

Annex J Performance Characteristics Subcommittee

**March 23, 2016
Atlanta, Georgia**

**Chair: Ed teNyenhuis
Vice Chair: Craig Stiegemeier
Secretary: Sanjib Som**

J.1 Introduction / Attendance

The Performance Characteristics Subcommittee (PCS) met on Wednesday, March 23rd, 2016 at 3pm with 152 people attending. Of these, 62 were members and 90 were guests. Prior to this meeting, the total membership of PCS was 81 members; therefore, quorum was achieved with 76% of the membership in attendance.

There were 20 guests requesting membership of which 13 have attended three of the past 5 meetings or two immediately preceding meetings.

Further, due to a lack of required participation in the subcommittee, 7 of the current members will be removed prior to the Fall 2016 meeting. Also, 190 of the 428 people on the roster will be removed as they have not attended any of the past 5 meetings. All of these changes will be made through the AMS system.

The Vice-Chair distributed rosters for the seating arrangement in the room.

J.2 Chairman's Remarks

The Chair provided updates on the status of standards under PCS.

PCS is again sponsoring a technical presentation on Thursday 24th March 2016 with the topic being "Review of IEEE C57.159 - Guide of Transformers for Application in Distributed Photovoltaic (DPV) Power Generation Systems by Dr. Hemchandra Shertukde, Mr. Sheldon Kennedy and Mr. Carlos Gaytan".

The Chair congratulated Sheldon Kennedy on being awarded fellow of IEEE. He was cited for his contribution towards Rectifier Transformer standards work.

J.3 Approval of Agenda

The Chair presented the agenda. A motion to accept as proposed was given by Dan Sauer and seconded by Ken Skinner. The chair requested comments or objections - there were none. The agenda had been earlier sent to the members by email several weeks prior to the meeting

J.4 Approval of Last Meeting Minutes

The chairman presented the minutes of the last meeting held in Memphis, Tennessee – October, 2015. A motion to accept as proposed was given by Ken Skinner and seconded by Dan Sauer. The acceptance of the minutes was passed by unanimous vote.

J.5 Minutes from Working Groups and Task Force

The following WG and Task Force reports were received next (the reports are below):

- | | |
|---|--------------------------|
| • WG on Tertiary/Stabilization Windings PC57.158 | E. Betancourt |
| • WG on PCS Revisions to Test Code C57.12.90 | M. Perkins |
| • WG on C57.109 - Through-Fault-Current Duration | V. Mehrotra |
| • TF on Audible Sound Revision to Clause 13 of C57.12.90 | B. Beaster for R. Girgis |
| • WG on Non-sinusoidal Load Currents C57.110 | R. Marek |
| • WG on PCS Revisions to C57.12.00 | T. Ansari |
| • WG Shunt Reactors C57.21 | S. Som |
| • IEEE/IEC WG Wind Turbine Generator Transformers, P60076-1
Buckmaster | P. Hopkinson for D. |
| • WG on C57.18.10 | S. Kennedy |
| • Loss Evaluation C57.120 | R. Verdolin |
| • WG 3-ph Transf. Connections C57.105 | A. Bromley |
| • WG on Distributed Photo-Voltaic Grid Transformers C57.159 | H. Shertukde |
| • TF on HV & EHV Transients C57.142 | J. McBride |
| • TF Short Circuit Criteria | S. Patel |

J.6 Unfinished (Old) Business

None

J.7 New Business

Enrique Betancourt requested a motion for PCS to approve Draft C57.158 for balloting. The WG had already approved the Draft for balloting. The motion was proposed by Dan Sauer and seconded by Marnie Roussell. The motion passed with overwhelming majority by show of hands.

The Chair requested a motion for PCS to approve Draft C57.120 for balloting. The WG had already approved the Draft for balloting. The motion was proposed by R. Verdolin and seconded by Wally Binder. The motion passed with overwhelming majority by show of hands.

During the report on WG on PCS Revisions to C57.12.00 by T. Ansari – Amitabh Sarkar opined that for windfarm transformers, that this could be part of the rectifier transformer. He will discuss further with T. Ansari.

The TF on HV & EHV Transients C57.142 chaired by Jim McBride is nearing completion. The TF approved a motion that the C57.142 scope be expanded to include HV and EHV transients. Based on this the TF will begin a PAR revision for C57.142 to expand the scope to include HV and EHV transients. The PCS Chair also stated that he will request Jim McBride to be the chair of this C57.142 standard revision WG.

The Chair then requested a discussion on the TF Short Circuit Criteria report submitted by Sanjay Patel. This TF approved a motion that IEEE should develop its own guide for short circuit design criteria. It was recognized that IEC has a short circuit guide whereas IEEE has no such guide. During the discussion, the following comments were made:

- Wally Binder: Since many transformers have failed, specifications have been strengthened year after year by purchasers. However there has been no testing. He thought the right questions were not being asked and felt that there is need for something.
- Steve Antosz: He felt that there is a need for something similar to IEC, there should be a short circuit review criteria. He opined that IEC document could be a possible starting point.
- Dan Sauer: He stated that the short circuit criteria should not impose restriction on manufacturers. He has successfully short circuit tested his company's products in North America, South America and China. He would hate to see criteria that would invalidate his test results.
- Javier Areatga: He wanted the requirements for short circuit review to be very clear. He expressed his availability to be vice-chair.
- Dan Sauer: He referred to Waters book on short circuit.
- Sanjib Som: He stated that hand calculation is okay for simple designs but finite element analysis is required for other types.

A motion for PCS to create a task force to prepare a PAR for short circuit was proposed by Sanjib Som and seconded by Bill Boedkar. There was overwhelming support with two abstentions and two opposing (Dan Sauer and Craig Colopoly).

Adjournment was proposed by Ken Skinner and seconded by Dan Sauer.

The meeting was adjourned at 4.15 pm.

J.8 Minutes of Meetings of Working Group (WG) and Task Force (TF) Reports (all unapproved)

J.8.1 WG on Tertiary/Stabilization Windings PC57.158

E. Betancourt

PCS Working Group on Guide for Application of Tertiary and Stabilizing Windings PC57.158

Performance Characteristics Subcommittee
IEEE / PES Transformers Committee

March 21, 2016 9:30 AM
The Sheraton Atlanta Hotel, Capital South Ballroom
Atlanta, Georgia, USA

UNAPPROVED MINUTES

The WG C57.158 met at 9:30 AM on March 21, 2016. 20 Members out of 28 were present so we had a quorum to conduct regular business. 76 Guests were also present and six of them requested membership.

Hamid Abdelkamel	Ameren
Hamid Sharifnia	HDR
Hugo Flores	CG Power Systems
Markus Schiessl	SGB Trafo
Victor Garcia	Siemens
Waldemar Ziomek	PTI Manitoba Inc.

The Agenda was approved with no comments or amendments.

A motion for approval of the Memphis WG meeting minutes was made by Hemchandra Shertukde, seconded by Sukhdev Walia and approved.

The Draft Guide was approved by the WG by a 2/3 majority by email vote on Jan 26, 2016.

A. Old Business

The Chair discussed the present status of Draft 5 rev. B of the Guide and the timing for submitting the draft for ballot and comment resolution. A PAR extension will not be required if the Guide can be submitted by October 17 of this year.

The draft distributed to the WG for comments received only editorial comments and had an 86% approval.

A motion to allow the WG members to conduct the comment resolution by email was made by H. Shertukde, seconded by D. Walia and passed unanimously.

The Chair proceeded to review the changes to the document and diagrams of Draft 5 rev. B with the WG.

The most significant items discussed centered on reformatting the Guide to comply with the required template and obtaining consent or recreating diagrams with copyrights.

H. Shertukde commented that the terminal markings on some of the diagrams need to be per ANSI (IEEE) not IEC.

The Chair explained how the section on “Short Answers to Frequently Asked Questions” was moved to an Annex in the Guide, as recommended by some WG members.

B. New Business

No new business was presented before the WG.

Question was raised as to when this document will go to ballot – Chair referenced previously timeline for submission of this Guide; the document would need to go out for ballot by the beginning of May of this year. Given the case, the Chair will apply for a PAR Extension, with the consent of the Group Members.

Question was raised on whether this document will change any of the present test requirements listed in other IEEE Standards – Chair did not foresee any changes to present testing requirements as this Guide is focused on application of stabilizing windings and provides recommendations about verification by calculation.

Motion to adjourn WG meeting was made by Mike Spurlock and seconded by Dough McCullough.

Meeting was adjourned at 10:30 am.

Respectfully submitted,

Enrique Betancourt
WG Chair

Brian Penny
Vice Chair and Acting Secretary

J.8.2 Working Group on PCS Revisions to C57.12.90 - Mark Perkins

Meeting Minutes

Working Group on PCS Revisions to C57.12.90

March 21, 2016, 11:00am-12:15pm

Capital North, Sheraton Atlanta

Mark Perkins, Chairman; Craig Stiegemeier, Secretary

1. Introduction of members and guests
 - Mark Perkins presided over the meeting as Chair. Craig Stiegemeier was secretary. Attendance rosters were circulated for those in attendance to record their presence and confirm their membership or guest status.
2. Attendance
 - A review of the adjusted membership was conducted and 32 of the 54 WG members were in attendance. This resulted in attendance of 59% of the membership, making this meeting “official” as a quorum was reached. In addition, 64 guests were present and 23 of those guests requested membership. Of those 23, 12 meet the requirement of participating in the WG and have either attended the previous 2 meetings or 3 of the past 5 WG meetings. They will be on the roster for the Fall meeting, and 11 of the current members will be removed due to a lack of participation.
3. Agenda approval
 - Dan Sauer made a motion to approve the agenda and Kenneth Skinger seconded the motion. All approved the agenda. Later in the meeting, a correction was made noting that the spring meeting was held in San Antonio.

4. Minutes of the Fall 2016 meeting

- A review of the Fall 2015 Memphis minutes was conducted by the chair. Dan Sauer made a motion, and it was seconded by Kenneth Skinger to approve the spring minutes as written. Minutes were approved by the membership unanimously.

5. Old Business

- A survey was conducted with the recommendation of changes to standard C57.12.90 section 9.3.1. The survey was sent to the all members and guests of the WG and Performance Characteristics Subcommittee. These recommended changes will be included on the next ballot of C57.12.90.

6. New Business

- Load Tap Changer Performance Test Procedure for C57.12.90
 - At the Memphis meeting, the chair of the working group on PCS revisions to C57.12.00 discussed the need for including a performance test on load tap changers as part of C57.12.90 and indicated that this had been surveyed in his working group. It was determined that this should be covered in detail at the Spring 2016 meeting in Atlanta.
 - The scope of the WG is to determine if a test is to be performed and if necessary, the procedure for performing this test.
 - Joe Foldi suggested that historical information be reviewed. A task force of the WG of PCS revisions to C57.12.00 some time ago reviewed this topic, and the information covered by the TF should contain good information that would support this effort. Rainer Frotscher from Reinhausen offered to make a presentation covering background previously covered. Steve Antosz made a motion and Terry Martin seconded that Reiner make that presentation at this meeting. This was unanimously approved.
 - Rainer Frotscher made a presentation. The main challenge is that there is no test in C57.12.00 for a performance test requirement after the LTC is installed and the transformer is complete, ready for other testing.
 - There was a discussion that a polarity test should be performed on reactance type tap changers. This should be done after the unit is fully assembled and before voltage is applied to the transformer.
 - A slow transition test was discussed. This test is common from some manufacturers, as it is referred to by unique names.
 - There may be a need for a test with 85% voltage on the motor drive.
 - Sanjay Patel of SMIT suggested that when there are 3 single phase LTC's, there should be some sort of time delay test to make sure all LTC's are operating simultaneously.
 - The Chair suggested that a review of each specific type of performance test be conducted, including the process of performing the tests.
 - Test with voltage induced at the power freq.
 1. Voltage requirement (freq., voltage)
 2. Voltage induced on LV winding or HV winding
 3. Number of steps required
 - a) end to end twice
 - b) Both directions through neutral for reversing sw.
 4. Pass/Fail Criteria
 - a) Tripping (may trip an electronic power supply)
 - b) Monitor current and/or power?

- c) Sound?
- d) DGA?
- Pierre Riffon noted that this test is well documented in IEC 76.1.
- CG Power systems noted that a lower voltage should be allowed for the test due to problems with electronic power supplies.
- Sanjay Patel suggested that the test must be performed at 100% voltage. Pierre supported keeping the voltage near to the rated voltage.
- Rainer said 80% voltage may be okay, but 10% would be a problem. Mark suggested that the voltage be 90% or higher.
- Javier Arteaga noted that some voltage variation must be allowed.
- Mark Perkins suggested that following the IEC standard would be best.
- Ajith Varghese from SPX suggested that there should be a voltage test from end to end, with 80% voltage. The IEC standard typically applies to transformers with the LTC in the HV.
- Mark called for all to agree for end to end to end as being acceptable. Ajith made and Dan Sauer seconded this approach, with unanimous agreement. Each tap change must be covered, from both direction. It could start from the neutral point or an end point.
- The voltage requirement of having at least 80% may be required due to transformers that have variable flux during LTC operation. Hakim Shamaun suggested that changing the voltage at each position is impractical. Dan Sauer suggested that the test sequence be performed at least at 95%. Chris Schalt from ComEd suggested that the LTC be tested at operating voltage. Hakim Shamaun suggested that a lot of these problems come about due to limitations of the electronic power supply. Joe Foldi suggested that 90% be used, since at no load the transformer can operate up to 100%. Mark re-focused the group into an operating target at 100% of voltage. The test should be performed at 100% voltage when possible. Setting a lower limit of 95% - 3 were opposed. 1 person thinks it should be lower than 90%.
- Dan Sauer made a motion that we set a voltage requirement of rated voltage, but not less than 95% due to test equipment limitations at rated frequency. Kenneth Skinger seconded the motion. Discussion occurred that there's a need to identify the specific voltage being discussed. The vote on the motion was 14 in favor, 3 opposed
- There was not time to review all of the following:
 - Test with current at load loss connection
 - Test of motor drive without voltage on transformer
 - Low voltage test to verify proper connections and polarity
 - Test of limit switches or other protective devices
 - Test of hand crank operation
 - DGA limits or other pass/fail criteria after testing
- Other new business was called for, and none was offered.

7. Adjournment

Dan Sauer motioned and Kenneth Skinger seconded that we adjourn. The motion was accepted unanimously, and the meeting was adjourned at 12:18 pm.

J.8.3 Working Group for Revision of C57.109

Working Group for Revision of C57.109
IEEE Guide for Liquid-Immersed Transformer Through-Fault-Current Duration
Atlanta, GA, March, 21 2016

The meeting was held on Monday March 21, at 1.45 pm. Six of the ten members were present at the meeting so a quorum was achieved. There were a total of 37 people present which consisted of 6 members and 31 guests. Three guests requested membership and were added to the membership.

A motion was raised by Weijun Li to approve the Atlanta Meeting Agenda. Bill Griesacker seconded the motion. The working group unanimously approved the Atlanta Meeting Agenda.

A motion was raised by Weijun Li to approve the San Antonio Meeting Minutes. Bill Griesacker seconded the motion. The working group unanimously approved the San Antonio Meeting Minutes.

A motion was raised by Weijun Li to approve the Memphis Meeting Minutes. Bill Griesacker seconded the motion. The working group unanimously approved the Memphis Meeting Minutes.

The Working Group reviewed the request that was presented to the Chair (Tauhid Ansari) of the WG PCS Revisions to C57.12.00. Mr. Tauhid Ansari informed the WG that the request was on the agenda for discussion for their Atlanta WG meeting. There was no further discussion on this topic.

The working group chair reviewed the minutes from the January 12 Memphis meeting of the task force (KTF20) of the Power System relaying Committee K. In addition to the comments received from an active group working on C37.91 which were addressed in the previous two meetings clarification was sought for one significant issue of interpretation of the impedance to use for calculation of through-fault current for Class IV transformers. The maximum short circuit is limited by the system impedance plus transformer inherent impedance, but the graph in the C57.109 guide seems to neglect system impedance, implying that only transformer inherent impedance is to be used. This comment will be addressed during the revision of the guide by adding a note to the graph regarding impedance used.

The vice-chair, Hemchandra Shertukde, reviewed the Scope and Purpose of the PAR for the WG with an emphasis that the guide is to focus on over-current devices applied to limit the exposure time of transformers to short-circuit currents. Also that the focus is on establishing a guide to help coordinate these devices to relate fault duration and magnitude to withstand capability.

The secretary, Jason Varnell, presented a topic for discussion relating to an alternate method to establish the damage curves by using an iterative method to determine the duration required to reach the winding short circuit temperature limits as specified in C57.12.00 section 7. This method uses the winding temperature calculation from C57.12.00 section 7.4. Javier Artega commented that this calculation was too complex with too many variables for the use of this guide and that it is best suited to keep the damage curves. There was no further discussion.

The Chair then requested for additional volunteers to assist in revising the guide. Weijun Li and Branimir Petosic agreed to provide assistance in revising the guide.

A motion was raised by Weijun Li to adjourn. Bill Griesacker seconded the motion. The working group unanimously approved the adjournment. The meeting adjourned at 2.20pm.

The Working Group will meet at the next meeting in Vancouver.

Respectfully submitted
 Vinay Mehrotra
 WG Chair

J.8.4 TF on Audible Sound Revision to Clause 13 of C57.12.90 - R. Girgis

Unofficial Minutes of Spring 2016 Meeting of TF “Audible Sound Revision to Test Code C57.12.90”, in Atlanta, GA

The TF met at 1:45 PM, on Monday, March 21, 2016. Chairman Dr. Ramsis Girgis presided over the meeting. Secretary Barry Beaster assisted with the administrative duties.

After the Fall meeting, the membership had been adjusted to 52 members. For meeting preparation, a meeting agenda along with the unapproved Fall 2015 minutes were circulated to all members and guests of the last meeting. A copy of the prior meeting attendance for the past five years was circulated to the members for any possible oversight in recording attendance.

The meeting was attended by 26 of the 52 members and 43 guests for a total of 69 persons. A quorum was established at the end of the meeting. There were no requested agenda changes. The Fall 2015 meeting minutes had no requested changes or corrections. Since a quorum was achieved at the end of the meeting the minutes were approved with no prior modifications requested.

There were five requests for TF membership; which will be reviewed based on previous meeting attendance.

After the introductions, Chairman Dr. Ramsis Girgis presided over the technical portion of the meeting.

The first item of business was an overview of the additions & changes implemented in the 2015 revision of the C57.12.00 and C57.12.90 Standards. These are summarized in the following bullets.

Implemented additions and changes in C57.12.00:

- In the “Audible Sound Level” section of Table 18 (Routine, design, and other tests for liquid-immersed transformers)
 - Added the option: “Upon purchaser’s request, the transformer may be tested for its audible load sound level”.
 - This allows the determination of the “Total sound level” of the transformer under pre-specified load(s).
 - For reference levels of load sound power, Annex B was added
- Added the requirement: “The purchaser’s specification shall make it clear whether the sound levels to be guaranteed refer to No – Load noise or the Total noise of the transformer; including Load Noise”.

Implemented additions and changes in C57.12.90:

- Making the following corrections when using the Sound Pressure measuring method:
 - Wall sound reflection correction
 - Per IEC but limit correction to 4 dB and # of test room cases to 5
 - Near-field correction
 - -1 dB for ONAN contour, no correction for ONAF contour
- Using the “Sound Intensity Method”
 - Alternative method
 - Use newly developed correction for $4 < (L_p - L_i) \leq 6$ dB
 - Consider method invalid for $(L_p - L_i) > 6$

- Use Sound Pressure method with corrections
- Measuring Load Noise
 - Measure when requested by Purchaser
 - Can measure at current $60 \% \leq I \text{ rated} \leq 130 \%$ and correct per IEC
- Changing the ONAF measuring contour
 - Per IEC, 2 m all around transformer
- Determination of Total Noise level of a transformer
 - Adding Load and No Load noise levels, per IEC

The second order of business was a status update of the IEC noise standard. The following bullets are the bullets reviewed at the meeting.

Status of IEC Noise Standard:

- Both the “Sound Determination” Standard and “Sound Application Guide” have been published as FDIS (Final Draft International Standard) and were approved
 - Received minor editorial comments only
- We provided technical comments that were not considered because only editorial comments are permissible at the FDIS stage
- Will be published as valid IEC standards in the near future
- The documents are widely comparable to the IEEE Standard

The next order of business was presenting a review of the proposed CIGRE working group. The following is the information shared at the meeting.

Proposed CIGRE WG:

- Title: “*Power transformer audible sound requirements*”
- Convener: Dr. Christopher Ploetner
- Background
 - No reference / guidance on typical transformer sound levels
 - This often results in technically unreasonable sound level specifications
 - Unnecessary high
 - But more recently often also too low, which often requires external sound mitigation means (sound panels / enclosures)
- Scope
 - Define transformer classes with respect to sound level
 - Development of sound level ranges for core, load, and cooling system noise level for each of the transformer classes
 - Study information on sound level legislation in different countries and compare with technical findings
 - Summary information on sound mitigation (mounting, panels, enclosures, walls around units)
 - Transformers to be considered:
 - Distribution and Power transformers 10 kVA to 1500 MVA
 - Distinction between 1 - Φ & 3 - Φ and 50 & 60 Hz units
- Meetings
 - First Meeting held on March 1-2, 2016 in Germany
 - Next Meeting scheduled for this August in Paris
 - Completion of work expected within 3 years

The next item on the Agenda was the development of reference No Load and Load noise levels for Power Transformers. The Chairman announced that the Performance Characteristics Subcommittee approved, in its fall 2015 meeting, a motion submitted by this TF that the TF be assigned the task of developing new Reference sound levels; using present data and recent work in these areas. This is since this TF has

completed its assignment of revising Clauses in C57.12.00 and C57.12.90 related to transformer noise Standards and testing. The TF has already started this work about 2 meetings ago.

The Chairman first presented an overview of the recommended reference levels of Load Noise developed over the past two TF meetings for 3 – phase power transformers. The recommended reference levels are 10 dB higher than the levels calculated per the Reiplinger equation.

The Chairman then presented measured load noise data of a limited number of 1-phase transformers ranging in power ratings from 25 – 250 MVA. The data again indicates that reference levels of Load noise of 1- phase transformers can be 10 dB higher than the levels calculated using the Reiplinger equation. Before this meeting, the Chairman sent requests to a number of Power Transformer manufacturers for measured load noise data. He expects to get this data in the next few weeks. The new data will be added to the already obtained data to hopefully finalize the proposed reference levels of Load noise of 1-phase transformers in the fall meeting of the TF.

Shamaun Hakim of CG Power questioned whether the data reflected the different core types 1-phase transformers can have. The Chairman commented that the data included at least two core types and many other design features that impact Load noise. Ajith Varghese asked whether the full MVA rating of an Auto Transformer or the two - winding equivalent MVA should be used in the Reiplinger equation. The Chairman responded that the calculation using the equivalent 2 – winding MVA provides an underestimation of the measured Load noise level.

The Chairman then led a discussion on the purpose of developing ‘Reference Noise Levels’. He presented the following two possible purposes during the meeting:

- Providing a Maximum Noise level if no special mean (s) of noise reduction is used in the design
- Providing ranges of Sound levels for No Load and Load Noise for some transformer classes (Per CIGRE plans)

He also questioned whether there is a need for anything but the proposed Maximum noise levels.

In order to further understand the need for reference noise levels, the Chairman invited utility representatives present how they define the required sound levels of their transformers. A number of them presented how each developed their specification values. There were some NEMA minus 6 to 12 dB used and some had Standards that considered adhering to local noise ordinances of sound levels allowed at the boundary or at the closest residential areas. In order to maintain flexibility each substation was typically, not individually, used to set levels, but a value to cover a wide range of installations.

Mr. Joe Foldi had commented from a consultant viewpoint that ideally specifying a level would be preferred based upon the resultant sound level at the first residence. He suggested that Reference Noise levels should be used only as a measuring stick to how much lower a guaranteed noise level of a transformer is from the Reference levels. This proposal was fully supported by the Chairman.

Mr. Bill Boettger stated that in some cases the no load loss evaluation may be driving the core flux density down; resulting in a lower core sound level. Dr. Girgis commented that this has to be carefully evaluated for the specific transformer design; as the resultant load noise typically increases as the size of the core and windings increase for those designs.

Mr. Sanjay Patel questioned the need for separate no load and load sound levels. He asked whether one level would not be sufficient. Dr. Girgis commented that there are different sound level requirements for nighttime and daytime; which correspond to different levels of Load. Hence, Reference No Load and Load Sound levels are needed.

To move forward, the Chairman stated that he intends to request a tutorial on specifying Transformer sound level requirements to be presented to the IEEE Standards group by experts in the industry who perform these tasks on a routine basis. This would help the group understand the requirements of the Industry moving forward. Mr. Bertrand Poulin asked whether there is a need for an Application Guide. This will be discussed in the fall TF meeting.

The meeting was concluded at 3:00 PM.

Respectively submitted,

Barry Beaster, TF Secretary

Ramsis Girgis, TF Chairman.

J.8.5 WG on Non-sinusoidal Load Currents C57.110 - R. Marek

Working Group for Revision of C57.110, Recommended Practice for Establishing Liquid-Immersed and Dry-Type Power and Distribution Transformer Capability When Supplying Non-Sinusoidal Load Currents

MEETING MINUTES (UNAPPROVED)

Sheraton Atlanta Hotel; Atlanta, Georgia USA

Monday, March 21, 2016

3:15 PM – 4:30 PM

Chair: Richard Marek

Secretary: Samuel L. Sharpless

The fourth meeting of this working group took place at the Capital North meeting room of the Sheraton Hotel in Downtown Atlanta. The meeting was called to order at 3:20 PM by Richard Marek, Chairman.

15 members were present in a hand count at the start of the meeting, representing a quorum of the 27 registered members. 3 members arrived later for a total attendance of 18 members. There were 55 guests on the roster and 6 of those persons requested membership.

The meeting agenda was unanimously approved and the minutes of the November 2, 2015 meeting in Memphis, TN were presented for approval with one correction by Hasse Nordman. The minutes were approved unanimously.

As a preface to the meeting, the Chair first noted that in the last meeting a considerable amount of time was devoted to a discussion of Clause 6.2 which addresses how to estimate the eddy losses for a transformer when only the test report is available. This portion of the document dates back to the first edition in 1986 and has not been revised since that edition was published. The rationale for the guidelines suggested was lost long ago. Although the scope included transformers up to 50 MVA, originally it was mostly used for small dry type transformers. Subsequent revisions removed that size limitation. However, it seems likely that a user with a unit 10 or 20 MVA and larger would likely go back to the manufacturer for more information rather than relying on the gross estimates provided by this document.

In discussion regarding comments on Draft number 3:

- The chair congratulated Tom Holifield for finding an error in equation 21 which had gone unnoticed for several revisions. The probable error was suggested at the meeting in Memphis and at the time it was decided that it would be investigated and then discussed at the next meeting. After a careful review and many emails, the problem was located. Accordingly, the Chair congratulated Tom for finding and noting the error and also for being persistent in locating the source. Tom noted that the example using the equation was actually correct. However, an error in that example was also discovered in search of the primary error. These errors will be corrected in the next draft.
- The next topic was a proposed revision to Clause 6.2: Transformer capability equivalent calculation using data available from certified test report. The group had a long discussion concerning the portion of the stray loss that should be used in the eddy loss calculations at the last meeting. The Chair agreed to summarize the discussion and modify the text accordingly. A survey was sent to all members, but the response was disappointing with only 8 of 26 members

responding. All were in favor of the revision. With the meeting notice, the Chair included two revision proposals after the survey. Rev 1 was the result of discussions from the previous meeting. However, after the survey additional actual test data was submitted by Professor Alvaro Portillo, prompting Rev 2 which presents the guidelines in tabular form. Just before the meeting CSA data on LVGP dry-type transformers was also submitted by Dhiru Patel as well as data for power transformers by Ramsis Girgis and Hasse Nordman. Other manufactures have also promised to submit test data. This test data will be considered for an annex so that the data used to determine the estimates for this clause is not lost.

- Bertrand Poulin spoke on behalf of Hasse Nordman observing that the suggested rules for determining the split in losses was most applicable to smaller transformers. There was no dissention and the chair agreed to add this information in the preface to the table.
- The chair noted that the test data provided by Professor Alvaro Portillo demonstrates how difficult it is to characterize losses in a simple way. The data does not always follow the factors proposed in the original guidelines and not in the revision either. The chair expressed concern that revising the guideline to a table could give the impression of precision when it is in fact only a gross estimate that is generally very conservative.
- Jagdish Burde noted that neither row of the first table accounted for the precise 4:1 ratio and suggested that one of the rows include this ratio.
- Chuck Johnson of ABB expressed support of the tables as presented.
- Aleksandr Levin recommended that the title of the tables should be “estimate of distribution of total stray loss...” and he suggested combining certain rows of the second table.
- Mr. Levin also suggested changing “other stray losses” to be “stray losses outside of winding”. The chair noted that the existing wording better agrees with the wording elsewhere in the document. Sanjib Som proposed adding a note below the tables that defines “other stray losses”
- Vijay Tendulkar suggested combining the two tables. He also asked if note “e” should be 300% instead of 400%.
- The chair requested that anyone having additional data send it to him for comparison. Tim Mai and Arthur Cumella both said that they would provide data.
- Jagdish Burde suggested a need for voltage differences to be reflected in the table. The Chair requested that he send more information for consideration.
- Dhiru Patel said that data he supplied shows the table recommendation to be high compared to general purpose transformers. The chair reiterated that the table was intended to be conservative.
- Shamaun Hakim questioned the values in the table for larger transformers. The chair noted that the values were based around the data that was provided. He also noted that foil eddy losses increase dramatically with higher currents.
- Sheldon Kennedy stated that the numbers in the guide should be conservative - users should contact the manufacturer if more precision is required. Also, he cautioned against changing definitions because it can affect other standards.

New Business

- The chair noted that the PAR expires in December 2018. However, the document is nearly complete. Working Group approval will be required to request subcommittee approval before going to ballot, so the members should expect a survey ballot requesting approval before the next meeting.
- In preparation for the ballot, the chair requested;
 - Please verify personal data so that the ballot is correctly delivered.
 - Please look at the document now and be ready for ballot.

- The chair requested volunteers to double-check the examples in the document. The following volunteers were noted
 - o Dhiru Patel
 - o Aleksander Levin
 - o Others may be requested to assist

The meeting was adjourned at 4:15 PM.

J.8.6 WG on PCS Revisions to C57.12.00 - T. Ansari

PCS Working Group on General Requirements C57.12.00

Performance Characteristics Subcommittee
IEEE / PES Transformers Committee

March 21, 2016 4:45 PM
The Atlanta Sheraton Hotel
Atlanta, Georgia, USA

UNAPPROVED MINUTES

The PCS Working Group on General Requirements for C57.12.00 met on Monday, March 21, 2016. The Chair Tauhid Ansari called the Group to order at 16:45 and explained purpose and scope of the WG. **46** Members and **84** guests were present, and as Working Group membership stands at **80** members, we did have a quorum and were able to conduct official business. The following **15** guests requested membership:

Brian Penny	ATC	
Christopher Baumgartner	We Energies	
Jarrold Prince	ERMCO	
Jeremiah Bradshaw	Bureau of Reclamation	
Kirk Robbins	Exelon Generation	
Kristopher Neild	Megger	
Marcos Ferreira	LADWP	
Matthew Weisensee	PacifiCorp	
Rodrigo Ronchi	WEG-Voltran Ryan Musgrove	OG & E
Ryan Thompson	Burns and McDonnell	
Selvaro Pugazhenth	VA Transformer	
Sukhdev Wallia	New Energy Power Company	
Thomas Holifield	Howard Industries	
Thomas Melle	HIGHVOLT	
Tim-Felix Mai	Siemens AG	

The Agenda and the minutes from the Memphis meeting were approved (M. Perkins, K. Skinger), with no comments or amendments.

Agenda Items were covered as follows.

1. OLD BUSINESS

- A. **WG Item 104, Sec 6.1 – Discuss the P dimension that affects the interchangeability of bushings.**

This request comes from Keith Ellis. Discussion on this item started during the last WG's. The Chair reported that he reviewed the subject with Steve Snyder, Chair for Std. C57.12.00, and that it was Steve's impression that the subject does not belong neither to C57.12.00 nor to C57.12.10. Discussion within the WG followed.

Jeff Ray described the case of having an LV bushing failure where components with similar electrical characteristics did not fit within the space for CT's. In his opinion, turrets dimensions is a transformer manufacturer issue. As no motion was stated, the Chair agreed to continue reviewing the subject with other TC officials.

B. Sec.4.1, Sec.7.0 Clarification on Short circuit condition

This item was brought up by Vinay Mehrotra, from WG C57.109. It was requested to define the worst condition to be considered for short circuit calculations. As under over-excitation of the transformer 110% rated voltage can be applied, it was asked if that pre-fault voltage should be considered, instead of the rated voltage.

Mark Perkins and Javier Arteaga pointed out that C57.12.00 applies to transformer design and that the 110% over-excitation requirement is a system condition that should be considered apart. Jason Varnell, Kenneth Skinger and Jill Holmes were in favor of considering a pre-fault voltage between 105% and 110%. Joe Foldi explained how Canadian standards scaled down from 110% pre-fault voltage to 100%, considering that the last provides enough margin. He recommended also to consider practical consequences from raising the pre-fault voltage. Some users specify the pre-fault voltage they expect.

A motion was brought up (Ajit Varghesse/Vinay Mehrotra) as to include a statement in C57.12.00 specifying that for short circuit calculations 1.0 PU is the pre-fault voltage and that anything different has to be specified by user. The motion was amended by Mark Perkins to start first with a survey among the WG's Membership about this proposal.

26 Members approved the motion, with none opposed. The Chair agreed to conduct the survey before the next meeting.

2. NEW BUSINESS

Shamun Hakim brought up that in windfarms specifications an unnecessarily high LV side fault capacity is required and if it should be considered in C57.12.00.

The Chair agreed to survey about this question among the WG Membership.

With no new business and having completed the agenda the meeting was adjourned at 5:30 PM (K.Skinger/E.TeNyenhuis).

Respectfully submitted,

Tauhid Ansari
WG Chair

Enrique Betancourt
Secretary

J.8.7 Shunt Reactors C57.21 - S. Som

IEEE Standard Requirements, Terminology, and Test Code for

Shunt Reactors Rated Over 500 kVA C57.21

Atlanta, GA USA
Sheraton Atlanta Hotel
Tuesday March 22, 2016

The working group met in the Capital Center room of the Sheraton Atlanta Hotel on Tuesday March 22, 2016, at 9:30 AM.

The meeting was called to order at 9:30 AM by Chairman Sanjib Som

There were a total of 51 participants: 11 Members and 40 Guests out of which 7 Guests requested membership.

- The meeting was opened with the introduction of participants and the circulation of attendance roasters.
- 11 of the current 16 (please check) WG Members were present and quorum to carry out business was met.

Meeting notes:

■ **Meeting Agenda**

- Meeting agenda, which was circulated among members and guests on March 4th, 2016 by email, was presented to the audience.
- Motion to approve the agenda was made by Hemchandra Shertudke and seconded by Enrique Betancourt.
- There were no objections or comments and the agenda was approved.

■ **Minutes from previous meeting**

- The minutes from the F15 meeting in Memphis, which were circulated on March 4th, 2016 by email, were presented to the audience.
- Motion to approve the meeting minutes was made by Klaus Pointner and seconded by Enrique Betancourt.
- There were no objections or comments and the F15 meeting minutes were approved.

■ **Old Business:**

1. **Luc Dorpmanns: Presentation of proposal for vibration test limits:** This topic has been discussed in previous meetings. The proposal includes comparison of what currently in the standard to IEC limits and also refers to related work by CIGRE WG. Proposal intended for discussion. In IEEE standard it covers units larger than 50 MVar and 115 kV at rated voltage, with specific details on where to measure the vibration. It specifies average values and maximum below 200 μm peak-peak. In IEC it is a type test, for all shunt reactors at maximum operating voltage and less specific about number of points or location. Discussion to lower the limits took place at CIGRE and rejected. This presentation with full details will be distributed to Members and Guest for information and further discussion.

Proposal for revision of C57.21 includes for vibration test to be a design test instead of 'other'-test, for all reactors and eliminate the average requirement, only stating the maximum pk-pk.

Comment from Mathew Welsensee: shunt reactors would vibrate more or less than other of the same identical design. Example in size: 3-phase 245 kV 15 to 30 MVar.

Comment from Bertrand Poulin: support the idea of each reactor being tested as shunt reactor units don't behave the same even of the same design; however sound is more sensitive to detect problems than vibration. Example in size: under 15 up to 765 kV; typically 30 to under 40 MVar

Comment from Dharam Vir: every shunt reactor behaves differently; vibration test should be routine test and limit could be lowered.

Comment from Mike Sharp: Vibration tests should not apply to dry-type air-core shunt reactors.

- 2. Presentation by Gael Kennedy:** Comparison of Section 4 of C57.21 to other transformer standards referring back to basic standard C57.12.00. The question is how to consider the C57.21 standard: as stand-alone or as part of a group referring back to C57.12.00. How to reference other standard within the standard? Note on this topic will be circulated by the WG Chair to the membership for inputs.

Comment from Bertrand Poulin: clarification on the scope of C57.21 is needed to decide whether the standard is stand-alone or covered by C57.12.00. Does it include requirements? The title cover 'requirements'.

Comment from Klaus Pointner: since C57.21 covers both oil-filled and dry-type, this standard should be stand alone. C57.21 should combine requirements for both and cover full scope for requirements and test.

- 3. Dieter Dohnal: Presentation on tap changer as applied to variable shunt reactors:** this presentation covered different aspects on the application and use of OLTC on variable shunt reactors including construction, selection, regulation schemes, special requirements, etc. The full presentation will be send to the WG for information.

Other comments and input:

Comment from Shamaun Hakim: on section 4.4.2: maximum allowed cooling air temperature for altitude higher than 3300 ft need to be lower. Need further clarification from Shamaun.

Comment from Shamaun Hakim: on testing losses and analytical correction to reference temperature. Need further clarification from Shamaun.

- Standard is now available for distribution by WG Chair in Word and pdf formats for the subgroups to start working on the modifications and revisions.
- Subgroups as set by the Chair to work on different sections of the standard. The following members volunteered to work on:

Sections 1 through 4: Sanjib Som, A. Del Rio.

Sections 5 through 9: David Joe Meisner, Subash Tully, Rogerio Verdorin, Raj Ahuja.

Section 10: Bertrand Poulin, Shamum Hakim, Subash Tully, Klaus Pointner, Kris Ploetner

Sections 11: Dharam Vir (new)

Section 12: Mike Sharp

Pictures: Rogerio Verdolin.

Members and guests were requested that if anyone wished to participate in the above groups or if anyone's name is not included inadvertently in the list, they were to contact the WG Chair.

Meeting was adjourned at 10:45 am.

Next meeting: Fall 2016, Vancouver, Canada October 23-27.

Comments, as sent, submitted prior to the meeting by email from Dr. Christoph Ploetner:

1. Comment to Bertrand's Linearity proposal: It is a more practical adoption of IEC 60076-6, Annex B and I suggest to consider it for the revised standard. I agree with Enrique that it would be good to see some more test data for the DC method (tests for 1~ and 3~, not just simulations) before bringing it into the standard.
2. Loss evaluation based on power factor was extensively discussed during last revision of C57.21 but at the end not followed even though it is commercially probably the best. Loss guarantee at rated voltage remained applicable for simplicity reasons but also because this situation is the closest to service conditions. IEC guarantees losses at rated current in order to protect the manufacturer commercially. As whatever it is, quantities are within narrow bands, it technically therefore doesn't matter and is more a commercial subject.
3. I volunteer to re-write section 10.6 'Audible-sound-level test' and will provide this before the Vancouver meeting. I will take latest changes in IEEE C57.12.90 and IEC sound standards into consideration – as I did for the recent IEC/IEEE HVDC standard revision.
4. I suggest Luke Dorpmanns to re-work section 10.7 and Klaus Pointner 10.8. As per San Antonio discussion one major change here would be the vibration test becoming routine as fingerprint.

Respectfully submitted,

Chairman: Sanjib Som (sanjib.som@siemens.com)

Secretary: Arturo Del Rio (Arturo.delrio@trench-group.com)

J.8.8 IEEE/IEC WG Wind Turbine Generator Transformers, P60076-16 - D. Buckmaster

WG P60076-16 Standard Requirements for Wind Turbine Generator Transformers

Chairman: David Buckmaster; Vice Chair: Phil Hopkinson; Secretary: Donald Ayers

The Working Group on Wind Turbine Generator Transformers was called to order at 9:30 a.m. EST on Tuesday, March 22, 2016 at the Sheraton Hotel in Atlanta, Georgia. There were 110 attendees, 34 members were present of a membership of 50 and 76 guests. A quorum was present. The chairman, David Buckmaster, was unable to attend the meeting and the Vice Chairman ran the meeting.

The following guests requested Membership on the Working Group. After two consecutive meeting attendance they will become members.

- Nikita Dave, Georgia Transformer, Rincon, GA
- Jose Gamboa, Siemens Energy, Richland, MS
- Mark Gromlovits, EMC OEM Products Division, Bristol, VA
- Mohammad Iman, MGM Transformer Co., Commerce, CA
- Brad Jensen, Burns & McDonnell, Kansas City, MO

- Branimir Petosic, Boiler Inspection & Insurance Co., Toronto, Canada
- Stephan Voss, Siemens AG, Nuremberg, Germany
- Shawn Wu, Shihlin Electric, Pasadena, CA
- Michel Veillette, Morgan Schaffer, LaSalle, QC, Canada
- Waldemar Ziomek, PTI Manitoba, Inc., Winnipeg, MB, Canada

Larry Lowdermilk made a motion to accept the agenda for the meeting and was seconded by Rogerio Verdolin. The motion passed unanimously.

Larry Lowdermilk made a motion to accept the minutes from the Fall 2015 meeting and was seconded by Rogerio Verdolin. The motion passed unanimously.

The vice-chairman gave a summary of the status of the standard. The standard has been commented on by both IEEE and IEC ballot groups. The IEEE comments have been addressed and resolutions recommended. The IEC commented on the IEEE resolved version of the standard and the comments resolved by IEC. The document was returned to the committee. The modified document was reviewed by the meeting attendees which could see both the IEEE and IEC comments.

A motion was made to by Larry Lowdermilk to accept the changes to the document as reviewed so that the modified document can be recirculated to both IEEE and IEC ballot groups. Only changes to the document are reviewable by both groups. The motion was seconded by Rogerio Verdolin and passed unanimously.

A discussion was held on the timing of the next step and it was concluded that the recirculation could not be completed before the PAR expires.

A motion was made by Larry Lowdermilk and seconded by Rogerio Verdolin to request a two year extension for the PAR. The motion passed unanimously.

With no new business, the meeting was adjourned at 10:25 a.m.

A working group session is planned for the Vancouver meeting.

Respectfully submitted,

Donald E. Ayers
Secretary

J.8.9 WG on Semi-Conductor Rectifier Transformers -C57.18.10 - S. Kennedy

Task Force for Semi-Conductor Rectifier Transformers
Meeting Minutes – March 22, 2016
Atlanta, Georgia, USA
Sheldon P. Kennedy - Chair

The Task Force met on Tuesday, March 22, 2016 at 11:00 AM with 5 members present and 41 guests. 9 guests requested membership. Sheldon Kennedy chaired the meeting. This was the first regular meeting for a Task Force since the spring of 2011 in San Diego.

The Task Force was formed to develop a new PAR for a revision that is due for the standard.

A quorum was achieved with 5 of the 6 members present.

The minutes and agenda were approved.

The meeting concentrated on completing a new PAR. The scope of the original standard was modified to be sure to include transformers for rectifier, inverter, furnace and adjustable speed drive loads.

It was requested to lower the Scope of the PAR to “100 kW and above” from “300 kW and above” for single phase loads Also, three phase loads were lowered from “500 kW and above” to “100 kW and above”.

Also, Dhuru Patel had previously requested that we add to the excluded list “If a user connects mixed loads with more than 10% non-converter fundamental frequency power content, IEEE C57.110 shall apply”. This was modified to show the exclusion as: -mixed loads of more than 10% non-converter fundamental frequency power content. All other portions of the previous C57.18.10 Scope will be kept.

There was discussion about whether a joint document with IEC 61378-1 Converter Transformers – Part 1, would be of interest. The Task Force felt this was premature and that while there are many common treatments in both documents, there are also significant differences at this time. A revision of IEEE C57.18.10 must be accomplished by January of 2019, so there is little time for this. The Chair will ask IEEE to procure a copy of IEC 61378-1 for harmonization work on the new C57.18.10 revision. While this work is being accomplished, notes will be made of common and different treatments for possible harmonization of the two documents into one in the future.

The Chair again made a call for additional Task Force/Working Group officers. William Whitehead of Fuji Electric had previously volunteered to be Vice Chair to help with the work. David Walker of ABB volunteered to be Secretary of the Task Force and succeeding working group.

Future topics for addition to the revision of the document plan to include phase shifted windings; electrostatic ground shields; interphase transformer applications and why circuit breaker interaction and snubbers; and non-classical harmonics and waveforms due to new inverter and adjustable speed drive topologies.

The Chair will complete the PAR form for submission to the NesCom.

There were no further comments.

The meeting adjourned at 12:15 PM.

Submitted by;

Sheldon P. Kennedy
Chair

J.8.10 WG Loss Evaluation C57.120 - R. Verdolin

PC57.120 LOSS EVALUATION GUIDE FOR
DISTRIBUTION AND POWER TRANSFORMERS AND REACTORS
Tuesday, March 22nd, 2016 — (11:00 AM – 12:15 PM)

Chair: Rogerio Verdolin

Vice-Chair: Rod Sauls

Par status: Par approved

Par expiration date: December 31, 2016

Current draft being worked: D15

1. Attendance
 - a. Members: 12
 - b. Guests: 90
 - c. Guests granted membership: XX
 - d. Guests requested membership: XX
 - e. Total (Members + Guests): 102
2. Meeting was called to order promptly at 11:00am on March 22nd, 2016.
3. Rosters were passed out and introductions were made.
4. Rogerio asked for a motion to approve the minutes of the Memphis meeting. Wallace Binder made the motion to approve the minutes. Ewald Schweiger seconded the motion.
5. Attendance was checked to see if a quorum was established. There were 19 active members on the roster and at least 10 were needed for a quorum. There were 12 members present.
6. Rogerio asked for a motion to approve the agenda. Eduardo Garcia made the motion to approve the agenda. Wallace Binder seconded the motion.
7. Both the minutes and agenda were approved.
8. Rogerio discussed highlights from the latest draft and mentioned corrections to some of the formulas in the document.
9. Wallace Binder made a presentation on the alternate methods of loss evaluation for non-vertically integrated companies.
10. Question was asked about the differences of vertically integrated vs. non-vertically integrated. Wallace answered basically saying the vertically integrated has generation, transmission and distribution components while non-vertically integrated does not have one or more of these components.
11. Rogerio mentioned the previous IEEE legal review/comments on how to use \$\$ in the document.
12. Wallace Binder made a motion to that the WG approve the latest draft to go to ballot. David Murray seconded.
13. All 12 attending members voted to approve for ballot.
14. Rogerio discussed next steps in the process and Gary Hoffman made the comment that he would need to get on the PCS subcommittee meeting agenda for approval as well.
15. Rogerio asked for volunteers to help with the ballot resolution. The following persons volunteered:
 - Marcos Ferreira
 - Wallace Binder
 - Rogerio Verdolin
 - Rod Sauls
 - Hamid Sharifinia
 - S. Dev Walia
16. Meeting was adjourned.

Respectively submitted,
Rogerio Verdolin, Chair
Rod Sauls, Vice-Chair

J.8.11 WG 3-ph Transf. Connections C57.105 - A. Bromley

Spring 2016 IEEE Transformers Committee Meeting — Atlanta, GA, USA
 C57.105 – IEEE Guide for Application of Transformer Connections in Three-Phase Electrical Systems
 Tuesday, March 22nd, 2016 — (1:45 PM – 3:00 PM)

Chair: Adam Bromley

Vice-Chair: Rogerio Verdolin

1. Attendance
 - Members: 10
 - Guests: 16
 - Guests requested membership: 2 (will check attendance records)
 - Total: 26
2. The meeting was called to order at 1:45 pm on Tuesday, March 22nd, 2016.
3. Chair presented agenda for the meeting. A motion to approve agenda for the meeting was made by John John and was seconded by Samuel Sharpless.
4. A motion was made by John John to approve the meeting minutes from the Working Group Spring 2015 meeting in Memphis, TN. The motion was seconded by Samuel Sharpless. By unanimous vote, the minutes were approved.
5. Par status: Par expires December 31st, 2019, which represents 4 meetings before we have to conclude the guide. The PAR was approved March 2015.
6. Rogerio Verdolin and David Walker have provided the references regarding ferroresonance. David Jacobson, from Manitoba Hydro, an expert on ferroresonance and one of the authors of the Cigre guide, has agreed to help Rogerio and David to find appropriate, modern, references on ferroresonance. We are also going to look for more modern, easy to obtain, general information on transformer connections to supplement or perhaps replace some the out-of-print textbooks listed in the current references.
7. The references regarding ferroresonance are:

[1] Mork, B.A., Morched, A.S., and Walling, R., “Modelling and Analysis Guidelines for the Investigation of Slow Transients in Power Systems: Part III-Study of the Phenomenon of Ferroresonance”, Slow Transients Task Force of IEEE Working Group on Modelling and Analysis of System Transients Using Digital Programs, July 27, 1996.

[2] Ferracci, P., “Ferroresonance”, Groupe Schneider: Cahier technique no 190, pp. 1-28, March 1998.

web site: http://www.engineering.schneider-electric.se/Attachments/ed/ct/ferroresonance_en.pdf

[3] Jacobson, David A. N., “Examples of Ferroresonance in a High Voltage Power System”, Conference Paper, IEEE Power Energy Society Annual meeting, Toronto, Canada, July 2003.

[4] Dugan, Roger C., “Examples of Ferroresonance in Distribution Systems”, Conference Paper, IEEE Power Energy Society Annual meeting, Toronto, Canada, July 2003.

[5] CIGRE 569 - Resonance and Ferroresonance in Power Networks, Working Group C4.307, February 2014, ISBN: 978-2-85873-264-7.

8. The Chair will add the previous ballot comments provided by John John to the new draft. Most of comments were editorial.
9. The Chair has shown the revision he has made in the draft by using the IEEE style guide. The Figures were provided by Samuel Sharpless using AutoCAD/jpeg format. Some Tables were changed to Figures. Symbols will be changed to text, such as Transformer connections: delta, wye, zigzag, etc.
10. The Chair asked for volunteers to help to review the draft.
11. John John and Samuel Sharpless volunteered to review Sections 4 and 5, Electrical Connections and Magnetic Circuits.
12. Mike Thibault volunteered to review Section 6, Harmonic Currents and Voltages.
13. Daniel Mulkey and Benjamin Garcia volunteered to review Section 7 - Primary Faults, Section 8 - Unbalanced Loads and Secondary Ground Faults, and Section 10 - Unsymmetrical Banks and Special Connections.
14. The Chair/Vice-Chair will contact David Jacobson to find out if he would be able to help us review Section 9 - Ferroresonance. David Walker will also provide some information regarding his experience with ferroresonance.
15. The WG still need to work on the bibliography. References for transformer connections were provided by members such as: Electric Power Transformer Engineering, The J&P Transformer Book, and others. Other GE and ABB references will be provide by members to be included in the draft.
16. The meeting adjourned at 2:30 PM.

Respectively submitted,
Adam Bromley, Chair
Rogerio Verdolin, Vice-Chair

J.8.12 WG on Distributed Photo-Voltaic Grid Transformers C57.159 - H. Shertukde

Working Group PC 57.159 Guide on Transformers for Application
in Distributed Photovoltaic (DPV) Power Generation Systems
Unapproved Meeting Minutes
Atlanta, GA, USA
Tuesday, March 22, 2016

AGENDA

1. Roster and Quorum Verification
2. Meeting Agenda Approval
3. Approval of the F2015 Memphis Meeting Minutes
4. Update on the ballot results and comment resolution of the Guide Draft 6: Recirculation #1 and recirculation #2
5. Guide Draft 6.2 submitted to RevCom
6. Discuss the next WG meeting in Vancouver
7. New Business

The Working Group met in the Capital North room of Sheraton Atlanta Hotel. This was eights meeting of the WG. The meeting was called to order at 1:45 pm by Chairman H. Shertukde.

The meeting was convened with 53 participants present, 18 of them are members (this constitutes a quorum out of 30 current members in the roster).

The Meeting Agenda was approved.

The Fall 2015 Memphis Meeting Minutes were approved.

1. Chairman H. Shertukde updated WG on submission of Guide Draft 6.2 after recirculation # 2 to RevCom. WG officers expressed appreciation to WG members for the active participation in the development of the Guide. H. Shertukde mentioned about the tutorial our WG will present to the IEEE TC general session in Atlanta. Thanks to C. Gaytan and S. Kennedy for their contribution.

Chairman also informed the group the he has presented the WG position paper to International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) in India. The position paper will be published in IEEE Explore.

2. Secretary A. Levin updated WG on the results of the Guide ballot recirculation # 1 and # 2:

- just one individual has disapproved the Guide Draft 6.1 and provided 4 comments related to the definitions. The comments were accepted and Draft 6.2 was submitted for the ballot recirculation # 2.

- just one individual has disapproved the Guide Draft 6.2 and provided 2 comments. One comment related to the definitions was accepted, but other comment was rejected as it was out-of-scope of the recirculation # 2 (comment on the unchanged portion of the standard after 75% approval vote has been achieved).

- the Guide Draft 6.2 has been submitted to the IEEE RevCom for approval. Our PAR will expire on 31 December 2016. S. Kennedy commented that we need monitoring comments from RevCom, address them and receive confirmation that resolution is accepted. P. Hopkinson recommended to watch PAR expiration date in order to submit the PAR extension, if necessary, on time.

2. A. Levin reviewed the content of the Guide Draft 6.1.

3. A. Levin has presented and WG discussed the list of the additional topics that were indicated during the Guide development for the future consideration.

3.1. Add 5.1.4.1 Winding Connections and Utility Consideration.

3.2. Fast transient voltage in PWM (pulse-width modulation) inverters due to IGBT commutations.

V. Tendulkar explained his suggestion for specific consideration of aging of insulation subjected to multiple IGBT commutation impulses. He referred to known problems with motor conductor insulation. S. Walia commented that similar phenomenon observed in relation to cables in wind power AC-DC systems with inverters.

3.3. Transformer sizing based on loading.

P. Hopkinson commented that he is going to propose to Distribution Transformers SC to form a TF to investigate the loading of transformers up to 10 MVA based on application (including renewables), geographical region, etc. He thinks that we can find end users that will share available information in order, eventually, to develop justified recommendations on the transformer sizing.

3.4. Does electrostatic shield really necessary in all cases?

V. Tendulkar agreed that it's possible to develop more specific recommendations on the application of shields in DPV transformers.

3.5. Improve recommendations on Winding Configuration and Impedance Requirement for 3-winding transformers.

3.6. Include consideration of other available inverter and system topology technologies (e.g. string inverters).

3.7. Grounding of skid mounted transformers.

B. Ensen informed that he forwarded this question to Distribution Transformers SC.

3.8. Reverse power flow transformers.

A. Levin informed on CIGRE Working Group A2.50 "Effect of the distributed energy sources and consequent induced reverse power flow (step up) on transmission and distribution transformers".

3.9. B. Petosic proposed consideration of the Guide on transformers connected to inverters (battery energy storage, fuel cell, etc.)

J. Mango commented that large battery storage systems (up to 20 MW) can have multiple charge – discharge operations per hour and its effect on transformers needs to be addressed.

P. Hopkinson said that, during the meeting of WG on rectifier transformers, it was proposed to create a TF to investigate a feasibility of the Guide for transformers connected to inverters.

4. The decision on the IEEE TC Fall 2016 WG meeting in Vancouver will be taken later based on the results of RevCom review of the Guide.

With no more old or new business the Meeting adjourned at 3:00 PM.

Chairman: H. Shertukde

Vice-Chairman: M. Sauzay

Secretary: S. Levin

J.8.13 TF on HV & EHV Transients C57.142 - J. McBride

IEEE / PES Transformers Committee
Performance Characteristics Subcommittee
TF to Investigate the Interaction between Substation Transients
and Transformers in HV and EHV Applications
Atlanta, Georgia
Tuesday, March 22nd, 2016
3:15 PM – 4:30 PM
Capitol North
Chairman – Jim McBride
Secretary – Tom Melle

- 1) Welcome and Chair's introductory remarks.
- 2) Circulation of Attendance Sheets
- 3) There were 127 individuals in attendance with 28 members present. Quorum was achieved.
- 4) Fall 2015 Meeting Minutes presented and approved with no opposition
- 5) Spring 2016 Agenda presented and approved with no opposition
- 6) Chair mentioned the summary paper will be posted to the TF website. Sue McNelly did so immediately. Thank you Sue!
- 7) Chair began presentation and discussion of three primary issues from the Fall 2015 meeting. All three issues are addressed in the latest revision of the TF summary paper:
 - I. The Chair presented a few example traces of a three phase capacitor switching transient from the TF paper, noting that capacitor switching can produce three types of interactions. Simple LC interaction, back to back interaction, and traveling waves with reflections. The second two were most likely to excite lightly loaded transformers to resonance.
 - a) Phil Hopkinson suggested that (whenever possible) current measurements and traces from all three phases be included in the paper. Chair was not opposed to this, but no motions were made to make changes to the TF summary paper.
 - b) The example oscillations presented ranged from 1.1 kHz (base) to 52 kHz.

- c) Waldemar Ziomek commented that phases A & C are opposite polarity due to transformer interaction and reflection of waves.
The chair also showed a trace of an energization transient which had a much higher frequency voltage waveform. Approximately a 500ns rise with a 580 kHz ring.
 - II. Mitigation Methods - Chair reviewed the mitigation sections of each of the failure categories in the TF summary paper. Chair commented that RC snubbers are not commonly used on HV/EHV circuits. Phil Hopkinson agreed it is difficult to mitigate transients at higher voltages with snubbers and supports capacitor use as a mitigation tool. It was noted that special emphasis should be applied whenever possible to monitor and mitigate high frequency transients.
 - a) Pierre Riffon made a motion for the TF paper to include additional impulse testing as a possible mitigation method (e.g. non-impulsed windings are typically shorted to ground in the factory – suggest “real world” shorting using simulated impedance of system during test). Motion was seconded by Waldemar Ziomek and passed with no objections.
 - III. Chair explained the separation of Conclusions and Recommendations sections in the paper. Chair stated that the TF paper is nearly finalized and must undergo review for IEEE Transactions submission. Ideally the paper will be utilized in an upcoming Committee tutorial.
 - a) Phil Hopkinson inquired regarding the duration of magnetization current and relationship to core saturation. Comments were received stating the more likely contributors to failure are series resonant voltage, air core inductance, and leakage flux. Phil asked if the TF paper should describe these resonant interactions that cause failures. The Chair pointed out that this interaction as a failure mode is included in the GSU backfeed section of the paper, noting that generator step-up transformers operating in back feed mode may be excited to resonance by system transients.
 - b) Bertran Poulin commented that the low frequency response of transformers is easier to model; as high frequency response requires a more detailed model. Chair added that CIGRE continues to develop “white-box” transformer models, but measurements are needed in order to validate these models. Bertran commented further on the importance of measuring the magnitude of the transient voltage at the transformer terminal – given this information, “it is imperative that manufactures design transformers with necessary immunity”.
 - c) Phil Hopkinson commented on Figure 4 (Disconnect Switch Bus De-Energization Transient) that re-striking can last up to several seconds, leading to many consecutive restrikes per disconnect operation. Chair agreed and commented that although restrikes during closing operations are generally much shorter, these closing operations may also excite internal resonance due to multiple re-ignitions and re-strikes.
 - d) Vijay Tendulkar commented that core saturation is dependent upon total circuit impedance and that very different conditions can arise in differing circuits from the same voltage transient.
- 8) Motion for Task Force to move forward with submission of the paper to IEEE made by Sanjib Som. Motion was seconded by Phil Hopkinson with no objections.
 - 9) New Business – none presented
 - 10) A motion to adjourn the meeting was made by Pierre Riffon and seconded by Bertran Poulin. The meeting was adjourned at 4:15 PM.

Respectfully Submitted,
Tom Melle, TF Secretary
03/22/2016

J.8.14 TF on short Circuit Criteria - S. Patel

Task Force Short Circuit Criteria
Atlanta GA, USA – Mar 22, 2016

Ed teNyenhuis, Mar 23, 2016, Rev 0

- The Task Force met at 4.45 PM in the Capital South Ballroom on Mar 22, 2016
- At the first meeting of the TF in Memphis, it was approved by the TF that IEEE should have some short circuit design criteria in the standards. The subcommittee reviewed this and then gave the TF the task to give recommendations on how the short circuit criteria should be done in IEEE standards and to possibly collaborate with IEC. This was the purpose of this meeting.
- Sanjay Patel was the Chairman of the meeting and Ed teNyenhuis was the secretary.
- An attendance roster was circulated with 6 requesting membership. There were 73 persons total in attendance with 24 members. The membership list had 41 members so there was quorum.
- The minutes from the previous meeting were approved (initiated by Phil Hopkinson and seconded by Krzysztof Kulasek).
- The initial suggested options were presented by the Chairman:
 - Dual logo guide with IEC (they are revising the standard now)
 - Do our own guide where we develop it on our own
 - Do our own guide where we take the wording from the new IEC guide that fits with IEEE
 - Add wording to some other IEEE Std or guide (C57.12.90?)
- Joe Foldi presented again the background of the short circuit design criteria request:
 - Transformers must be designed for short circuit but what is the criteria to use? Can we have agreed upon design limits?
 - The IEC guide is a baseline guide and is not mandatory and IEEE should consider to have something similar
- There was discussion on the subject from manufacturers and users:
 - Main issue is the interpretation of the calculated results (Sanjay Patel)
 - IEEE should not tell manufacturers how to design transformers for SC (Waldimar Ziomek)
 - CSA has agreed to follow the IEC Annex A as a guideline (Waldimar Ziomek)
 - KEMA short circuit testing for the last 15 years shows that 1 in 4 fail and that the failure is not always in the windings (Shankar Subramany)
 - The manufacturing is very important with regards to short circuit (Joe Foldi)
 - Each company has its own design calculations that are validated by testing (Vinay Mehrota)
 - Should we adopt the highest or lowest criteria? This will be difficult to get consensus on (Krzysztof Kulasek)
 - We should do our own guide based on IEC and keep in contact with IEC to harmonize as much as possible (Jason Varnell)

- Users are happy with any option as long as they follow some criteria
- Some users have criteria already in their specs

- A motion “for IEEE to go in the direction of producing an IEEE guide that uses input from the IEC guide” was initiated by Bill Boettger and seconded by Joe Foldi. This motion passed by 15 to 1 votes.

- The meeting was adjourned at 6.00 pm (motion initiated by Markus Schiessl and seconded by Bill Boettger)