MINUTES - INSULATION LIFE SUBCOMMITTEE MEETING
8:00 AM Wednesday, March 19, 2003 Raleigh, NC

9.1 Insulation Life Subcommittee – D.W. Platts

The Insulation Life Subcommittee met at 8:00 AM Wednesday, March 19, 2003 in Raleigh NC. Attendance was 29 members and 78 guests.
The minutes of the October 23, 2002 meeting in Oklahoma City were approved.

9.1.1 Chair's Report

9.1.1.1 ADCOM meeting on Sunday. Details of the discussions will be reviewed in the Main Committee meeting.
The metrification policy is still being discussed. As of now, there are no changes in our directions or plans.
Linden Pierce, the former chair of this subcommittee has requested Emeritus membership status, and it has been approved.

Our next subcommittee meeting will be in Pittsburgh PA on October 8, 2003.

9.1.2 Status Reports for active projects:

9.1.2.1
C57.91 Loading Guide
The loading guide, C57.91, has been balloted for reaffirmation, along with a corrigendum covering several errors that had been found in the printed document. The ballot included an electronic version of the guide and it contains several errors produced during the scanning process. It had to be revised to clean up those errors.
The Standards Board would not approve the guide because the contents of the corrigenda had not been included in the balloted document. There were also some negatives and Linden is working to get the document ready for recirculation.

9.1.2.2
Corrigenda ballot C57.91 Loading Guide. This document has been approved.

9.1.2.3
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.

9.1.2.4
Definition of Thermally Upgraded Insulation.
Several members of the subcommittee and many guests met on Tuesday, to review efforts to find a definition of thermally upgraded insulation. Attendance was 58.

The Insulation Life Subcommittee received a request at our meeting in October 2002, to provide the definition to Phil Hopkinson. IEC representatives had asked him to provide it for consideration in their loading guide applications.

Although we are certain that these items were thoroughly debated and reviewed 40 years ago when thermally upgraded insulation was first introduced to the standards, none of us have found documentation. It would have most likely been internal documents produced by Westinghouse, GE and the other manufacturers, not in publicly available papers.

Tom Lundquist reported that ASTM test D982 tests paper to determine the nitrogen content. The conclusion to be drawn from the test is that if the nitrogen is between 1.3% and 4%, the paper is thermally upgraded insulation.

Tom Prevost questioned if a test that determined nitrogen content is adequate to define thermally upgrading. And suggested that a definition should somehow be tied to the rate of aging.

Harold More and Tom both stated that there are/were several different methods for upgrading paper. The methods used different chemicals and different means of introducing it into the paper. A complete description must include both the chemical and the processing techniques. They also agreed that an aging criteria must be applied.

Hasse Nordman explained some of the history of the request from IEC. The latest draft of the IEC loading guide included a side by side comparison, item for item of the IEC calculation method vs. the US IEEE method – where operation at 98ºC produces a relative aging factor of one vs. the 110ºC operation. An explanation that the material had to achieve a given aging duration at 110ºC was considered inadequate and the document revision was rejected based on that. Therefore, a purely functional description based on aging criteria alone is not sufficient for the IEEE response to IEC.

Patrick McShane explained that Cooper has done a great many tests using a procedure they got for LADWP, and which is now described as the test procedure in C57.100 Annex A. These sealed tube aging tests compared nearly perfectly with the tests reported in an IEEE paper by Bill McNutt. He will collect some of that data to share with the group.

Various persons discussed testing to determine loss of tensile strength, DP, furan analysis and their correlation to the N2 content. Jim McIver requested that if we agree to use nitrogen content as the evaluation that we verify its correlation to aging tests.

Harold Moore has agreed to look for old Westinghouse information and John Crouse will look for old GE data.

Tom Prevost suggested that a nitrogen test may be acceptable as the quality control test done by an insulation manufacturer and that type tests could be done to verify aging performance and conformance to the requirements of the standards. He also offered to get tests done to help verify the correlation of nitrogen content to long term aging properties.

A task force was formed to pull together this information and prior work. Don Platts will chair it.

9.1.2.4.1
Discussion within the Subcommittee followed the report.

Marlow stated that the IEC 98ºC temperature for the basis of thermal loading is based on operating in a 20ºC average ambient, versus the ANSI 110ºC life operating in a 30ºC average ambient. So they are not that different.
McShane asked how IEC verifies thermal quality?
Fyvie offered to get a definition of IEC thermal criteria.

9.1.3 Working Group reports were as follows:

9.1.3.1 Working Group on Loading of Liquid Immersed Transformer – Tim Raymond, Chair.

The Working Group met at 8:00am on Monday, 17 March 2003. The attendance results have not yet been compiled.

Don Platts informed the group the Linden Pierce was no longer able to serve as the WG chair. Tim Raymond was introduced as the new WG Chair. In addition to the appointment of a new WG chair, Glenn Swift was appointed Vice Chair and Sue McNelly was appointed Secretary/Technical Editor.

Current Status

The 1995 Corrigenda is complete and awaiting editor approval. The Corrigenda corrects some minor errors. A reaffirmation ballot will be conducted soon. We have 2 years to revise or reaffirm.

There have been two revision drafts by Linden Pierce. The latest draft (Draft 2) was sent out approximately 1 year ago. No changes have been made since.

Changes as of Draft 2 are as follows:

- Scope expanded to include voltage regulators
- Scope expanded to include silicone and high fire point liquids
- Gas evolution material replaced with model by T. V. Oommen
- Thermal models changed
- LOL limits added for power transformers
- Temperature. limits on bushings added
- Limits for 55C transformers added
- Many annexes moved to main doc.
- Effects of Over-, Under-excitation and non-sinusoidal load currents
- Clarified LOL section

New Business

Is there a need to revise? In previous comments, Don Platts gave three reasons he could think of for a revision:

1. Users are having problems with failures resulting from the use of the guide.

2. The guide is not applicable to their applications.

3. There is improved technological information available that should be provided to users.

Tim Raymond indicated that he thought a revision was appropriate based upon the amount of good work that has already been accomplished. There were no disagreements.

The scope, as it read in Draft 2, was then reviewed to ensure that the WG agreed with the expanded scope. Two issues were raised concerning the revised scope:

1. Are we de-emphasizing the 65C winding rise for the 110C hot spot?

   Discussion:
   - Don Platts indicated that he didn't feel that there was a big difference with either set of wording as they both would refer to C57.12.00.
   - Tim indicated that he felt that using 65C would lead to less confusion. A comment was made that voltage regulators that are rated 55C have 110C rated insulation.
   - The scope is a bit misleading with the "at rated load" in the description. Should either remove the "at rated load" or add "at 30C ambient.
   - Due to the "30C average, 40C maximum ambient" wording in C57.12.00, we may want to add 120C maximum in parenthesis if we leave the scope as 110C.

2. Tom Prevost indicated that the WG may not want to expand scope to all fluids as it would greatly expand the amount of work and revision that will be required.

   Discussion:
   - Transformer manufacturers are coming up with new vegetable oils faster than the standards can keep up with them.
   - Tim asked is there was a concern in applying this standard for transformers using vegetable oil. There was no answer.
   - If we try to make the model work for all types of oil, it will be very complex. Should write a separate model for vegetable oils and one for mineral oils.
   - Vegetable oils should be included, but should have a different loss of life than mineral oils.
   - Tim asked for someone to elaborate on what other differences between mineral oil and vegetable oil. Main differences identified were: Viscosity, Coefficient of expansion, specific heat, thermal conductivity and one other that was not identified. Tim asked what the difference would be in temperature between the mineral oils and vegetable oils. Comment was made that it would be minor.
   - Jin Sim indicated that he agreed that we would make the revision a huge task if we include the vegetable oils at this time due to heat transfer concerns that would also need to be addressed.
   - Paper ages slower in vegetable oils, therefore, vegetable oil will become more dominant and have a positive effect on transformer loss of life.
   - Tim indicated that his inclination at this time would be to not include vegetable oils and leave that to a later revision.

Following the discussion during the meeting and discussion with individuals after the meeting, it was decided that the Scope will read:

"This guide provides recommendations for loading mineral-oil-immersed transformers manufactured in accordance with IEEE C57.12.00 and tested in accordance with IEEE C57.12.90, and voltage regulators manufactured and tested in accordance with C57.15.

Because a substantial number of 55C rise transformers are still in service, recommendations that are specific to this equipment are also included."

Liquids other than mineral oil will not be covered in this revision of the guide. Should the need for loading guide coverage of other insulating liquids arise, the issue will be readdressed at that time.

The last subject discussed was the issue of the thermal modeling. There was quite a bit of comment on this area at the previous meeting and in the interim. There appeared to be some concern over the data requirements for the new proposed models (Annex G of C57.91-1995). Reasonable minimum data requirements must be established. Difficulty in obtaining data must be balanced with increased accuracy. There have been difficulties in obtaining data from transformer manufacturers for distribution transformers.

Proposed min data:

- No-load loss,
- load loss
- top oil rise
- avg winding rise
- hot spot rise
- weight of core & coils
- tank
- oil volume
- bottom oil rise?

Comment – Take the old equations and improve on the definition of the old equations and if possible extend them to make them better. Do studies that compare the different models to see what the differences are. Tim showed a graph that he had put together that showed a rough comparison of the different methods.

Question – Is there anything in the guide that if the user requested the information, that the manufacturer could not supply? The answer is no, but the concern is for older existing transformers. It would be a concern to the manufacturer if requested at the time of bid, but could easily be provided at the time of order or with test reports.

In other discussion, it was commented that it doesn't do any good to have a loading guide if C57.104 indicates that CO is a gas that needs to be monitored and has values that conflict with the loading guide. Tim suggested that maybe there should be a section that discusses increased maintenance intervals following overloads. Discussion followed. Not too detailed but maybe add a note in the standard for users to indicate what they could expect to see for gassing.

Bipin Patel suggested that the work needs to be broken up into sections or smaller groups. Due to the large size of the WG, it will be difficult to get anything done with such a large group. The Chair agrees and anyone that wishes to volunteer is encouraged to do so. The chair will attempt

to identify areas that would benefit from the focused effort of a designated Task Force. It is hoped that a great deal of work can be accomplished between meetings, using electronic resources where possible.

The meeting was adjourned at 9:15am.

Respectfully Submitted,
Tim Raymond
Working Group Chairman

9.1.3.1.1
Discussion within the Subcommittee followed the report.
Corkran commented the carbon dioxide level increase over time and within 1 to 2 years begin to bump into the levels identified in C57.104 as being of concern. He recommended that labs perform 1 or 2 year aging tests to check the CO levels to verify the C57.104 criteria.

9.1.3.2 Working Group on Definition of Thermal Duplicate – Barry Beaster, Chair.

The working group met on Tuesday, March 18, 2003 with twelve members and 29 guests attending. The membership roster has been adjusted by removing those members who have retired or will no long attend the meetings. Two guests have requested membership. Mr. Tim Raymond of Power Delivery Consultants and Raj Ahuja of Waukesha Electric Systems were accepted as members. Due to the issuance of the document for an IEEE ballot, the ramification of member changes will be discussed with IEEE. The membership roster remains at twenty-three members. An agenda, a collection of the comments from the IEEE sponsored ballot that closed in December 2002, and a new draft of Annex A – an example of modified calculations were electronically mailed prior to the meeting. Some additional paper copies were available for guests.

Since the document was balloted last fall, no working group meeting was held at the last Transformer Committee meeting. The ballot has met both the 75% return requirement and the 75% affirmation requirement. However, of the 104 votes returned, 20 negative ballots with a significant number of specific issues were received. After a short review of the document scope and purpose, it was agreed to address many of the small technical issues by individual working group assignment and have this working group meeting focus on a couple of key ballot comments where group discussion would bring a spectrum of thoughts and help to focus on the manner to resolve these issues. The working group had time to discuss four of these issues.

- The first is a new requirement in the guide that requires the test report to contain the hottest spot winding temperature rise. Some discussion was raised whether a comparison between the hottest spot temperatures between the tested and proposed duplicate should be made similar to other thermal characteristics. Due to the possibility that two transformers, which may meet the all the other comparison tests, may have discrete differences, such a de-energized tap arrangements, it will be necessary to require independent hot spot factor considerations for each transformer. This will be developed in greater detail and presented to the working group for further input and comment.
- The second issue was the conflict with the requirement for the maximum thermal loss measurement in the guide versus the C57.12.00 requirement for loss measurement only at the tap extremes when no thermal test is specified. In some cases, the maximum loss position may not as specified in C57.12.00. This comment will be reviewed with the C57.12.00 revision working group for a recommendation.

- The third issue was the tolerance given for the winding gradient in the table of thermal characteristics. The tolerance given in the table is not reasonable considering the range of average winding rise and average oil rises permitted. Although the document implies the comparison is to be made between the calculated value for the new transformer to the measured value for the tested transformer, it is not clearly stated and if true, the objection is valid. Since this document is only a guide, several redundant comparisons are included for 'comfort' for individual examiners. It must be determined which of these comparisons in evaluating whether a design should be compared to another should be made on a calculated to calculated basis and which could compare the calculated values of the new design to the tested values of the first transformer. A modification to the table will be made and circulated among the members for comment.
- The fourth issue relates to the relevance of this document to the large distribution or small power market. The negative comments related that the market may not be demanding the detail required by the guide for these size transformers. A comment made during the discussion may hold the answer for this market. In the introduction of the guide the purpose for developing this definition is intended to address situations where a user has a specification statement, "Perform a thermal test in accordance with C57.12.00 unless the manufacturer has thermal test data from a thermal duplicate transformer." If this is not identified in customer specifications, perhaps alternative techniques are acceptable? This guide cannot change the requirement of C57.12.00, but perhaps the 'thermal duplicate' definition might have a special clause for situations aforementioned. A section can be added and the validity tested in the working group.

Time had expired, the meeting was adjourned.

Respectively submitted,
Barry Beaster
Working Group Chairman

9.1.3.2.1
Discussion within the Subcommittee followed the report.
Vietch commented that too much time was being spent on the topic. Those tests should be done to verify thermal performance rather than trying to justify the basis of calculations.
Several members commented that while testing may be appropriate for large power transformers, it is impractical, and inappropriate for distribution transformers.

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

The Working Group met at 9:30 AM on March 17, 2003, with 22 requesting membership and 25 guests present. This was the inaugural meeting of this newly formed working group

After introductions, the Chairman presented the agenda for the meeting, and circulated the attendance rosters with emphasis on the need for working group members to participate in the work at hand.

Following this, the Chairman and Don Platts, Insulation Life Subcommittee Chair discussed the background on the document, which helps define the timetable for the working group activity. The document has a 1999 publication date, so action on this document is required by the end of 2004.

The Chairman briefly reviewed the scope of the document as outlined in the most recent PAR for the last revision of this document, as well as from the document itself. This initiated a round of discussion regarding what the scope of the document should be. Major items discussed included:

- Does the standard thermally evaluate the transformer or the insulation system?
- Does the standard, as written, successfully cover both power and distribution transformers?
- When should this document be applied, i.e. under what circumstances should an equipment manufacturer conduct a test per this standard?
- Can the testing be stand-alone (direct) vs. a specified value, or does it need to be comparative to either a standard system or previous testing by the manufacturer?

The working group upon completion of this discussion, voted on the first of these items, and agreed that we should change the title of our document in the PAR submittal to be more consistent with the document intent, i.e.:

IEEE Standard Test Procedure for Thermal Evaluation of Insulation Systems for Liquid-Immersed Distribution and Power Transformers.

After this vote, there was additional discussion generated by a vote related to the comparative vs. direct testing question. This again raised questions, including what would require a change, what criteria should be used for acceptability (especially in the case of a "new system" with no comparison to old data), and when would a single point vs. full Arrhenius plot be suitable.

The working group voted at the end of this discussion to modify the scope in the PAR submission to omit the word "direct" in the thermal evaluation. This change will be incorporated into a draft scope which the Chairman will circulate to the working group for comment, prior to submission to the Standards Board.

The working group next discussed main areas of work for the revision of the standard, and this included the following:

- Does there need to be a third method (beyond the two in the document), to make the document more usable by the power transformer manufacturers?
- Are there other factors, beyond those listed, such as liquid testing, other aging factors (such as moisture, oxygen), which either need to be specified in the test, or evaluated?
- There is an IEC document in Draft CD stage – 62332, which might have influence over this work. The working group chair will try and gain permission to circulate to members of the working group.

Finally, the group confirmed that we needed to revise this document, not just reaffirm it as there are too many open issues at this time. It was felt that if work were well underway by the end of 2004, that the Standards Board would allow an extension to allow the Working Group to finish the work.

Work Assignments: The Working Group Chair will send copies of the document to all working group members and guests. The Working Group Chair will send a draft PAR to all working group members and guests, and expect comments back from the working group members within a reasonable amount of time.

The Working Group Chair closed the meeting by requesting equipment manufacturers who would be willing to share evaluations they have made in the recent past which may apply to this document. A

couple of manufacturers and one material supplier agreed to provide short summaries of historical work.

The meeting concluded at 10:45 AM.

Respectfully submitted,

Roger Wicks	Robert Whearty
Chairman	Secretary

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

The meeting convened at 1:50 PM following the luncheon. Five members and 18 guests were present. Three guests requested membership and one guest who requested membership at the last meeting, was accepted as a member.

It must be reiterated that the objective of the Task Force is to write a technical paper and present a panel session on the subject of winding temperature indicators. An obvious requirement for membership in the group must therefore be a substantial contribution towards the completion of that objective. To require less would diminish the efforts of those who have contributed to the effort.

The minutes of the previous meeting in Oklahoma City were presented, but were not approved due to an oversight on the part of the chairman. (Solicit approval from members who were present at the WTI meeting yesterday and are present at this IL subcommittee meeting today).

Old Business:

A discussion of the changes and additions to the technical paper was had. Four major revisions were made:

1. The paper was re-sequenced to place common terms, instrument and sensor categories at the beginning of the paper in order to introduce them for later reference.
2. The paragraphs in section 1.2.1 which describe optical probes was amplified.
3. The abstract was modified to explicitly declare that an exploration of the response of winding temperature indicators to cooling inadequacy and step load increase is an objective of the paper.
4. Section 1.3.6 was added to address the response issues.

The group was polled regarding the thought that the manufacturer's section may become irrelevant in view of the lack of response to requests for help in completing it. The group responded that they thought the manufacturer's experiences on the subject were critical. The chair agreed and another request for authors to contribute to the transformer manufacturer's section was made. Several persons expressed interest and those persons will be contacted in the weeks following the meeting.

New Business:

During the last meeting in OKC it was decided that data was needed which could substantiate the various WTI type's response time. The data could be used to help describe how a particular WTI type would respond to a cooling auxiliary failure. The person who had thought that he could

provide the data was unable to do so, and other alternatives were discussed by some of the members. The members agreed that the most desirable solution would be to run a survey on a transformer or transformers which contained optical fiber imbedded in the winding as well as a heated hotspot thermowell.

It was decided to see if any such transformers existed and if so, whether their owners would be willing to allow a survey to be conducted. We were able to find three Transformer's Committee members who knew of several such transformers and would solicit their owners for permission to run the surveys. Hopefully the permission can be obtained and the surveys can be completed in time for the presentation of the paper at the next meeting in Pittsburgh.

While on the discussion of the surveys, the usage of fiber in Europe versus the US broke out. It was stated that fiber was routinely installed in transformers intended for service in Europe. The fiber is brought out through the tank wall, but is not often equipped with a measurement instrument. The fiber is used in the factory for testing purposes and is used with a portable measurement instrument in the field, by the utility, for verification or diagnostic purposes.

It was suggested that this practice should be suggested in the paper as a cost effective alternative to a permanent measurement instrument installation.

It was then pointed out that the paper did not include a section which was dedicated to these types of recommendations and it was suggested that a discussion section could be added immediately before the conclusions section to address that omission.

The meeting was adjourned at 1:30 PM.

Respectfully Submitted
Phillip G. McClure
Chairman

9.1.3.5 Task Force on Temperature Rise Clause 5 C57.12.00- Dennis Marlow, Chair
The task force did not meet - time for discussion was allotted during the subcommittee meeting. The Survey of the SC produced about a 50% return. The results were generally positive suggesting that we continue with the effort.
Dennis urged others to provide additional responses as input. He will try to resolve the negatives received in 4 weeks, and get a draft of the final proposal out in 8 weeks. Platts asked guests to contact him if they wanted to participate in the survey.

9.1.3.5 Task Force for Revision of Temperature Test Code in C57.12.90 – George Henry
Due to our sudden loss of George Henry, the task force did not meet formally. Don Platts did lead a short discussion to review the work ahead of the group- particularly the need to standardize the cooling curve extrapolation method. He also asked others to help to identify any open items that may have been considered by the previous task force that George chaired, but was deferred to a future time.
After the meeting Paulette Payne responded to the call for a volunteer, and she will chair this task force. Allen Mitchell has agreed to serve as vice-chair.

9.1.4 Old Business
9.1.4.1 None

9.1.5 New Business

9.1.5.1

The chair explained that Subhash Tuli had reported at our last meeting 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 comments. More than 40 of them were forwarded to our subcommittee for notification or for resolution. They have not yet been reviewed to determine the extent of our work requirements.

The meeting adjourned at 9:15 AM.

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