Insulation Life Subcommittee - Un-Approved Meeting Minutes
October 25, 2006 – Montreal, Quebec, Canada

7.4 Insulation Life Subcommittee – Don Platts, Chairman

The Insulation Life Subcommittee met in Montreal, Quebec, Canada on October 25, 2006, at 8:00 AM. There were 51 members and 75 guests present, with 7 guests requesting membership in the subcommittee.

The minutes of our meeting in Costa Mesa, CA on March 22, 2006 were approved as submitted.

7.4.1 Chair's Report

7.4.1.1 The Spring 2007 IEEE Transformers Committee Meeting will be held March 11 - 15, 2007 in Dallas, TX. The Fall 2007 meeting will be held in Minneapolis, MN.

7.4.1.2 IEEE is updating the My Project pages of the website including My Ballot. The revised website should be easier to use.

7.4.1.3 The Chair recognized Drs. Oleg Roizman, Valery Davydov and Jim Dukarm for Monday's Tutorial, "Water-in-Paper Activity – a New Concept for Moisture Assessment in Transformers."

7.4.2 Project Status Reports

7.4.2.1 Reaffirmation Ballot 1276-1997, IEEE Guide for the Application of High-Temperature Insulation Materials in Liquid-Immersed Power Transformers

RevCom approved the reaffirmation and the standard has been published.

7.4.2.2 Reaffirmation Ballot C57.119, IEEE Recommended Practice for Performing Temperature Rise Tests on Oil-Immersed Power Transformers at Loads Beyond Nameplate Ratings

C57.119 needs to be reaffirmed by the end of 2006. Subhash Tuli will be initiating the effort in the next few weeks.

7.4.3 Working Group and Task Force Reports

7.4.3.1 Working Group for the Revision to C57.91 Loading Guide - Tim Raymond

The working group Chair, Tim Raymond, called the WG meeting to order at 9:30 AM on Tuesday, October 24, 2006. Vice Chair Glenn Swift and Secretary Susan McNelly were also present.

There were 20 members present and 57 guests with 10 guests requesting membership to the WG.

Approval of minutes from the October 25, 2005 meeting was requested. The minutes were approved as written.

The IEEE Patent disclosure requirements were discussed and a request was made for disclosure of any patents that may be related to the work of the WG. There were no responses to the request for disclosure.

Discussion:

- Draft 4 was posted last week (finally). You can view changes in detail via the track changes option in Word.
- Comments by Tom Holifield – Sec. 5.1

- (1) Page 8, 5.1 General: Consider removing the word "large" from the following the sentence: "The risk areas, which should be considered when loading large transformers beyond nameplate rating, are listed below."

  (2) Page 8, 5.1 General, Short-Term Risks: Consider adding: Hot-spot temperatures exceeding limits of the magnet wire enamel can cause turn to turn initiated failures.

  (3) Page 8, 5.1 General, Short-Term Risks: Consider adding: Top oil temperatures exceeding the glass transition temperature of thermosetting bushings may cause them to become brittle and less resistant to mechanical stress.

  (4) Page 8, 5.1 General, Short-Term Risks: Consider adding: Tank surface temperatures that exceed acceptable limits for safe contact.

  (5) Page 8, 5.1 General, Long-Term Risks: Consider adding: Mechanical strength of components that use thermoplastic insulators (bushings, fuse holders, etc.) diminish as a function of time, temperature, and moisture content much like paper but at different rates.

  (6) Page 8, 5.1 General: Temperature of tank surface may exceed limits of gaskets causing the gasket to crack and fail.

  Should we try and write a section for Distribution and for power transformers. Consensus was yes we should. Volunteers were requested. Mike Spurlock volunteered.

- Clause 6 - Insulation Aging
  - Moved much of the background material from the Annex into this section. Addresses a lot of the hows and whys.
  - Some of this material is still overkill, needs to be pruned and merged with the existing material. Volunteers?
  - Now includes appropriate material for non-thermally upgraded 55C insulation systems (moved from Annex), as well as, for 65C systems.
  - Volunteers to edit this section?

  Tom Prevost and Carl Arpino volunteered to edit this section.

- Clause 7.3 needs some editing to reflect consensus on moisture estimation (or point to some other source). What type of guidance do we want?

  Suggestions:

- Sidestep and not provide guidance at this time as the supportive information is not yet available.
- Move back to the Annex if guidance is not to be provided. There is a potential of misapplication but it is a useful tool that would not be good to lose.

Vote was requested on whether this should be moved back to the Annex. Concensus was that the information should be moved back to an Annex. It will be kept as a discussion item and TV Oommen will be contacted for discussion.

- Clause 10 – Calculation of Temperatures
  - We previously decided to move Annex G into body of guide and move Clause 7 to an Annex. Tim changed his mind on this.
  - This guide needs to be useable or users will revert to old versions. Many users will not have rated bottom oil rise.
  - Therefore, both the Annex G and Clause 7 models are included. The "bottom oil" model is labeled "Calculation of temperatures where rated bottom oil temperature rise is available" and the "top oil" model is labeled "Calculation of temperatures where rated bottom oil temperature rise is not available".
  - The user is free to use the old model where appropriate, but is encouraged (strongly) to use the new model when possible.

  Comment – The two methods will provide quite different values. Could this cause confusion? If a customer specifies a step load profile, if the transformer is designed per the old method it will require less cooling than with the new method. Response: For a new transformer, the manufacturer is required to provide the bottom oil temperature on the test report and this method of calculation should then be used. Need to add a brief paragraph why the new method is strongly recommended for use, but the guide also needs to provide a method for when the bottom oil information is not available.

- Clause 10 (Thermal models) could still use some editing for "flow" and clarity.

  Clause 10 is presently over 20 pages long. Tim requested volunteers to look over the section to try and clarify and make it flow better. Don Platts and Oleg Roizman volunteered to help.

  Clause 10.1.6.2 – Should the section on Losses be kept – Recommendation that Rick Marek will review.

- Clause 10 comments by Tom Holifield
  - Temperatures predicted by the equations in 10.1 do not account for heating due to solar radiation or cooling due to wind and rain. Will be left out.
  - Clause 10.4.1 – Exponents n for ONAN changed to .7 from .8. Could this change be listed in the "Major changes" section of page ii with some explanation of the reason for the change? Also, what is Method C should this be Annex D? Typo, will be change to 0.8. Second part referring to Method C is no longer applicable and will be corrected.
  - Equation 90 – Under light loading and a rapidly changing ambient, heat may transfer from the environment to the transformer. For this equation there is an implicit assumption that heat flows from the transformer to the environment. The problem arises if heat flow is reversed. A simple warning of this issue

might be best. Another option is an explicit correction as follows: Agreed, add correction to average oil temperature.
    - Equation 93 – It seems like the index of avg oil should be "i" as below instead of "I+1". Top to bottom oil gradient is calculated after and derived from average oil. Therefore use value from current time step, I+1, not i.

- Clause 11 (Distribution Transformers and Voltage Regulators) – Holifield comments.
    - 11.1.1 – General, consider changing the sentence "but does not account for such factors as deterioration of gaskets, rusting of tanks, etc…." to "but does not account for such factors as deterioration of bushings, fuse holders, gaskets, rusting of tanks, etc…" OK
    - Clause 11.4, Table 7 – Consider adjusting limits of Table 7 to be the same as Table 9 or those of section 12.2. Consensus was that we don't need to duplicate tables if they have the same values. Duplicate tables will be removed. Tim requested volunteers to review Clause 11 as this is the meat of the guide and try to flesh them out more. Carl Arpino and Bob Tillman volunteered.

- Page 1, Annex D – The annex needs to include a calculation for the top oil time constant at rated load and its correction or a reference to these equations since they are listed in Annex G. OK

- Clause 12 (Power Transformers)
    - Changed temperature limits table to recognize additional factors.

  Tim requested volunteers to review Clause 12. Carl Arpino volunteered to look over this section.

- Clause 14 (Operation with Part of Cooling Out of Service)
    - There has been a suggestion to include equation for loss of fans.

Tim asked whether there were any general comments on the progress or direction. Glenn reqested a timeline for getting information back from volunteers. A timeline of the end of January was set.

The meeting was adjourned at 10:40 am.

Respectfully Submitted

Tim Raymond
Working Group Chair

Glenn Swift
Working Group Vice-Chair

7.4.3.2 Working Group On Thermal Evaluation Of Power And Distribution Transformers (C57.100) – Roger Wicks

7.4.3.2.1 Introduction and Rosters
The working group met on Monday, October 23, 2006 at 11:00 AM with 15 members and 48 guests attending, with one guest requesting membership. This brings the number of members to 51.

7.4.3.2.2 Approval of minutes from March 20, 2006 meeting
The minutes of the March 20, 2006 meeting in Costa Mesa were approved as written.

7.4.3.2.3 Patent Disclosure
The chairman asked if anyone knew of any patents which could pertain to this project. There were none.

7.4.3.2.4 Discussion of DuPont-Weidmann test of power transformer model.
The chairman gave a presentation to the working group of the dual temperature aging model. He gave a brief background of the model and then proceeded to present some of the results of testing to date. A copy of the presentation will be posted on the IEEE PES transformers committee website. Some specific topics were presented with the data that has been collected so far. These include:

- Comparison of Aging Curves to historical curves (Taken from C57.91-1981 and C57.92-1981)
- Comparison of dual temperature model test results to sealed tube test results
- Comparison of DP Life Curves to 50% Tensile Retention Life Curves
- Comparison of Upgraded to Non-Upgraded Paper
- Oil Quality vs Life
- Work in Progress/Future Work
    - Future work includes investigating the effect of moisture and oxygen

7.4.3.2.5 Following the presentation the chair opened the floor for discussion and comments:

- Jin Sim commented that moisture should be measured in the insulation system throughout the test period.
- Hasse Nordman commented that the big question to be answered by this group is what parameters should be included in the formulas in the loading guide.
- Hasse also suggested that it would be of interest to start a test with 3% moisture and then measure the effects as well as the moisture profile during the test.
- TV Oommen commented that there have been many aging studies done over the years. He added that this is a good test and that it should be standardized.
- Patrick McShane commented that to obtain the proper starting moisture content in the insulation it is a trial and error approach. Patrick has sent the chair the process that Cooper used in some of their aging studies. He added that they were able to get a standard deviation of 0.14% on moisture levels of 0.5% with the method they used.
- The chair requested comments from the group in regards to what parameters we should consider in order to be able to evaluate all potential insulation systems.
- Don Platts commented that we need to establish a benchmark of the currently accepted insulation system for 65 C rise transformers, that is, cellulose in mineral oil. This would set a baseline from which to reference future insulation systems. He stated that the focus of this working group should be to establish this baseline.
- Tim Raymond commented that the working group needs to add wording to the guide that the critical life parameters need to be based on the application of the insulation involved. For example, compressibility of spacer material.

7.4.3.2.6 The chair asked for volunteers to review other sections of the present C57.100.

- Distribution Transformer Testing (Lockie)
- Sealed Tube Test (Annex)

The following individuals volunteered to review these sections:
Jin Sim, Patrick McShane, Geoff Gill, Tim Raymond

7.4.3.2.7 Adjournment

The meeting adjourned at 12:07 PM

7.4.3.3 Task Force on Winding Temperature Indicators - Phil McClure

This Task Force is in abeyance until the privatized paper is published. The need for this Task Force will be re-evaluated at that time.

7.4.3.4 Working Group for Temperature Rise Test Procedures Section 11 of C57.12.90 - Paulette Payne

The Working group met October 24, 2006 at 8:00 AM in the St. Laurent room of the Delta Centre-Ville Montreal hotel. There were 13 members and 33 guests present.

Members were provided the opportunity to identify or disclose any patents believed to be essential for the use of clause 11.0; no patents were identified or disclosed.

Minutes from last meeting in Costa Mesa, CA were approved as written.

The first topic discussed was a proposal by Mr. Subash Tuli regarding top oil temperature rise correction based on equation 29 of section 11.4.2, but applied to oil stabilizations done while maintaining constant current instead of constant losses. C57.119 guide for temperature rise beyond nameplate rating allows oil stabilization at constant current. From the audience some testers use constant current while others use constant losses. When using constant current a correction factor is being proposed. It was stated that the use of constant current is necessary specially for windings designed for overload which will not operate near the 65+20 °C standard temperature, then the reported losses will be higher than the losses seeing during operation at rated load. Other point that was discussed is the influence of ambient temperature for a constant current test, the 0°C ambient stabilization losses would be lower than those at 40°C. The wording of the existing standard says “circulate sufficient current to produce total losses” for oil stabilization. Some interpret this as should use constant current, others think losses should be constant. The two methods can produce different results. More discussion will be required on this subject.

Next topic in the agenda was a presentation by Mr. Jerry Corkran. He presented results from several winding temperature rise tests for the same transformer for:

- the winding that is measured first, primary or secondary
- holding one hour rated current between primary and secondary shutdowns
- re-stabilizing at rated current between shutdowns
- re-stabilizing at rated losses between measurements

As a conclusion the test results data shows that, for this transformer, the one hour constant period between windings shutdowns is within +/-1°C variation compared to stabilizing the oil methods, and that stabilizing the oil does not add any accuracy to the test results. All three phases temperature rises were measured for primary and secondary, and the variation was low within 1°C.

On the next topic, Mr. Bob Ganser proposal for a standard cooling curve format "of at least one measurement be made on all windings within 4 minutes of shutdown and that a minimum of 4 be made on all windings as B phase may not necessarily give the highest temperature rise" raised questions regarding the 4 minutes time period to get resistances from all windings. And it was not clear if he was referring to windings or phases. Since he was not at the meeting, further clarification will be required from him.

As the last item, a proposal by Mr. Marcel Fortin was read where he asks to make mandatory the back-to-back temperature stabilization method for transformers rated 1500 kVA 3 phase, 500 kVA 1 phase and lower. In general there was no support from the audience to this proposal, it was recognized that this method could give different test results compared to the short circuit method. The topic will be discussed in the future.

Not having new business, the meeting was adjourned at 9:12 AM.

Vice chair
Juan Castellanos

7.4.3.5 Task Force: on Moisture Estimation in Transformer Insulation – Jin Sim

TF Moisture Estimation did not meet. Chairman Jin Sim reported that the members of the TF continue to evaluate available information on the subject. However, the TF did not find any technology that is suitable for estimating the moisture content of the insulation material near the hot-spot temperature of a transformer within a reasonable accuracy. TF will continue to search for existing technology to do this for one more year. By the Fall 2007 meeting, it will determine if we should continue to write the TF Report or not.

7.4.4 Old Business:

There was no old business.

7.4.5 New Business:

Joe Foldi presented two items for discussion, the calibration of winding temperature indicators (WTIs) and the tested hotspot rise.

- The WTI is calibrated for the top rating on transformers. This has lead to problems with ONAN/ONAF/OFAF units. When the unit is running at ONAF, the WTI is under-calibrated.

- The tested hotspot rise does not represent the actual maximum winding temperature rise when tested in accordance with IEEE 1538.

The discussion included the following:

- The first stage of cooling is typically set to operate at 75 degrees C. This temperature is too low to cause damage to the insulation.
- There are WTIs that allow 3 different stages of calibration. Using a WTI of this type would avoid an under-calibrated WTI.
- One manufacturer has found that maximum aging typically occurs when only half the cooling is running.
- It was suggested that the cooling be controlled by the WTI and top oil temperature in parallel. This parallel system provides a check and balance in case of a mis-calibrated or under-calibrated WTI.
- The different oil and winding temperature time constants can have a significant impact. The addition of a step load can cause the winding to heat up quickly while the top oil temperature is well within limits.
- The winding top oil temperature is much higher than the top oil temperature in the main tank. While fiber optic probes can provide the duct oil temperature, a small difference in the location of the probe has a significant impact on the temperature measured. It is not practical to measure the temperature of the duct oil. It was suggested we create a Task Force to examine this issue.
- One way to deal with the under-calibrated WTI is to run the oil pumps all the time.
- CIGRE is examining the issue of the K values. Their goal is to produce a technical report.
- It was stated that there is a reason not to run the pumps all the time.

At this point, we ran out of time to continue the discussion. The Chair indicated that there were additional topics for discussion. He asked that anyone who had additional topics for discussion should send them to him in the next few weeks. He would send out a survey with these items.

7.4.6 The meeting adjourned at 9:15 AM

Don Platts
Chair, Insulation Life Subcommittee