

Insulation Life Subcommittee - Unapproved Meeting Minutes
October 8, 2008 – Porto, Portugal

8.1 Insulation Life Subcommittee – Don Platts, Chairman

The Insulation Life Subcommittee met in Porto, Portugal on October 8, 2008 at 8:00 AM.

The minutes of our meeting in Charlotte, North Carolina on March 19, 2008 were approved as written.

8.1.1 Chair’s Report

The Spring 2009 IEEE Transformers Committee Meeting will be held in Miami, Florida in April. The Fall 2009 meeting will be held in Lombard, Illinois in October.

8.1.2 Project Status Reports

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

REVCOM approved the reaffirmation of C57.119.

8.1.3 Working Group and Task Force Reports

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

The working group was called to order by Don Platts standing in for absent Chair, Tim Raymond, and Vice Chair Carlo Arpino at 10:40 AM on Tuesday, October 7, 2008. Secretary Susan McNelly was also present.

There were 23 members present and 30 guests with 4 guests requesting membership to the WG. Guests requesting membership were:

Kirk Robbins	Amitav Mukerji
Abderrahmane Zouaghi	Oleg Roizman

Agenda:

- 1. Introductions**
- 2. Minutes approval and patent announcement**
- 3. Comments to latest revision**
- 4. Plans for Completion**
- 5. Adjournment**

Introductions of members and guests were made.

Approval of minutes from the Spring 2008 meeting in Charlotte, North Carolina 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.

Comment review:

Comments were received from the following to the latest draft 5.1:

- George Frimpong
- Luiz Cheim
- Malcolm Thaden
- Bipin Patel
- Oleg Roizman
- Don Platts

A special thanks was extended to those who took the time to comment.

General Comments

- The terms “55C rise” and “65 rise” are loosely used in the document. Use “55C rise rating” and “65C rise rating” for clarity.
- Unless there is a specific need we should avoid making reference of IEEE/ANSI standards by specific year and subclause #. Otherwise every time a referenced standard is revised we will have to revise this guide.
- The terms “loading in excess of nameplate”, “loading above nameplate”, “loading beyond nameplate” and “nameplate rating” v/s “nameplate” within these terms mean the same thing but a consistent use of terms will be helpful. Any suggestions?

Will verify that there is no standard way of referring to this in the standard definition guide. If not, will us the same terminology that is used in C57.119 which uses “at loads beyond nameplate ratings.”

- Equation numbering, figure numbering, etc. needs to be fixed.

The entire guide will be converted to the IEEE style template. These items will be fixed during this process before the next draft is sent out.

Clause 2.1 – Purpose:

- The wording implies that the sole purpose of the guide is to address loads in excess of nameplate rating. I think it should be something like this: “The purpose of this guide is to establish guidelines for loading transformers. Applications of loads in - - - risk. The purpose of the guide is also to identify these risks and to establish - - - level.”

Comment provided by Tim Raymond - I don’t think that we can change the wording at this time. Certainly Scope cannot be changed.

Discussion in the WG indicated that while the scope can be changed, it requires a PAR revision and is not desirable as the PAR expires at the end of 2009 and the document needs to move along.

Clause 4 – Nomenclature:

- Malcomb Thaden indicated that the nomenclature list is very useful in a standard like this and that he finds himself going back to it.
- Bipin Patel indicated that the nomenclatures are already included locally throughout the document as needed. Having them here also duplicates the efforts. It adds extra burden of making sure that all symbols and suffixes are included and consistent. On the other side having them here all at one place helps find a particular symbol or suffix when applying them. His vote was for not including them in this location.

The WG discussed the usefulness and location of these definitions. Many agreed that it was useful to have a listing of all of the terms used in the formulas throughout the document. The IEEE style guide requires that they be located by each formula so not having them with the formulas does not appear to be an option. Therefore, after much discussion, the consensus was that there is a need for a listing of all of the definitions in one location. However, it may be more appropriate to put them in an informational Appendix or Glossary at the end of the document. If this is done, Figure 1, which also needs to be revised as there are errors as a result of past draft translations, would need to be kept with the overall list.

Clause 5.2 – Load Current, voltage, core excitation, and frequency considerations

- Add:
 - c) The load current shall be approximately sinusoidal. The harmonic factor shall not exceed 0.05 per unit. Harmonic factor is defined in IEEE Std C57.12.80.

Response from Tim Raymond – The wording in this Clause was taken from C57.12.00, which did not have c). However, we should recognize that loading under non-sinusoidal loads is not within the scope of this Guide.

The general consensus was that there should be a reference added to this clause to C57.110 instead of adding an item c. Also, the guide needs to make sure it clearly indicates that it is intended for use for sinusoidal loads. Users should refer to C57.110 for non sinusoidal loads.

Clause 7 - Thermal Evolution of Gas from Transformer Insulation

- Comment that the statement “The risk of failure decreases when no insulation collars are used in highly stressed parts of the transformers with reduced BIL insulation systems.” may not be true.

Tim Raymond recommended that the sentence be removed and that the section could use some qualitative “fleshing out.”

The general consensus in the meeting was that the sentence made no sense and should be removed. Tom Prevost volunteered to take a look at revising the section with TV Oommen's help.

Don Platts indicated that he was also not sure that item 2 in this clause belongs in the guide. This will also be reviewed in the revisions to be done by Tom and TV.

Clause 9 – Information for loading calculations:

- Under “More precise calculations of loading capability may be performed if desired if the following additional information is also provided” add “top-of-duct oil rise at rated load (from design calculations).”

There was no discussion and no comments during the meeting on this item

- To perform calculations for under and over excitation, core loss test results should be requested for excitation levels of 90 to 110 per cent in 5 per cent steps.

Comment: Dick Amos – Why not just ask for an excitation curve?

Comment: Joe Foldi – Under load there is regulation and flux in the core that is not the same as under no load conditions. Usually this is done at 90, 100, and 110%. Joe indicated that he was not sure that the 5% steps were necessary.

General consensus was that the additional steps were not necessary and were not in favor of making this change.

Clause 9.4 – Calculations of rated losses at power level of loading:

- The multiple sets of subscripts (R, MVAI and MVAL) is confusing. The intent of this section is to explicitly describe the conversion of the measured losses (usually reported at the self-cooled rating) to the MVA rating for which the heat run was conducted. Somehow, this should be made more clear.

Don Platts indicated that there seemed to be some confusion on the use of the 2nd suffix “R” with the 3rd suffix. There were no specific comments, so this will be highlighted for review in the next revision. Don Platts will also further review this item.

- Before Eq 7 we state that the ohmic losses can be calculated from the winding resistances. We don't have symbols for this, but perhaps should state that the winding resistance from the test report must be multiplied by the square of the winding current (particularly important for autotransformers).

There was no discussion and no comments during the meeting on this item

Top-of-duct oil rise:

- “For the ONAN, ONAF, and ODAF cooling modes, the winding duct top oil temperature at rated load, $\Theta_{TDO,R}$ is assumed equal to the tank top oil temperature. Then the duct oil rise over bottom oil is (33A)”

Tim Raymond indicated this needs better clarification. The assumption is not as simple. For this to be true one must assume that all windings (HV, MV, LV) have the same longitudinal temperature gradients (rarely true) and one cannot neglect the core influence either. Notice that the longitudinal gradient measured during heat-run test is under “total losses” and not the effective losses of individual windings. While he agreed that the top of duct oil rise will not generally equal the bulk top oil rise, the assumption is consistent with assumptions we have made to date. If manufacturers are able to supply a more correct number, great. In the absence of this, the approximation (for other than OFAF) is reasonable.

The general consensus of the group during the meeting was that the top-of-duct oil rise information is normally available from the manufacturer and should be requested.

Plan for Completion:

1. Make editorial changes to fix numbering, etc. as soon as possible and circulate a “semi-final” draft for comments.
2. Submit for editorial review to prepare for balloting.
3. Barring major objections, submit the document for ballot by next meeting.

The meeting was adjourned at 11:45 am.

Respectfully Submitted

Don Platts for Tim Raymond (WG Chair) and Carlos Arpino (WG Vice Chair)
Susan McNelly – WG Secretary

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

8.1.3.2.1 Introduction and Rosters

The working group met on Monday, October 6, 2008 at Noon with 16 members and 54 guests attending, with 3 guests requesting membership. This brings the number of members to 75.

8.1.3.2.2 Approval of minutes from March 17, 2008 meeting

The minutes of the March 17, 2008 meeting in Charlotte were approved as written.

8.1.3.2.3 Patent Disclosure

The chairman asked if anyone knew of any patents that could pertain to this project. There were none.

8.1.3.2.4 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 first provided background information on the following subjects:

- Dry Aging data vs. C57.91 life curves (non-upgraded)
- Aging data for “dry” insulation for 4 different paper types.
- Dp vs. Tensile strength correlation
- Comparison of Dp 200 life vs. 50% tensile life curves
- Furan Data vs. Dp (upgraded vs. nonupgraded)

He then provided updated information for the working group on the following subjects:

- Moisture aging for non-upgraded paper showing a clear response vs. moisture content (ranging from 0.5 to 2% moisture)
- Nearly complete life curve which has data very similar to the C57.91-1981 life curve for non-upgraded paper (98C vs. 94.5C)
- Moisture aging for 1.7% upgraded paper showing a significantly reduced effect of moisture (at 0.5%)
- Nearly complete life curve with data different than C57.91-1981, but with a 112C life prediction vs. 110C prediction at 180,000 hours.

The chair then again solicited any input from the audience for any aging data from the past (especially the original Lockie test data) so we can compare how the data was interpreted, extrapolated, etc.

Don Platts mentioned that in the Annex I of C57.91-1995, there is a description of how the Lockie data was applied “historically”. The chair will review this information and determine other sources of information as a result.

8.1.3.2.5 Work groups for Draft 1.0

The chair then briefly discussed some of the work items assigned at the last meeting.

- Distribution Transformer Test Model (Lockie Test)
 - Jin Sim, Jerry Corkran – they have reviewed this document and feel that it is good as written. The chair added that moisture content might be needed to be added, and they agreed to this.
- Model test (IEC 62332)
 - Roger Wicks, Rick Marek, Bill Simpson – The chair noted that he will be reviewing this in the next two months in part due to a IEC meeting in November where work on this document will be initiated.
- Sealed Tube Test (Annex)

- Tom Prevost – Tom is working on the revision of this work. He noted that this is a very commonly used procedure due to its ease of use, but that some specificity (such as ratios of materials and temperatures to cover) needed to be added.
- Standard Test Conditions
 - Roger Wicks – the chair noted a few items here which are underway, including the need for standard conditions (temperatures, ratios, moisture content, etc.) that should be applied no matter the method. He also noted that we need to understand under which situations which test would be appropriate.
 - Jin Sim mentioned that certainly a brand new insulation system would require a more extensive evaluation (minimum three point curve) vs. a periodic re-qualification type test.
 - Don Platts noted that scaled models for power transformers could still be needed to better understand certain issues. This led to a discussion regarding things like exponents to understand loss of life and the influence this may have on “perceptions” of already installed transformers.
- Housekeeping (Style, references etc.)
 - Juan Castellanos, Don Platts – still open, since a more complete draft is needed before this work can be done.

Chairman Wicks then noted that a PAR extension is required and he will work with Bill Bartley to get this done in the next few days.

8.1.3.2.6 The meeting adjourned at 1:15 PM.

8.1.3.3 Working Group for Temperature Rise Test Procedures Section 11 of C57.12.90 - Paulette Powell

The Working Group met at 12:00pm October 7, 2008 in Porto Piso 1 of the Porto Palacio Congress Hotel and Spa in Porto, Portugal. There were 15 members and 44 guests in attendance. There were no patent disclosures.

The minutes of the March 18, 2008 meeting were approved as written.

The meeting focused on Hot Resistance Measurement straw ballot comments enumerated below:

Items a, c and f were accepted as written.

Item b: Unresolved negative ballot by Jerry Corkran proposing hot resistance measurement be made only on B-phase – harmonizing with IEC. The unresolved ballot comment will be provided to balloters with the next ballot.

Item b: terminal pair be defined in 3.0 Definitions clause - “terminal pair – an associated pair of accessible terminals corresponding to a phase of a winding.” The definition will be provided to WG C57.12.80.

Item d: Unresolved negative ballot by Steve Snyder concerning a 10-minute cooling curve for distribution transformers. Small distribution transformers have different thermal characteristics and different measuring equipment compared to large power transformers. The time constant is of short duration requiring measurements to be made more rapidly during the first 5 minutes. The unresolved ballot comment will be provided to balloters with the next ballot.

Item e: comment by Juan Castellanos for data not to only be fitted to an exponential decay curve, but also allow an otherwise suitable curve. Thang Hochanh noted that a polynomial can result in any value at time zero, whereas an exponential decay curve gives a discrete result. Juan Castellanos commented that the radiator configuration may result in a decay curve that is not exponential. For a low winding time constant, instead of the winding cooling towards average oil temperature, it cools towards bottom oil temperature. Bruce Forsyth raised the issue concerning the mean oil temperature surrounding the winding and the location of the winding – specifically, whether the average oil temperature is really measured because top and bottom oil temperatures do not always give the expected result. Through much discussion two scenarios were identified that could possibly result in data not being suited to fit an exponential decay curve:

1. Transformers with a short winding time constant.
2. Whether the average oil temperature is in actuality measured at the winding level because the top and bottom oil temperatures do not always give the intended result.

It was mentioned that otherwise suitable curves provided too much lead way for interpretation. The Chair proposed that item e not be changed, but a Note be written to inform of these two issues and in parallel have a small group of experts try to define the appropriate curve(s) for a future modification to this clause. The Chair will solicit volunteers as none were identified at the meeting.

There was no **Old Business**.

New Business:

Mark Perkins discussed forming a TF to develop provisions for a Q/C heat run. The intention is to get the required data in a short period of time; i.e. a single temperature test for a short duration. The reasons for such a test were given as follows:

1. Verify average winding gradients (e.g. checking blocked cooling – each phase would be tested).
2. Verify no unexpected gassing (concerning hotspots – a minimum rating and duration for the heat run defined)
3. Verify oil temperature rise.
4. Verify a middle rating (normally just the top and bottom rating verified).
5. Verify overload rating of transformer.

6. Verify rating, e.g. for a thermal duplicate.

Issues defined were the minimum duration for the test and should the test be full current circulation test. Pierre Riffon mentioned HVDC Converters have a similar test – a 48-hour extended load current test. This new business item will be discussed at the Insulation Life SC for direction as it was stated by Bill Chiu that the proposal is not within the WG scope of responsibility.

Being no other business, the meeting adjourned at 1:00pm.

Paulette Payne Powell, Chair
Juan Castellanos, Co-Chair

8.1.3.4 Task Force on Moisture Estimation in Transformer Insulation – Jin Sim

8.1.3.4.1 Rosters

The task force met on Tuesday October 7th, 2008 at 4:15 PM.

8.1.3.4.2 Patent Disclosure

The chairman asked if anyone knew of any patents that could be pertaining to this project. The following two people that spoke up.

Claude Beauchemin of GE
Mark Perkins of ABB

8.1.3.4.3 Discussion of the Task Force Activity

- It was noted that this was the first and the only task force meeting as it will be dissolved with the publication of the report
- The chairman discussed the objectives and scope of the TF
- The draft TF report was briefly discussed
- This draft will be emailed to the attendees of the TF meeting
- The chairman requested that any additional contribution must be communicated to him by the end of November 2008
- The TF will post the final draft of the IEEE Special Publication within the transformers committee website by the end of December 2008
- Any interested persons reviewing the draft will be encouraged to provide their comments to the TF chairman before the Spring 2009 meeting of the IEEE Transformers Committee

8.1.3.4.4 The meeting adjourned at 5:30 PM.

Respectfully submitted,

H. Jin Sim, Chairman

8.1.3.5 Task Force on Furan Testing – Kent Haggerty

The Task Force on Furan Testing met Monday, October 6, 2008. There were 14 members and 31 guests in attendance and 4 requested to be added to the Task Force membership. This would bring the total membership of the Furan Task Force to 60 members.

Chair, Kent Haggerty was not able to attend the meeting. Tom Prevost served as acting chair and opened the meeting with introductions and the required statement for patent disclosures. There were no patent issues to be disclosed. The minutes of the March 17, 2008 Task Force meeting were approved as written.

Tom Prevost and Don Platts provided some background and described the efforts to draft the task force report. The primary contributors have been Luiz Cheim, and Shuzhen Xu, working with Tom, Don, and Kent. The draft is posted on the Insulation Life Subcommittee website.

The members were given the opportunity to comment on the draft as it was presented. The comments included:

Scope: Clarify sentence 2- The references are based on laboratory testing to measure furans, not tests of oil samples from in-service transformers.

Comment: The draft refers to oil, not to insulating liquids. Furans can be detected in all fluids. The References that are cited probably only refer to oil, so it would be appropriate to retain the description of oil. This should be verified.

History Section: Comment “the hope of measuring a specific chemical that will translate directly into an indicator of the paper insulation aging. “ This should be rewritten to avoid saying a “specific chemical”.

Comment “made by the delignification of wood pulp by the KRAFT process, in which wood is treated with a mixture of sodium hydroxide and sodium. “ Should be checked and rewritten, since sodium is probably not added. Suggestion was to refer to the working in CIGRE brochure #323.

Comment We should note that this paper refers to Kraft papers, not other solid insulations, such as NOMEX, etc.

Comment: The ASTM method for detecting and measuring Furans was adopted in 1995. Are papers written prior to that valid for inclusion?

Discussion of effects of adding dicy in the thermally upgrading process. Does it affect the stability of furans and so it should be in the stability portion of the paper, or does it effect the production, so that it should be in the How Furans are Formed section?

We did a quick review of the contents of the remaining portions of the paper.

Tom noted efforts in the Insulating Fluids Subcommittee to gather DGA test data for transformers and for LTCs. The same database can be used to gather Furan data. He requested any company that has test data and the supporting other data about the transformers tested to submit that data for analysis by the task force.

The path forward for the Task Force is to continue working on the Technical Position Paper on Furans. In addition, a Transformer Survey Form will be posted on the Transformer Committee Website and gathering of transformer and Furan data will continue. In addition, the Task Force will continue to gather Furan and DP information on failed transformer units from utilities and users. Also, CIGRE has agreed to share the data and results of their study on Furans with the Transformer Committee and Furans Task Force. This information will be included in the Technical Paper and survey information.

Respectfully submitted,

Don Platts
Acting Task Force Secretary

8.1.3.6 Task Force on Winding Temperature Indicators - Phil McClure

The Task Force on Winding Temperature Indicators did not meet during the Fall 2008 Transformer's Committee meeting.

8.1.3.7 Task Force on High Temperature Transformers – Richard Marek

8.1.3.7.1 Introduction and Rosters

The task force met for the first time on Monday, October 6, 2008 at 4:15 PM with 48 in attendance. 23 requested membership.

8.1.3.7.2 Minutes

There were no minutes for approval.

8.1.3.7.3 Patent Disclosure

The chairman asked if anyone knew of any patents that could pertain to this project. There were none.

8.1.3.7.4 First body of work

The Chair introduced the meeting by discussing a proposal for the three items required for the PAR submission: the Title, the Scope, and the Purpose. The Chair will circulate these to the

task force members, with feedback needed by the end of October so a PAR can be submitted. The proposed Title is: IEEE Trial Use Standard for the Design and Application of Liquid-Immersed Transformers using High-Temperature Insulation Systems.

A question was raised whether this document should be a guide, a trial-use standard or a standard. After a short discussion the general feeling was that a guide was too weak and a standard was too strong. The Chair requested additional comments along with a response to wording of the title, since the document type will affect some of the language within the document such as should vs. shall.

8.1.3.7.5 Draft 1.0 Discussion

The Chair then spent the bulk of the meeting discussing his suggestions for the development of this document. He provided information on a similar IEC document which will provide the starting point for this work. IEC 60076 – 14 is a document of exception, depending on reference documents and only focusing on thermal aspects of transformers operating at temperatures above 65 C.

One key difference between this document and the IEC document is the “reference point” that is used as the basis for comparison. The IEC document defines non-thermally upgraded kraft and mineral oil as the reference system. For this IEEE document, the starting point will assume thermally upgraded kraft and mineral oil as the reference system.

The reference IEC document was reviewed, including the table of contents which details the topics which would be covered in the new IEEE document. The Chair has copied the reference IEC document into the IEEE template as a starting draft and expects to use a large portion of the document. The document depends heavily on IEC references which will be changed to equivalent IEEE and ASTM references. After the document has been reviewed and modified, a formal request for copyright approval from IEC will be requested for the portions that have not been modified.

8.1.3.7.6 Next Meeting

The Chair solicited input from members of the task force about holding an interim meeting late January in Atlanta as a way to speed up the development of the document. There was only mild interest in this suggestion. He further requested task force comments on draft 1.0 by the end of December, which would then be incorporated into a draft 2.0 for discussion at this meeting. This would lead to a more complete draft to be reviewed by the whole task force for the next meeting in Miami.

The Chair will post Draft 1.0 on the web. Permission to use the original document has been formally provided by IEC for use by the task force and will be posted on the web with a password to be provided to the members.

8.1.3.7.7 Adjournment

The meeting adjourned at 5:30 PM.

8.1.3.8 Task Force on Quality Control (Accelerated) Heat Runs – Mark Perkins

The new task force on Quality Control heat runs met in Porto, Portugal on October 5, 2008. This was the initial meeting of the task force which was formed at the previous meeting. There were three persons in attendance in addition to the chair, Don Platts, Paulette Payne Powell and Subhash Tuli.

The purpose of the task force is to address the need for addition to the test code of a loading test to check the transformer when a full temperature test has not been performed. This type of test has sometimes been referred to as a quality control heat run.

The task force defined the scope or some of the possible purposes of such a test. These included

- Verify the average winding gradients to check for blocked cooling. This should include gradients on each of the phases. It was also discussed that the gradients would be measured at only the top rating, and only the rated current would be applied for the minimum time necessary for the gradient to stabilize.
- Check for gassing
- Verify that the oil rise is in the appropriate range that it should be
- This test could be used to verify the overload capability of the transformer. An overload test would need to be customer and application dependent, so the amount and duration of the overload cannot be standardized.
- Verify the rating of the transformer. If this test indicates that the specified rating is exceeded, then the full temperature test is required, or else extra cooling could be added to insure that the specified rating is met.

The group then discussed how the task force should be organized. The recommendation was that this task force should be assigned to the working group on clause 11 of C57.12.90.

Mark Perkins

8.1.4 Old Business:

There was no Old Business.

8.1.5 New Business:

8.1.5.1 Moisture Content in Oil

Several of the Insulating Fluids Subcommittee members were working on the revision of the IEEE 62-1995, IEEE Guide for Diagnostic Field Testing of Electric Power Apparatus Part 1: Oil Filled Power Transformers, Regulators, and Reactors, which will be C57.152 when it is approved and published. They had several issues with the published IEEE Guide for mineral oil, C57.106-2006, in the area of the moisture content in oil. Older version of this guide, C57.106-2002, listed the moisture content in terms of "% Saturation" in addition to more

traditional "mg/kg" or PPM. The concept of % Saturation is technically more useful since the dielectric strength of the oil is directly related to the % saturation. However, since the amount of moisture that oil contains depends heavily on temperature and equilibrium. It is not practical to expect the actual transformer to reach the equilibrium and obtaining the temperature of the sample correctly. Since the introduction of this % saturation in 2002 version of the C57.106, there has been numerous cases where a significant number of very dry transformers had to be reprocessed to meet the recommended maximum % saturation.

The chairman stated that if this "% Saturation" is brought back to either C57.106 or C57.152 guides, he will vote negative. The group had a lively discussion following this statement and decided to take it up to the Insulating Fluids Subcommittee meeting.

8.1.6 The meeting adjourned.

Don Platts
Chair, Insulation Life Subcommittee