MINUTES - INSULATION LIFE SUBCOMMITTEE MEETING
8:00 AM Wednesday, March 10, 2004 -- San Diego CA

Note: This minutes are still in preliminary form, and some working group reports are still missing. Please refer to the Transformers Committee website, , for the final version of these minutes

9.7 Insulation Life Subcommittee - D.W. Platts

The Insulation Life Subcommittee met at 8:00 AM Wednesday, March 19, 2004 in San Diego, CA. Attendance was XX members and XX guests.

The minutes of the October 8, 2003, 2002 meeting in Pittsburgh were approved.

9.7.1 Chair's Report

9.7.1.1 ADCOM meeting on Sunday. Details of the discussions will be reviewed in the Main Committee meeting. There were no items that directly effected the work of this subcommittee.

Our next subcommittee meeting will be in Las Vegas on October 27, 2004.

9.7.2 Status Reports for active projects:

9.7.2.1 Mike Franchek has balloted the reaffirmation of IEEE 1276, Guide for the Application of High Temperature Insulation Materials in Liquid-Immersed Power Transformers.

The ballot closed Oct. 5, 2002 and was successful with an 87% return and a 99% approval. Mike will be working to resolve the one negative, and prepare the document for the standards board.

9.7.2.2 Subhash Tuli reported that ballots of C57.12.00 and C57.12.90 have been completed. They were successful, but there are several items to be resolved from the negatives and the comment. Some of them will be forwarded to our subcommittee for resolution.

9.7.3 Working Group Reports

9.7.3.1 Working Group on Loading of Liquid Immersed Transformer - Tim Raymond, Chair.
WG Meeting minutes

Meeting started at 1:50 PM, Tuesday, March 9, 2004.

There were 26 members present and 56 guests with 12 guests requesting membership to the WG.

Some work on Draft three has been done. A copy of Draft 3 is available on line for review. The draft is being edited to format per the IEEE style guide.

Presentation by Glenn Swift, "Comparison of Calculated Hot Spot Temperatures Using CLAUSE 7 Equations versus ANNEX G Equations."

Two methods of calculating *hot spot* temperatures in the current Guide are the Annex G method and the Clause 7 method. Which should be used?

Results from each model were compared for four different example transformers, covering each cooling type. For each case, three scenarios were studied: steady state, four-hour overload (1.4 PU), and typical daily load curve.

For ONAN, ONAF and OFAF, the results differ for short duration overloads, with the Annex G model rising more rapidly for ONAN and ONAF and more slowly for OFAF. The two models agree fairly well at steady state, with the exception of ODAF. For ODAF, the Annex G model gives significantly higher temperatures.

Conclusions: One source of error is that the *Clause 7* method ignores the effect of **oil viscosity** and **winding resistance**, both of which vary significantly with temperature.

The problem with using the Annex G method is that unless you have the bottom oil temperature information, you cannot use the Annex G method.

Comment: Don Platts indicated he would be more concerned with the maximum oil rise rather than the duct oil rise.

Modification of Clause 7 may make the results more correct; however, comparison to historical data may be lost as a result.

The equations that are there do not adequately cover ODAF designs. Therefore at a minimum, we need to discuss corrections to the calculations for those cases.

Will pursue making corrections for the ODAF type transformer model to present at the next meeting.

Comments from reaffirmation Ballot last fall:

- Overhead type transformer, knowledge of the bottom oil temperature requires that the heat run test is being made on a structure that make that air will freely circulate under the transformer. ***Don't feel this is necessary***

- In section 7.2.5 there is no indication that the weight of the tank and fittings does not include those items whose temperature is not affected by the oil. It is noted in section 4.4 note j, but would a person working through the equations in section 7.2 remember that note? ***Will make sure this is clarified.***

- Under paragraph on "possible bushing overload effects….. Suggested remedy was to add "Electrical failure can occur due to the rapid increase in partial discharges due to the increase in heat in the insulation." ***No resolution***

- The guide should be revised to include the real hot spot limits when tap changers are included. Suggested remedy: Revise to include the effect of tap changer position on hot spot temperatures per above comment. ***No resolution***

- Most users specify that transformer must meet overloads per C57.91. Suggested remedy: At the beginning of this guide include a paragraph that this Guide gives methods of calculations

and the user should include the specific overload profile required in their specification. ***Will add note to user to inform them of this.***

- Annex D and E (Prenninger): Would prefer to put these at the beginning of the Guide to make sure they are used and users are aware of what the risks are. ***The Guide should be almost tutorial like so that the user is aware of the risks.***

- Possible overloading of power transformers up to 2 times the rated current. The conditions of the core when the transformer is operated under high loads are not considered. Depending on the physical arrangement of the windings, the core could be heavily overexcited, stray flux pattern and eddy losses could be influenced. ***This will need to be addressed.***

- In Chapter 7, a formula is given to evaluate the bubble evaluation temperature. Can you determine the moisture content with enough accuracy to reliably predict the onset of bubble formation? Do we set a temperature limit, skip different temperature limits for dry or moderately dry transformers, etc. Implication is that the formula implies an accuracy that is really not there.

- Recommendation to change the hottest spot winding temperature for planned overloads to 140C and in case of extreme emergency to 160C. **Will discuss at another time.**

Meeting adjourned at 3:00 PM.

Respectfully Submitted,
Tim Raymond
Working Group Chairman

9.7.3.2 Working Group on Definition of Thermal Duplicate - Barry Beaster, Chair.
The working group met on Tuesday, March 9, 2004 with eleven members and 23 guests attending. An agenda, a copy of the Fall 2003 meeting minutes, a proposal to address two concerns from the last meeting, and a proposed subcommittee survey were electronically distributed to the working group just prior to the meeting. Additional paper copies were available for guests. After introductions, the Fall 2003 meeting minutes were corrected with the change of the word 'pre-quality' to ' pre-qualify', and the omission of the acceptance of Sheldon Kennedy from Niagara Transformer as a new member. The minutes will be corrected and issued. A request for membership was received from Ron Daubert of Finley Engineering and is accepted into the working group.

The three topics addressed at this meeting will be stated here and highlights of the discussion will follow:

1) A proposed future survey question to the Insulation Life Subcommittee. Do we still have a need for a definition of a thermal duplicate transformer, and a guide to determine what qualifies as that duplicate?
2) In what manner shall this guide address hottest spot rise?
3) In what manner shall this guide consider using a tested 55/65°C rise transformer to calculate thermal characteristics on a new unit rated for 65°C rise?

Due to the large number of participants discussing each topic and the amount of points raised by different people, individual's names were not recorded accurately enough to permit inclusion into the minutes. Summary points will be numerated for each topic to illustrate the discussion.

1) Discussion on the questioned need for a thermal duplicate guide generated the following:
   a) For companies doing dynamic loading, accurate and reliable thermal data is critical. It is important to have a guide to assure consistent results.
   b) With the emphasis on accurate hottest spot calculations, a trend in thermal test results shows greater margins between guaranteed and tested rises. Possibly due to larger hottest spot rises than previously applied.
   c) Since the hottest spot is generally the limiting factor, the use of manufacturers calculations should be sufficient to satisfy average winding rise and top oil rise for a range of designs. It would be the right of the user to challenge the manufacturer's models and calculations to ensure the results are proper.
   d) An example of a change in a tap switch location where all other factors being held equal was used to illustrate the flaw in using the present guide.
   e) In distribution transformer manufacture, design tests are made and have been shown to be useful for a range of new designs to be able to predict the rises will not exceed guaranteed values.
   f) The determination of whether to use a thermal duplicate seems to be a risk assessment the user should make. The focus is whether the cost and time of making a thermal test is offset by how critical the transformer is in its installation.

At this point the discussion was concluded and a hand vote was held to gauge the proposed survey question. One voted to continue the project; six voted to continue but re-ballot based on the discussion; and eight voted stating there is no need for the guide. As a follow-up, an official survey of the working group membership roster will be made prior to a survey of the subcommittee.

2) With respect to the guide addressing hottest spot rise the following points were discussed.
   a) It was proposed prior to the meeting that an example hottest spot rise be included in the guide. It was generally felt that no example should be added as several methods are available and precedence might be indicated if just one method were presented.
   b) A descriptive section may be appropriate to identify how critical the need is to have a reliable calculation for hottest spot.
   c) It was further commented not to apply a uniform 'H factor' as this value may not only vary from design to design, but may also vary from winding to winding in the same transformer.

The meeting consensus stated the guide should include the importance of accurate hottest spot in determination of thermal duplicates, but will leave the specific determination in other standards.

3) With respect to how to address 55/65°C and 65°C rise transformers the following was discussed.
   a) The consensus of the meeting was it would be unlikely that enough thermal characteristics already included in the guide would be within range to consider comparing transformers with different temperature guarantees.
   b) There may be other thermal characteristics not considered that make this comparison more difficult to accept.

The meeting consensus was to prohibit the use of 55/65°C transformers for the thermal basis for a 65°C transformer and include another thermal characteristic stating both the tested and proposed thermal duplicate transformer have the identical temperature rise guarantee.

As time had almost expired, it was suggested a greater tutorial section near the beginning of the guide might be needed to identify the focus of the guide. The focus has to consider more than just the ranges of the thermal characteristics included in the guide, as the consensus of this guide may still be a long way off.

Respectively submitted,

Barry L. Beaster
Chairman

9.7.3.3 Working Group Revision of C57.100, Test Procedure for Thermal Evaluation – Roger Wicks, Chair

To be provided later.

Respectfully submitted,

Roger Wicks	Robert Whearty
Chairman	Secretary

9.7.3.4 Task Force on Winding Temperature Indicators - Phil McClure, Chair

Monday, March 8, 2004 San Diego, CA

The meeting convened at 8:00 AM with eleven of the fourteen members and thirty-one guests attending. The members and guests introduced themselves and the minutes of the Fall meeting in Pittsburgh were approved as written.

One returning and two new members were welcomed to the group. Three more persons were added to the list of persons requesting membership.

Old Business

The first item of old business regarded the Presentation on WTI's which was given in Pittsburgh. There were no comments offered by the group and discussion was limited to thanking the participants for their efforts.

The second item regarded the transformer testing and survey proposal which was sent to members and other interested parties. The proposal was distributed to explain the purpose and major details of the testing to potential transformer owners and manufacturers so they may assess whether the testing would be appropriate and / or consistent with their operations. The testing itself is intended to measure and log the winding temperature of various transformers in controlled heat runs and field load-demand operation in order to provide a basis for conclusions regarding response time and accuracy of several types of winding temperature indicators.. As a result of the discussion, two new potential sponsors have agreed to look at the proposal. It is hoped that four tests (two surveys and two heat run tests) can be completed in time to include the results in the next revision of the paper.

New Business

The first item of new business regarded the scope and charter of the task force as it relates to the topics covered in the technical paper. This topic was raised as a way to explain the deletion of some topics from the paper. A slide presentation of passed meeting minutes was given, showing that the original charter prescribed a significantly narrower range of topics than the paper contained in revision four.

The second item of new business regarded discussion of the changes to the paper from revision four to revision six. It was explained that revision six was not released because it had segments added that had not been sequenced or edited.

In summary, the paper has a proposed title revision, it was completely resequenced and 12 sections were either added or largely re-written. Many of the changes were discussed and due to

the volume of comments it was requested that they be submitted through email for consolidation and re-distribution to the group.

The meeting adjourned at 9:20 am.

Respectfully Submitted,

Phil McClure
Chair

Respectfully Submitted
Phillip G. McClure
Chairman

9.7.3.4 Task Force on Temperature Rise Clause 5 C57.12.00- Dennis Marlow, Chair

The Task Force met on Tuesday, March 9, 2004 at 11:00 AM. There were 17 members and 22 guests in attendance.

The minutes of the previous Pittsburgh Oct. 8, 2003 meeting were included in the Subcommittee minutes, and were approved as corrected.

The task force was formed to make recommendations to the Insulation Life SC concerning the 2 proposals for temperature rise changes to C57.12.00 clause 5, submitted by Dennis Marlow at the Amsterdam meeting in April 2001.

The Chair indicated that this might be the last meeting of this Task Force unless the IL SC requests further work

Proposal 2 dealt with changes to the average temperature rise of two windings that were located one above the each other.

- The TF reviewed the new wording and editorial changes to this proposal. At the last meeting, it was recommended that a sentence be added to emphasis that a hot spot temperature rise limit of 80°C applies to all rated loading conditions. Changes to the last sentence revising “shall” to “should” and revising “all loading conditions” to “all rated loading conditions” are also in the final proposal
- The TF also discussed the proposal from one member to locate this proposal in a relevant section of the revision to C57.12.10. The chair of this WG already had expressed a reluctance to include this in the new scope of C57.12.10. The members of this TF present at this meeting, also agreed that it should not be part of C57.12.10, and that we should present this modified proposal 2 to the IL SC for their acceptance and inclusion in C57.12.00 Section 5.11.1.1 “Winding temperature rises”

A vote to refer a modified proposal 2 to the Insulation Life SC for inclusion into C57.12.00 was carried by a large majority

Proposal 1 dealt with changes to the average temperature rise for ODAF cooling from 65°C to 70°C

- The TF reviewed the new wording and editorial changes to this proposal. At the last meeting, it was recommended that a sentence be added to limit the top oil rise to 60°C. This was added to make the limits in this proposal more closely follow IEC standard 60076-2
- The TF also discussed the proposal from one member to locate this proposal in a relevant section of the revision to C57.12.10. rather than in clause 5.11.2 “ Other winding rises” of C57.12.00. There was not

unanimous agreement within the TF on this proposal's location. A straw vote from the guests also did not indicate a true majority for inclusion in C57.12.00.

Since we could not obtain agreement, one way or the other, the members of this TF present at this meeting, agreed that we should present this modified proposal 1 to the IL SC for their acceptance and inclusion in C57.12.00 Section 5.11.2

These final proposals will be distributed to the Insulation Life SC before the next meeting in Las Vegas for a vote when we will review the results of the Subcommittee ballot and comments.

NEW BUSINESS

There was no new business
The meeting adjourned at 11:58

Respectfully submitted,

Dennis Marlow. Task Force Chair

9.7.3.5 Working Group for Temperature Rise Test Procedures Section 11 of C57.12.90
Paulette Payne, Chair

The meeting of the Working Group was held March 8, 2004 at 11:00am in Boardroom West at the Catamaran Resort Hotel in San Diego, California. There were fifty (50) attendees; seventeen (17) members and thirty-three (33) guests of which seven (7) requested membership. The Minutes of the Pittsburgh Meeting were approved as written.

1. The discussion started on Clause 11.3.1.2 concerning the timings of the resistance readings after shutdown. The discussion centered on the 4 minute period for taking resistance readings.
   a. Thang Hochanh of Hydro Quebec moved the discussion to the one-hour time limit between the last shutdown and the re-energization for the next test. If the required readings are missed during the four minute period, then the test should be restarted within one hour.
   b. Bob Ganser didn't agree to such a blanket statement. He felt that the manufacturer should review other issues before using just a one-hour time limit: oil temperature, winding temperature, cooling equipment, etc. The manufacturer should return to the original test requirements concerning stabilization for guidance.
   c. Joe Foldi commented that the manufacturer would have very different test results if they waited more than one hour as the winding will stabilize at a lower temperature and an error will result in gradient measurement as the losses are different. Most people agreed.
   d. Jeff Ray mentioned that this one-hour time limit would be applicable in the case of a three winding transformer.
   e. At this point, Thang clarified his position on the one-hour requirement and the fact that this time limit is most important if you miss your required readings during the four minute period, then you should restart the test within one hour.
   f. Steve from Fort Pierce asked if this time could be shortened to 30 minutes.
   g. Instead of a vote in the meeting, the Chair will poll WG members on the proposed revision to clause 11.3.1.2 prepared by Joe Foldi and Thang Hochanh via e-mail.

h. Don Platts asked if this was a replacement of Section 11.3.1.2. The Chair stated that it was a partial replacement of text in the clause and confirmed this with the authors, Joe Foldi and Thang Hochanh.
i. Don mentioned that the equation for calculating the resistance to shutdown be a part of the standard and not just a suggestion (graphical method in IEC 60076 or a formula).
j. Thang clarified that he will prepare an equation to provide clarity. Thang also asked that suggestions to be forwarded to his attention.

2. The discussion then moved to the second subject of revising Clause 11.5.2.1. Paulette Payne reminded the group that part of being a member is voting and responding to e-mail requests. During the last vote, she only received 13 responses out of 34 ballots on this issue of revising 11.5.2.1.

- 8 votes Yes
- 5 votes No

a. Various comments followed and Paulette read Subhash Tuli's and Don Platts' comments on the issue; which she had provided to the group as Subhash proposed temperature correction of no load losses.
b. The discussion centered around correcting no load losses as well as load losses. The current standard indicates that only load losses are to be corrected.
c. Joe Foldi mentioned that load losses were corrected to 85C for the guarantee; but, that no load losses were being corrected to 20C for the guarantee. This makes it unclear for the temperature rise test. Should no load losses also be corrected to 85C since this is the temperature for the actual testing?
d. Steve from Fort Pierce commented that the standard is not clear on the subject.
e. Tim Raymond mentioned that the difference in losses is marginal and there may be little to no impact.
f. Bob Ganser mentioned that some manufacturers actually calculate the core temperature and core hot spots. However, this doesn't affect the total no load losses.
g. The idea is to calculate the total losses in the core. The core hot spot will not impact the core losses.
h. Alan Darwin of Areva reminded us that the temperature correction is a minor impact overall.
i. Martin Navarro of Siemens commented that there is an equation to correct to 20C and that most use this equation.
j. There was a suggestion that we leave the standard as-is since the difference is 0.5% or less.
k. Steve of Fort Pierce reminded us that we had moved off of the original subject of correction of the no load losses for temperature rise testing.
l. Bob Ganser suggested that we change the standard to indicate that the no load losses be corrected to 85C for temperature rise testing purposes.
m. Steve commented that the standard should provide consistency. He further commented that we should propose changes to provide this clarity and consistency.
n. Bob Ganser reminded us that the standards need to be very clear and direct.
o. Jeff Ray mentioned that the user should be happy either way. The 20C number is higher and therefore more conservative.
p. Paulette then asked for a general consensus: should no load losses be corrected to 20C or 85C for temperature rise test?

i. 15 Votes Yes
ii. 5 Votes to provide Clarification

q. Paulette referenced Linden Pierce's comments and asked if this proposed wording of clause 11.5.2.1 was clear. He mentioned that we should correct to 85C for temperature rise testing.
r. Paulette will send out a new ballot to the WG via e-mail with the choice of either the wording proposed by Linden Pierce, or the original wording.

3. The third item of discussion was the method for generating the shut-down curve to determine winding temperature. Paulette reviewed the position that we currently have with this issue.

a. Paulette referenced the Blume text which she had provided to the group. She asked if anyone followed the method outlined in Blume. Two manufacturers indicated that they used this method, others indicated they have developed their own techniques.
b. Bob Ganser mentioned that the first reading of any value to the curve was usually around 4 minutes due to core issues. He further mentioned that it is more critical to take the cold reading correctly and note the timing of the first accurate reading then. This will be an indication of the accuracy of the first hot reading. Also, the average oil temperature reading is very critical.
c. Steve mentioned that all factories do this differently and we need to define a clear method for performing the cooling curve in the standard so that all manufacturers are the same. The method should be based on the laws of physics and not averages or curve fitting methods.

4. New Business: Hasse Nordman of ABB Finland mentioned that they had performed some testing on a 2,500 kVA transformer with thermocouples in various locations to look at core, winding, oil gradients, etc.

a. The results for average oil were not as they expected.
b. They found very strange gradients.
c. The comment was made that transformers without forced oil have non-uniform oil gradients. Most people in the room nodded in agreement.
d. IEC uses average oil times 0.8 to correct for this inconsistency.
e. Bob Ganser mentioned that he has also seen this in larger transformers. This quickly leads to disagreements on oil gradients and ultimately the final hot spot determination.
f. Hasse Nordman mentioned that the current IEEE method would have led them to a hot spot value that was 10C to 20C higher than actual; due to the oil fluctuations.
g. The WG requested to have ABB Finland's test results and conclusions for review before the next meeting. These will be forwarded via e-mail.

5. There was a motion to adjourn; and a second.
The meeting ended at 12:15pm.

Respectfully submitted,
Allen Mitchell

9.7.3.4 Task Force Definition of Thermally Upgraded Paper- Don Platts, Chair

The Task Force and many guests met on Tuesday, March 9, 2004 at 8:00. Attendance was 5 members and 46 guests.

Don Platts, the chair, reviewed the activities since the October meeting, to establish a definition of thermally upgraded insulation. We conducted a survey of The Insulation Life Subcommittee to approve the definition agreed to at the last meeting. There was little response, only 15% responded at all. Accordingly, the approval of the definition was added to the agenda for the subcommittee meeting.

Based on the assumption that the task force accepted the definition, and therefore the Subcommittee would accept it, IEC has adopted that definition. The task force has turned it efforts to implementation of the definition in the IEEE standards.

To resolve issues with the definition, and the content of C57.100, we have concluded that the requirement for a minimum life expectancy for the insulation system must be a requirement in C57.12.00, not listed in the loading guide, C57.91, and in the Standard Test Procedures for Thermal Evaluation of Liquid immersed transformers, C57.100. To support that goal, the chair prepared a draft statement for inclusion in C57.12.00, which was primarily the existing wording, the Arrhenius curve, and the formula from C57.100. That was circulated to the task force members for review and comment.

The early feed back indicated concern with the appropriate end of life criteria and the corresponding minimum aging expectancy. Today we have 3 different sets of values in use, and it is creating confusion. A second concern was that the wording did not refer to the need to use "thermally upgraded paper", but just to the minimum aging criteria of that paper as the minimum for any insulation system used. To resolve some of these issues, a second draft was prepared and circulated, but due to the short time available for review, and the lack of task force members at the meeting, this effort had little effect.

Hasse Nordman offered a suggestion to parallel the work of IEC and attempt to separate the theoretical life expectancy from the in-service life expectancy. His explanation left many in the audience puzzled, so the chair asked him to provide his comments in writing for consideration. [He has done so, and his comments are attached].

As noted above, there were very few members present, and most of the guests had no exposure to the discussion of previous meetings, so the chair had to regroup to address the many questions. He explained the need for this continuing effort, the objective of adding a requirement to the standard, and the basic plan to accomplish the goal.

Sheldon Kennedy commented that the thermally upgraded insulation is not only used for conductor insulation, but also for layer insulation on layer wound transformers.

The group got into an extended discussion of testing of different material and techniques, and evaluation criteria. The chair noted that this discussion is a part of the scope of the working group revising C57.100, not this task force.

There were comments in the discussion those insulation temperature indexes are assigned to materials based on testing, and that our work should investigate that rating system, and ensure that our results are consistent with that, where appropriate. This has been referred to the working group chair.

The meeting adjourned at 9:20.
Donald W. Platts
Chair Task Force - Definition of Thermally Upgraded Insulation

9.7.4 Old Business

The TF for Definition of Thermally Upgraded Insulation conducted a survey of The Insulation Life Subcommittee to approve the definition agreed to at the last meeting. There was little response, only 15% responded at all. Accordingly, the approval of the definition was added to the agenda for the subcommittee meeting. By a unanimous vote, the subcommittee approved the definition. It will be included in the next revision of C57.12.80.

9.7.5 New Business

There was no new business presented.

The meeting adjourned at 9:15 AM.

Respectfully submitted by:
Donald W. Platts, Chair Insulation Life Subcommittee
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