied to the terminal under test using the short tail duration, after which a second test would be performed using a tail extended by use of our so called "alternative methods" (for example placing a resistor in series with the non impulsed terminal of the winding under test). Bertrand Poulin commented that the impulse used in the "short tail duration test" should be the best (longest) available using the optimum configuration of available impulse generator stages. This suggestion was well received by the members.

Some concerns were again voiced by manufacturers concerned that the proposal would require them to replace existing test equipment to meet the proposed energy levels. Pierre Riffon pointed out that proposed energy levels were not mandatory levels but minimum recommended levels. The only additional requirement was, that those manufacturers not having the recommended levels available from existing test equipment would be required to make that known at the contract bidding stage, along with the test strategy that would be used to optimize the applied impulse wave shape used during the impulse test.

2) Non-linear Devices (NLD). A variety of proposals regarding the number and levels for the Reduced Full Wave (RFW) shots to be applied during tests on transformers using NLD were discussed. The most favorable compromise offered was for a sequence that included two RFWs, one at a level between 50% and 70%, the second at a level between 75% and 85%. The main concerns were on selection of RFW levels that would enable repeatable operation of the devices to be demonstrated during the test. It was pointed out that while the repeatability of operation at particular applied voltage levels above the NLD operating level was good, the actual applied voltage level required to cause NLD operation was not known prior to the impulse test. The test sequence would therefore be:

   RFW1 (50% to 70%)
   RFW2 (75% to 85%)
   100% FW
   2 Chopped waves
   100% FW
   Repeat of RFW2
   Repeat of RFW1

   The actual levels used in the test to be agreed between the manufacturer and user. The transformer would be considered to have passed the test if the impulse records obtained before the chopped wave applications compared with the corresponding voltage level records obtained after the chopped wave applications

3) Steve Beckman again pointed out that the present test code includes wording to the effect that the 100% full wave be the final impulse test applied to the terminal under test and so appropriate changes would have to be made to the test standard itself.

4) Voltage Divider Measuring Lead. A paragraph was provided by Pierre Riffon regarding connection of the voltage divider to the terminal under test.

5) Pierre also provided additional paragraphs regarding the location of the chopping gap and the length of connecting leads.

There being no other new business the meeting was closed at 4:15 PM.

However, as was later pointed out by Subhash Tuli an item of old business regarding Switching Impulse testing, though noted in our previous meeting minutes, had not been discussed during this meeting. It was therefore suggested that discussion of this topic would be continued via our electronic mailing list system.

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

Tables Needed and proposed

a.) Y-Connected Test Levels
b.) Delta-Connected Test Levels
c.) Chopped Wave and Switching Surge vs. BIL
d.) Relationship Between Short & Long Time
e.) Relationship for Arrester Protection
f.) Arrester Protection Levels – Wye
g.) Arrester Protection Levels – Delta
h.) Commentary on Considerations for Delta and Wye

Items a) and b) were addressed and the Chairman has the latest version of the Tables. None of the other items were addressed.

7.9.3 Liaison Reports

7.9.3.1 Surge Protection Devices – Bob Degeneff

- Recall that several years ago the Dielectric Test SC provided the Surge Protective Devices Committee with an insulation characteristic curve for the transformer to be used in the evaluation of insulation coordination between arrester and transfromer.
- Recall that the curve was based on 5 points; FOW, CW, BIL, BSL, and Induced.
- Initially there was resistance to use of these characteristics, since it was a significant departure from convention.
- Now the 5 point curve has been fully incorporated into C62.22, Paragraph 5.2.5.1-3.
- It will be out for ballot soon, as reported by Eva Tarasiewicz.
- Please look for it, get on ballot pool, and vote.

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

There has not been a meeting of the HVTT WG since the one reported at the Pittsburgh meeting. The next meeting will be at the facility of Florida Power and Light in West Palm Beach, FL on April 14-15.

7.9.3.3 PCS TF on Frequency Response Testing – Rowland James

The PCS task force met for the development of a guide for Frequency Response Analysis (FRA) in San Diego, California on March 9, 2004 at 3:15 P.M. There were 39 persons in attendance, 21 members & 18 guests of which 3 requested membership.

Rowland James made a brief report on the development of the draft and thanked the contributors for the efforts put forth in the development of the guide. He also announced that a PAR will be submitted for approval. The minutes were presented and approved.

Charles Sweetser reported that he received contributions for all six sections. The contributions were appended as submitted. Each section was then discussed.

- **Section 1:Scope and Application** – Progress has been made on this section. A definition section was added, however definitions are needed. Further input of expanded use and application is also needed. It was recommended to add verbiage regarding baseline, sister unit, and phase comparisons in section 1.1. Subhash Tuli will review this section for technical content.

- **Section 2: Test Parameters** – Ernst Hanique discussed test leads and emphasized that test lead lengths must not differ more that one centimeter. Fred Elliot and Sokom An reported in absentia that greater repeatability is possible when testing the high voltage because test leads are fully extended. Careful attention given to placement of the leads performing measurements on shorter bushings. Richard Breytenbach commented on the use of either magnitude or phase measurements. He stated that they are directly related to one another and therefore there should be no difference in the results. Sokom An will be asked to provide additional review to this section.

- **Section 3: Measurement Parameters (test plan)** - A section on safety is included in this section. Diagrams have been added to illustrate various test setups. Charles Sweetser discussed types of test, namely, open circuit, short circuit and inter-winding tests and displayed typical test curves. He asked the Task Force if we should establish a convention. This section will be further reviewed by Richard Breytenbach.

- **Section 4: Test Records** – Open data formats and nameplate data requirements were discussed. This section requires further development to determine what will be the recommended format and required fields. Bertrand Poulin and Barry Ward will address.

- **Section 5: Analysis and Interpretation** – There perspectives were submitted regarding interpretation (sweep, impulse, Objective Winding Asymmetry). The group expressed that we need to document what we already know. Richard Breytenbach made a brief presentation on FRA interpretation and explained the significance of the lower frequency range (core displacement) and the mid range, 50-200 kHZ (bulk winding movements). Larry Coffeen gave a presentation on NEETRAC's technology that will produce a predictive maintenance system that is designed to detect loose coils. Richard Breytenbach, Larry Coffeen and Charles Sweetser will work on this section.

- **Section 6**: **Appendix I –** Bob Degeneff will continue to develop this section.

Charles Sweetser announced that the Task Force will establish a relationship with CIGRE regarding FRA testing

7.9.3.4 Web Page Development – Eric Davis

Chairman not present. Nothing to report.

7.9.4 Old Business

7.9.4.1 Phase to Ground Clearances – Loren Wagenaar

Nothing to report. Will continue this activity next time.

7.9.5 New Business

7.9.5.1 Alan Wilks is co-chair of the WG on Overhead Distribution Transformers, C57.12.20. He recently sent an email to Loren requesting resolution of the issue that specific dielectric tests required on distribution transformers in C57.12.20 Paragraph 5.2 are different than those listed in C57.12.00. This clause has been in C57.12.20 since at least 1981, and the WG is asking that it be included in the appropriate way into C57.12.00.

This issue will be referred to Mark Perkins' WG on Low Frequency Tests for resolution.

7.9.5.2 It was proposed to extend Class 2 units down to 69 kV, since many customers are specifying this anyway. (Don Platts and Bob Hartgrove agreed that their company's do this.) This would cover corona and impulse testing. In some cases users are going all the way down to 15 kV, even with the understanding that there is no capacitance tap.

7.9.5.3 Phil Hopkinson proposed that all Class 1 transformers receive an Impulse Test**.**

Members Present

1. Antosz, Stephen
2. Artiega, Javier
3. Ayers, Donald
4. Barker, Ron
5. Beckman, Stephen
6. Bello, Oscar
7. Boettger, Bill
8. Bolliger, Alain
9. Britton, Jeffrey
10. Bush, Carl
11. Caruso, Charles
12. Chu, Donald
13. Colopy, Craig
14. Corkran, Jerry
15. Crouse, John
16. Damico, Frank
17. Darwin, Alan
18. Daubert, Ron
19. Davis, Larry
20. Degeneff, Bob
21. Dudley, Richard
22. Eckholz, Klaus
23. Elliott, Fred
24. Fallon, Donald
25. Fausch, Reto
26. Foldi, Joe
27. Ganser, Robert
28. Garcia, Ramon
29. Gardner, James
30. Garnitschnig, Andreas
31. Gianakouros, Harry
32. Griesacker, Bill
33. Gruber, Myron
34. Hanique, Ernst
35. Harley, Jack
36. Hartgrove, Bob
37. Hayes, Roger
38. Heinzig, Peter
39. Herron, John
40. Hochanh, Thang
41. Hopkinson, Philip
42. Huff, Tim
43. James, Rowland
44. Kennedy, Sheldon
45. Khalin, Vladimir
46. Lackey, John
47. Lemke, Eberhard
48. Leuenberger, Boyd
49. Marlow, Dennis
50. Matthews, John
51. McNelly, Susan
52. Miller, Kent
53. Molden, Arthur
54. Platts, Don

Guests Present

1. Wayne Johnson
2. Barry Ward
3. Justin Cho
4. Ronald McLaren
5. Brent Hayman *
6. Bruce Fairris
7. Krysztof Kulasek
8. Marion Jaroszewski
9. Steve Schappell *
10. Michael Williams *
11. Ali Ghafourian *
12. Bob Grunert
13. Michael Mitelman
14. Chris Baumgartner
15. Charles Sweetser
16. Dan de la Cruz
17. David Aho *
18. Richard Breytenbach *
19. C P McShane
20. Ken McKinney
21. Scott Choinski *
22. Marnie Roussell
23. Tim Cargol
24. Dieter Wagner *
25. Stephen Shull
26. Kipp Yule
27. Barry Beaster
28. Marcel Fortin
29. Juan Castellanos
30. Virenda Jhonsa
31. Charlie Drexler
32. Dennis Allan *
33. Dilip Shah
34. Tommy Cooper
35. Wayne Gibson
36. John Graham
37. C J Kalra
38. Wally Binder *
39. Alan Peterson
40. Kjell Sundkuist
41. Mark Cheatham *
42. Alan Wilks
43. Roger Verdolin *
44. Pritpal Singh
45. Jurgen Gerth
46. Peter Zhao *
47. Otto von Staden
48. David Goodwin *
49. Andy Steineman
50. Les Recksiedler *
51. Paulette Payne
52. Emilio Morales
53. Don Russell

55. Poulin, Bertrand
56. Preininger, Gustav
57. Riffon, Pierre
58. Rivers, Mark
59. Russwurm, Dirk
60. Schweiger, Ewald
61. Sharma, Devki
62. Snyder, Steve
63. Speegle, Andy
64. Spitzer, Tommy
65. Thompson, Robert
66. Tuli, Subhash
67. Wagenaar, Loren
68. Walls, Albert
69. Ziomek, Waldemar

* Requested Membership.