# Performance Characteristics Subcommittee

**November 4, 2015**

**Memphis, Tennessee**

**Chair: Ed teNyenhuis Craig Stiegemeier**

**Vice Chair: Craig Stiegemeier**

**Secretary: Sanjib Som**

## Introduction / Attendance

The Performance Characteristics Subcommittee (PCS) met on Wednesday, November 4th, 2015 at 3pm with 164 people attending. Of these, 68 were members and 96 were guests. Prior to this meeting, the total membership of PCS was 91 members; therefore, quorum was achieved with 75% of the membership in attendance.

There were 25 guests requesting membership of which 15 have attended three of the past 5 meetings.

The secretary distributed four rosters for four columns of seating arrangement in the room.

## Chairman’s Remarks

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

PCS is again sponsoring a technical presentation on Thursday 5th November 2015 with the topic being "Review of IEEE C57.32, Standard Requirements, Terminology and Test Procedures for Neutral Grounding Devices".

## Approval of Agenda

The Chair presented the agenda. A motion to accept as proposed was given by Dan Sauer and seconded by Tauhid Ansari. 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

## Approval of Last Meeting Minutes

The chairman presented the minutes of the last meeting held in San Antonio Texas, USA – April, 2015. A motion to accept as proposed was given by Dan Sauer and seconded by Rogerio Verdolin. The acceptance of the minutes was passed by unanimous vote.

## 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
* TF on Audible Sound Revision to Clause 13 of C57.12.90 B.Beaster in place of R. Girgis
* WG on C57.109 - Through-Fault-Current Duration V. Mehrotra
* 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 - P.Hopkinson in place of D. Buckmaster
* Loss Evaluation C57.120 Rogerio 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
* WG on Neutral Grounding Devices PC57.32 S. Kennedy
* WG on C57.18.10 S. Kennedy
* TF Core Gassing & Grounding Ed t in place of D. Buckmaster

## Unfinished (Old) Business

None

## New Business

The TF on Short Circuit Design criteria reported back to the subcommittee that it agreed that IEEE should have some short circuit design criteria in the standards.

Paul Jarmin requested collaboration with IEC and he confirmed that Sanjay Patel is on IEC group.

Phil Hopkinson confirmed that IEC is trying to expand their scope by introducing rectangular coil. He also opined that a unified group of IEC and IEEE would be difficult and that IEC and IEEE should have their individual committees. Both Steve Antoz and Don Platts opined that only performance and function should be considered and design should not be touched. Paul opined that may be design review criteria could be set.

A motion to was put forward for the TF to give recommendations on how the short circuit criteria should be done in IEEE standards and to possibility to collaborate with IEC was proposed by Hemchandra Shertudke and seconded by Rogerio Verdolin. The motion was overwhelmingly passed with majority in favor, two members opposing and one abstaining.

Having run out of time, adjournment was proposed by Mark Perkins and seconded by Dan Sauer.

Meeting was adjourned at 4.15 pm.

## Minutes of Meetings of Working Group (WG) and Task Force (TF) Reports (all unapproved)

### 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*

*November 2, 2015 9:30 AM*

*The Peabody Memphis Hotel, Ballroom A*

*Memphis, Tennessee, USA*

**UNAPPROVED MINUTES**

The WG C57.158 met at 9:35 AM on November 2, 2015. **22** Members out of **29** were present so we had a quorum to conduct regular business. **92** Guests were also present and **five** of them requested membership.

Jeffrey Wright Mitsubishi Electric

Kushal Singh ComEd

Rahur Rajendran Palakandy Black and Veatch

Shankar Nambi Bechtel

Stephen Schroeder ABB South Boston

The Agenda and the minutes from the previous WG meeting were approved (Hemchandra Shertukde, Krishnamutri Vijayan) with no comments or amendments.

As the first Agenda Item, the Chair presented briefly to the group the comments received from Draft 4C of the Guide for Application of Tertiary and Stabilizing Windings, most of them being of editorial nature. The main technical question was about Clause 2.3.2 related to what will be recommended in the document as methods to define the thermal or continuous rating of stabilizing windings.

The Chair mentioned that several of the contributors are not currently regular members of the WG and it was informally agreed that they will be recognized on the final version of the document. Xose Lopez-Fernandez and Nambi Shankar volunteered to support re-drawing of some figures in present Draft, which were borrowed from literature references, to avoid potential copyright issues. Other members will be called to help with this task too.

As next Agenda Item, Section 2.3.2 “Recommendations for Thermal Rating of Stabilizing Windings” was presented to the group, in form of a new text already considering all editorial changes received as comments. At the end, Table 2.4 summarizing different forms to define the thermal or continuous rating of a stabilizing winding was presented to the group, as basis for further discussion.

Discussion on Section 2.3.2 – Thermal ratings:

It was explained how time basis for application of using all heat stored vs. IEEE Loading Guide will provide different thermal capacity, and how system and transformer’s zero sequence impedance network affects SW loading. A method to size SWs, which is based on papers published between the 50’s and 70´s was discussed and decision made to include in the Guide just as historical reference.

Clarification was made (B. Poulin) that for larger kVA ratings shorter time periods for unbalanced operation of Y-Y connected transformers would be allowed. Question on definition of capacity of SW to clarify whether of active parts or total kVA are considered will be submitted in written (R. Amos).

Members voted in favor of keeping on Methods A & B as presently stated, with none opposed.

Other relevant recommendations include to leave out consideration of harmonics external to the transformers (deemed possible in windfarms), as it does not belong in this document. Since this is a Guide carefully review the use of the term “recommendation” (B.Poulin). It is important to provide range of system impedance to determine worst case for evaluation of thermal rating, as system impedance can change through the years, or the transformer be moved to another place in the system.

Draft 5A is in preparation, with all editorial changes already included, and will be distributed next month, after incorporation of changes discussed in this meeting. A timeline for further processing of the document towards its final approval as an IEEE Std. will be distributed by the Chair among the WG.

Deadline to recirculate the Draft and provide all comments is January 2016. Motion was made to submit draft to PCS by H. Shertukde and seconded by K. Vijayan – Results of vote: 15 in favor, 1 against and 5 abstain. Timeline to submit is latest by March 2016.

As New Business, a question about recommended voltage rating specification of stabilizing windings was brought up (A. Portillo), discussed and considered within the scope of the Guide, K. Vijayan agreed to submit supporting text for inclusion in the Guide.

The meeting was adjourned at 10:45 AM.

Respectfully submitted,

Enrique Betancourt Brian Penny

WG Chair Vice Chair and Acting Secretary

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

**Meeting Minutes**

**Working Group on PCS Revisions to C57.12.90**

November 2, 2015, 11:15am-12:30pm

Grand Ballroom C, The Peabody, Memphis, Tennessee

Mark Perkins, Chairman; Craig Stiegemeier, Secretary

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.
* Due to the highly anticipated “Duck Walk” and the delayed start time, the introduction of members and guests was suspended.

Attendance

A review of the adjusted membership was conducted and 38 of the 50 WG members were in attendance.  This resulted in attendance of 76% of the membership, making this meeting “official” as a quorum was reached.  In addition, 88 guests were present and 17 of those guests requested membership.  Consult the AMS system for the full attendance roster.

Agenda approval

Dan Sauer made a motion to approve the agenda and Joe Melanson 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.

Minutes of the Spring 2015 meeting

A review of the Spring 2015 San Antonio minutes was conducted by the chair. Dan Sauer made a motion, and it was seconded by David Murray to approve the spring minutes as written. Minutes were approved by the membership unanimously.

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. The survey went out October 22. As of October 31, there have been 73 returns, with 58 approvals, 8 approved with comments, and 7 disapproved. To aid in a time-effective review, the chair consolidated the returned disapprovals and approvals with comments into the following list of 9 grouped comments:

1. The bushing CT may not meet the accuracy requirement. **Discussion:** Sam Mehta commented on the accuracy, as did Dan Sauer. The burden would not be significant. Baitan Yang noted that he does not believe one CT should be used for other requirements. The accuracy requirements for C57.12.00. Bertrand Poulin noted that the CT accuracy must be known and traceable. Daniel Chen (sp? from Delta Star) noted that they verify the CT is appropriate for the measurement. Ajith Varghese noted that the test is not done at full load. Joe Melanson clarified that the CT needs to have a test and certification to confirm the ratio is appropriate for performing the test. Bertrand Poulin noted that the burden could be an issue, but a dedicated CT should be used for factory acceptance tests. Phase angle error is not significant unless the power factor exceeds 3-4%. Bertrand Poulin made motion, Joe Melanson 2nd that the wording “an appropriate CT” be used, removing the word bushing – in both the text and on the drawing. This passed with no objections.
   1. This CT is used for current measurement only
   2. Protection or Metering CT’s normally better than 0.5%
   3. Use Measurement Class if available
2. Capacitor loss (0.2 W per KVAR) is not understood – **Discussion:** Bertrand noted that if you only deduct 0.2kW, it may not be enough. Once the capacitors are in a bank, losses are influenced by contact resistance. Thang Hochanh noted that a specific device can do the measurements. They use a company to do the verification of the measurement, and they always match within 1%. Baitan noted that traceability is important. Using 0.2W/kVAR should give a conservative result. Sam Mehta suggested that the wording include something like “the measured losses include the losses in the capacitor bank.” Mark noted that it is recommended to measure losses, when possible. Pierre Riffon noted that loss measurement of capacitors is not an easy measurement. A single capacitor is easy, but the loss of the assembled bank is a challenge. He believes that leaving the wording should remain as it is for this, as well as #3 and #4. No one objected to continuing with the as-proposed version of the wording.
   1. The capacitor loss is small (1 or 2 percent of transformer loss)
   2. Capacitor loss and kVAR both vary with voltage squared
   3. Capacitors with higher loss can be used if loss value is known
3. Each Capacitors loss should be measured
   1. It is difficult to measure loss of capacitors with PF=0.0002
4. Most test labs use capacitors on the source side.
   1. Not practical for field application
   2. Some repair shops or small labs use this simpler method
5. This method is more complicated and will be less accurate than traditional method. **Discussion:** Mark noted that this method was discussed in the working group, and that this method is equally acceptable to meet the requirement of the standard. Everything must be appropriately calibrated. There was not disagreement with that statement.
   1. We resolved this question in our WG.
   2. This method proven to be as accurate as traditional method.
6. We need to include Figure 19 for 3 phase case. **Discussion:** The chair asked the group – do we need to include a 3 phase case? A vote was conducted, and no one raised a hand believing that Figure 19 needs to be added.
   1. Three phase is just 1 phase repeated 3 times
   2. Present figures 15, 16, and 17 show this.
   3. Do we need a Figure 19?
7. Setting Capacitors close to Transformer in Test Lab is bad Practice. **Discussion:** This is a basic safety requirement. No one in the room believed that a change was required.
   1. Capacitors can still be installed outdoors
   2. Losses in the cables can be accounted for
   3. Field Applications this is not a problem
8. Modern Power Analyzers are most accurate at 90° Phase angle and the Error increases as the angle decreases. **Discussion:** Bertrand noted that this is true for a bridge, but not a power analyzer. Dan Sauer noted that at 90 degree phase angle, the loss is zero.
   1. Does anyone agree with this?
9. This should be in C57.152 not in C57.12.90 if it is for field use. **Discussion:** The chair suggested that this is used in some factories, and not only in the field. Dan Sauer suggested that it should be forwarded to C57.152 in addition to C57.12.90.
   1. This has been used in several factories so it should be in 12.90

After the completion of the discussion of the above 9 items, Dan Sauer motioned and Joe Melanson seconded that that the changes to section 9.3.1 as surveyed and amended by removing references to bushing CTs be forwarded to the working group on C57.12.90 for inclusion into the next draft of the standard. The motion passed unanimously.

* New Business – Load Tap Changer Performance Test Procedure for C57.12.90: Tauhid Ansari, 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. The chair reviewed the types of issues that would need to be considered, and Ramsis Girgis made a motion to include this as a new business item for the working group, Tauhid Ansari seconded the motion and it was unanimously voted for this motion. Mark noted that this would be covered in the Spring 2016 meeting.
* Ramsis Girgis offered an informative comment that the new loss measurement would need to be performed as part of the loss measurement guide. Ed teNyenhuis requested this comment be included in the minutes.
* Chair Added working group will be meeting at the next transformers committee meeting in Atlanta
* Adjournment – Joe Melanson motioned and Dan Sauer seconded that we adjourn. The motion was accepted unanimously, and the meeting was adjourned at 12:15 pm.

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

**Unofficial Minutes of Fall 2015 Meeting of TF Audible Sound Revision to Test Code C57.12.90, in Memphis, TN**

The TF met at 1:45 PM, on Monday, November 2, 2015. Chairman Dr. Ramsis Girgis presided over the meeting. Secretary Barry Beaster assisted with the administrative duties.

After the spring meeting, the membership had been adjusted to 51 members due to the transition of Corresponding Members being added as Members. For meeting preparation, a meeting agenda along with the unapproved Spring 2015 minutes were circulated to all members.

The meeting was attended by 30 members and 49 guests for a total of 79 persons. A quorum was established. There were no requested agenda changes. The Spring 2015 meeting minutes were approved with no modifications.

There were nine requests for TF membership which will be reviewed on previous meeting attendance.

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

The first item on this portion of the meeting was a review of the comment resolution to C57.12.90 balloting on clause 13:

Comment: Remove reference to 50 Hz (Clause 13.5.6.1)

Response: Some overseas suppliers to NA market have 50 Hz test facilities only.

Comment: In the example (Clause 13.6.2.2), use different values for core noise and load noise

Response: 60 & 60 dB (A) were replaced with 59 & 61 dB (A)

Comment: 0.3, 1.0, and 2.0 m are not equivalent to 1, 3, and 6 ft.

Response: Impact is minimal on reported values of the noise level. This was shown in a table presented at the TF meeting. The differences were a small fraction of a dB.

The second item presented at the meeting was a review of the comment resolution to Table 18 of C57.12.00.

Comment: The "Comments" section for Audible Sound Level should state that the default condition for sound level measurements is the no – load condition at rated voltage when the purchaser's specification does not make it clear at which condition (s) the sound levels shall be guaranteed.

Resolution: Following statements have been added: “When the purchaser's specification does not make it clear at which condition(s) the sound level shall be guaranteed, the default condition for sound level measurements shall be the no – load condition(s).”

Comment: Change reference to NEMA TR1-1993 tables 0-2 and 0-3 to NEMA TR1-2013 tables 1 & 2 and clarify that the sound limits in the TR1 tables are for no – load noise levels

Response: Transformers shall meet standard audible no – load sound levels as listed in NEMA TR1-2013, Table 1 and 2.

The TF has completed its assignment of updating both C57.12.00 and C57.12.90. The next discussion was to determine if the TF should address the development of reference load noise levels in a continuation of the TF. As support to future work, Dr. Girgis presented measured load noise data provided by a number of medium and large power transformer manufacturers.

The data was summarized as follows: 5 manufacturers / 9 plants, 50 Hz: 105 transformers, 60 Hz: 98 transformers, Range of MVA ratings: 20 – 1100 MVA, and all 3 – phase, 3 – limb core form transformers

This measured load noise levels were graphically compared to Reiplinger’s equation for both the 50 and 60 Hz transformers. Adding 10 dB to Reiplinger’s equation was proposed as an approximate top boundary value for load noise levels. This proposed reference load noise level was then compared with the [NEMA TR1] values and the [NEMA TR1 - 10 dB] values. The proposed reference load noise level was seen to fall between the [NEMA] and [NEMA - 10 dB] curves. This might be proposed as a reasonable manner to estimate the reference load noise levels. A Table was presented that had the proposed Load noise Sound pressure levels for transformers with ratings ranging from 20 – 800 MVA.

The update on the status of the IEC Noise standards was summarized as follows:

* Both the “Sound Determination” Standard and the “Sound Application” Guide have been published as FDIS (Final Draft International Standard)
* FDIS is in the last voting stage prior to publication. No further modifications other than minor editorial corrections are allowed at this stage.
* The documents are presently being translated into French (As required by IEC). Publication is expected for March 2016.
* The documents are widely comparable with the IEEE Standard

At this point, a discussion was opened to the attendees to comment and suggest possible direction in regards to whether reference load noise levels should be added to the NEMA Table TR1 or move the NEMA table to C57.12.90 and add the reference Load noise levels to it. A good discussion with participation of Sanjay Patel, Steve Antosz, Joe Foldi, Vijayan Krishnamurthy, and several others. The comments included the issues with the manner in which NEMA presented its reference levels and the proposed reference Load noise levels. The use of BIL and MVA were pointed out as being a stumbling block if any modification or additional column would be added to the NEMA table. The discussion talked about the history and relevance of the decades old NEMA TR1 table to today’s designs, materials, and knowledge gained through the years on no – load noise. It was agreed that it is more appropriate to develop more representative NEMA levels for no load noise and add those to C57.12.90 along with the reference Load noise levels. It was also brought up by the chairman that the reference Load noise levels and Reiplinger’s equation apply only to three phase core form transformers with a 3 limb cores. There is a need to develop reference load noise levels for other transformer types (1 – phase, other core form types, and shell form).

The Chairman then presented information on a new CIGRE WG that is being formed at this time. The background to the need of this WG was stated by CIGRE as being the following:

* 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 required external sound mitigation means (sound panels / enclosures)

The Scope of this WG was stated as:

* 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)
* Units to be considered:
* Distribution and Power transformers: 10 kVA to 1500 MVA
* Distinction between 1 - Ф & 3 - Ф and 50 & 60 Hz units

The Schedule and the Deliverables of this WG are as follows:

* Fall of 2015: Starting the WG
* End of 2017: Interim Report
* August 2019: Final Report

Bertand Poulin raised a point about the relevance of sound generation as it relates to leakage flux and current as the basis for development of a reference table. The chairman responded that there are a large number of design parameters that determine the level of Load noise. The intent of the reference levels, however, is to provide a boundary for Load noise levels of transformers of different sizes / ratings.

At this point, Steve Antosz raised a motion that the TF presents the following proposal to the Performance Characteristics Subcommittee as follows: “The TF has completed its assignment of Revising the items in C57.12.00 and C57.12.90 related to transformer noise standards and testing. The TF requests it be assigned the task of developing new Reference No Load Sound levels instead of the NEMA TR1 Table and Reference Load sound levels using present data and recent work in these areas. The TF agreed to this motion without exception. Subsequent to this meeting, the PCS Subcommittee, in its meeting on Wednesday November 4, unanimously approved this motion. The TF will continue with the new manadate.

The meeting was concluded with a motion for adjournment

Respectively submitted,

***Barry Beaster, TF Secretary***

***Ramsis Girgis, TF Chairman***

### Working Group for Revision of C57.109

**IEEE Guide for Liquid-Immersed Transformer Through–Fault-Current Duration**

**Memphis, TN, Nov, 2 2015**

**Minutes of the Working Group Meeting**

The meeting was held on Monday November 2, at 1.45 pm. Two of the nine members were present at the meeting so a quorum was not achieved. There were a total of 32 people present which consisted of 2 members and 30 guests. Five guests requested membership.

The Working Group was informed that Michael Thompson the current chair of Power System Relaying Committee K communicated that the subcommittee on Substation Protection met on Wednesday, September 16th and set up a task force headed by Jim Niemira to review the current draft of C57.109 and provide comments back for consideration by the working group. They will meet for the first time in January and would likely have their input ready for us after their May, 2016 meeting. He also informed that his term as chairman of the K subcommittee is ending at the end of this year and Don Lukach will be the new chairman.

This was followed by a presentation on transformer short circuit by the Chair as requested by the members and guests during the San Antonio meeting.

The remainder of the meeting was spent discussing the remaining comments that were provided from an active group working on C37.91. The comment sought clarity on the word “balanced” in section 4 for the winding fault currents since the faults could be balanced or not. Discussions were held and it was agreed that the term balanced may not be appropriate and could be dropped. The referred current is the symmetrical short circuit current.

The Chair then requested for volunteers to assist in revising the guide. Javier Arteaga, Kiran Vedante, Steve Schappell, Hemchandra and Alvaro agreed to provide assistance in revising the guide. The meeting adjourned at 2.40pm.

Respectfully submitted

Vinay Mehrotra

WG Chair

### 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)**

**Memphis, Tennessee, USA**

**Monday, November 2, 2015   
3:15 PM – 4:30 PM**

**Chair:** Richard Marek **Secretary:** Samuel L. Sharpless

The third meeting of this working group took place at the Grand Ballroom of the Peabody Hotel. The meeting was called to order at 3:20 PM by Richard Marek, Chairman.

13 members were present at the start of the meeting, representing a quorum of the 26 registered members. One member arrived late, representing a total attendance of 14 members. There were 35 guests and 2 of those persons requested membership.

The minutes of the April 13 2015 meeting in San Antonio, Texas were presented for approval. A motion to approve the minutes as presented was made by Tim Holdway and seconded by Robert Ballard. The motion passed unanimously.

The meeting agenda was presented for approval. A motion to approve the agenda as presented was made by Phil Hopkinson and seconded by Sheldon Kennedy. The motion passed unanimously.

The chair stated that all changes proposed to date were reflected in draft #3 which had been previously mailed to all members and guests.

The chair discussed annex C, which includes excerpts from “Corrected Winding Eddy-Current Harmonic Loss Factor for Transformers Subject to Nonsinusoidal Load Currents” by Elmoudi, Lehtonen, and Nordman. He stated that the information in this particular paper is the best of 40 or 50 documents reviewed and it addresses some long standing criticisms of the C57.110 document for not including skin effect in the calculations. There were no comments by the membership on this issue.

Section 6.2, which shows how to calculate transformer parameters using certified test data and provides calculations for other loss parameters, was discussed. There were many comments about the recommended assumption that 33% of the total stray loss for liquid immersed transformers is due to winding eddy losses. Hasse Nordman suggested the number be changed to 50%, while Sheldon Kennedy was content with the 33%. The chair commented that 33% could be good for wire windings and 50% for foil windings, although the typical user would not know the winding construction. Dhiru Patel reported testing which indicates that smaller transformers have much smaller losses and recommended testing the transformer at multiple frequencies. The chair noted that the intent is to provide guidance for transformers that are already energized so this type of testing in the field was not possible. Hasse Nordman stated that he has reviewed data on many transformers from 31.5 MVA to 230 MVA which suggests that the percentage should be about 40% for inside windings and 60% for outside windings. Tank shunts will often increase the outside winding percentage to 80%. Low voltage windings are often in parallel which can make calculations difficult. Phil Hopkinson observed that there are many variables and suggested a 50 percent figure in order to be conservative. Sheldon Kennedy stated that the percentages for distribution transformers are lower than for bigger transformers or specialty units. He suggested different sets of numbers for different transformer sizes. Others noted that C57.18.10 suggests 60%. Joseph Foldi expressed concern that it may not be possible to use one number for all transformers, so users should consult transformer data reports whenever possible. Aniruddha Narawane noted that most data reports do not state eddy losses. Javier Arteaga raised the issue of differences between liquid and air cooled units. He also discussed differences between the high voltage and low voltage windings. He expressed concern that using 50% would be too generic. Alvaro Portillo noted that this percentage is very much relative to the design of the transformer and it would be risky to assume one number for all cases. Sanjib Som supported using 50% with qualifiers about the assumptions involved.

The chair noted that the method in section 6.2 is much more likely to be used for pad mount distribution transformers, 500 KVA and below. There was general agreement that a 50% figure is acceptable for typical pad mounted distribution transformers, so the chair agreed to edit section 6.2 such that it recommends 50% with the appropriate qualifiers and then circulate the wording for all to review as an official survey.

Dhiru Patel stated that he would provide data from CSA 802.5 that would be useful in qualifying the section 6.2 values. Alvaro Portillo stated that he has a large number of transformer measurements in a database that can be analyzed by KVA range as well. The chair heartily encouraged Patel and Portillo to provide their data for circulation.

Tom Holifield questioned if equation 21 should have I per unit squared added, observing that it is simply equation 16 divided by equation 2. The chair agreed to review the issue and compare it to previous editions.

There were no other comments offered. The chair encouraged all to read and comment on the document before the next meeting.

Sanjib Som made a motion to adjourn the meeting, it was seconded by Phil Hopkinson, and passed unanimously. The meeting was adjourned at 4:30PM.

### WG on PCS Revisions to C57.12.00 - T. Ansari

P*CS Working Group on General Requirements C57.12.00*

*Performance Characteristics Subcommittee*

*IEEE / PES Transformers Committee*

*November 2, 2015 4:45 PM*

*The Peabody Memphis Hotel*

*Memphis, Tennessee, USA*

***UNAPPROVED MINU*TES**

The PCS Working Group on General Requirements for C57.12.00 met on Monday, November 2, 2015. The Chair Tauhid Ansari called the Group to order at 16:45 and explained purpose and scope of the WG. **49** Members and **78** guests were present, and as Working Group membership stands at **72** members, we did have a quorum and were able to conduct official business. The following **11** guests requested membership:

Amitabh Sarkar CG Power Systems

Hugo Flores CG Power Systems

Kevin Sullivan Duke Energy

Kirk Robins Exelon Generation

Oscar Pinon Voltran WEG

Reto Fausch RF Solutions

Rodrigo Ronchi WEG

Shirish Mehta Mehta Consultants

Tim-Felix Mai Siemens AG

Verena Pellon Florida Power and Light

Waldemar Ziomek CG Power Systems

The Agenda and the minutes from the San Antonio meeting were approved (Sanjib Som/ John John, and Kenneth Skinger/Philip Hopkinson, respectively), with no comments or amendments.

Next, the Chair presented the first Agenda Item to the WG.

1. **OLD BUSINESS**
2. **WG Item 97, Table 18 Operational Tests of LTC Equipment**

A motion was passed in previous WG meeting for sending the survey to members and corresponding member to approve adding the LTC operation test in C57.12.00 Table 18, so that WG C57.12.90 could work on the details of test procedure and acceptance criteria. The test should be a routine test and be applicable to Class I and Class II power transformers.

The proposal was approved by 91% of the Members who responded, 7% disapproved and 2% abstained. The main technical comments received were presented to the Group and resolved. A motion was made by Sangib Som/Rogerio Verdolin, to leave out the part of “Comments” originally in the proposal to modify Table 18; the motion passed with no members opposed.

1. **WG Item 102, Sec 5.12.1 Remove "Metal" from first paragraph**

This item is related to first paragraph of Section 5.12.1, where it is requested that the transformer nameplate specifically be made of metal. The subject was discussed during the meeting, with main argument against that the nameplate should be readable after a period as long as 30 years, questioning if softer, synthetic materials would endure.

A motion was made by Don Ayers/Phil Hopkinson to keep the request for metal on Section 5.12.1. The motion passed with no members opposed.

1. **WG Item 103, Sec 5.5.2 - Remove “and shall be based on the turn ratio”**

Section 5.5.2 “Voltage ratings” of C57.12.00 requests that “The voltage ratings shall be at no load and shall be based on the turn ratio”. The proposed change was discussed with argument in favor that voltages on nameplate should be mainly based at the no load voltage.

A motion was made by Mark Perkins/Dharam Vir to remove the part of voltage ratings being based on turns ratio. The motion passed with 21 members in favor and 3 members opposed.

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

Section 6.1 of C57.12.00 reads as: Bushings that have dimensions in accordance with IEEE Std C57.19.01 [B25] shall have bushing mounting holes that are adequate to accommodate the maximum “P” dimensions for those bushings, as shown in the applicable tables.

The WG Chair clarified that the manufacturer of the transformer design the CT’s close to bushing size, so bushings can only be changed for others identical in design. Ed TeNyenhuis suggested to pass the question to the Bushing Subcommite and Steve Snyder recommended to first ask Keith Ellis about the fundamentals for that comment, and try to resolve the question within WG C57.12.00.

The subject was tabled for the next WG meeting.

1. **NEW BUSINESS**

Given the time, no New Business was discussed and the meeting was adjourned at 18:00 hrs (Eduardo Garcia/Aniruddha Narawane).

Respectfully submitted,

Tauhid Ansari Enrique Betancourt

WG Chair Secretary

### Shunt Reactors C57.21 - S. Som

**IEEE Standard Requirements, Terminology, and Test Code for**

**Shunt Reactors Rated Over 500 kVA C57.21**

**Memphis, TN USA - The Peabody Hotel - Grand Ballroom B**

**Tuesday November 3, 2015 – 9:30 to 10:45 AM**

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

There were a total of 72 participants: 11 Members and 62 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 22 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 October 12th, 2015 by email, was presented to the audience.
* Motion to approve the agenda was made by Luc Dorpmanns and seconded by Enrique Betancourt.
* There were no objections or comments and the F15 agenda was approved.
* Minutes from previous meeting
* The minutes from the S15 meeting in San Antonio, which were circulated on September 30, 2015 by email, were presented to the audience.
* Motion to approve the meeting minutes was made by Luc Dorpmanns and seconded by Klaus Pointner.
* There were no objections or comments and the S15 meeting minutes were approved.
* Old Business:

1. Bertrand Poulin: Draft proposal on definition of Linearity and Loss measurements/evaluation:

Bertrand Poulin presented a write up with a draft concept on proposed changes or additions to the standard on topics regarding the measurement and evaluation of impedance linearity as the present standard lacks specific methods. Also, Bertrand introduced a proposal on using a DC method and Ldi/dt and discharge current approach to quantify linearity whenever AC methods are not feasible. An example based on a single phase reactor was presented.

Issues with magnetic hysteresis affecting the DC measurement were discussed at request from Joseph Foldi.

Enrique Betancourt mentioned that additional data or a paper to demonstrate correlation between the AC and the proposed DC method would be needed.

The write up also proposes a more specific way of measuring and evaluating the losses based on power factor kW/KVAr or kW/KVA.

This draft document will be circulated by the WG Chair among the members and guests after the meeting as material for discussion.

1. Luc Dorpmanns: Presentation of draft proposal to add variable shunt reactors (tap changer type) in the standard.

Luc Dorpmanns presented a write up on the topic of variable shunt reactors. As informative point, it was mentioned that this topic is also covered in a next to be published document under CIGRE WG A2-48.

This write up also includes vibration limit recommendation 200 µm/pp and noise measurement at full voltage.

This document will be circulated by the WG Chair among the members and guests after the meeting as material for discussion.

Other topics discussed:

* Luc Dorpmanns brought up the issue as to why the linearity is specified by end users to 1.2 or 1.5 nominal voltages. Is this reasonable? Over-specifying?

Bertrand Poulin indicated that the request is based on system studies as load shed on long transmission lines result in over voltages of such magnitude lasting for several seconds and the shunt reactor must be able to perform its function when energized at as such voltage levels. Additional input from end users is needed to clarify this topic as manufactures don’t have enough information on this.

* Jane Verner made a suggestion that for variable shunt reactors, nameplates should be provided with a table of MVAR at each tap position. Jane will clarify her request to the WG Chair in a form of a write up to be discussed in the next meeting.
* Dieter Dohnal offered to provide a write up on on-load tap changers for variable shunt reactor application. Dieter to send the information to the WG Chair for discussion in the next meeting.
* The WG Chair indicated that the standard will be saved on the updated template so each of the subgroups could start formatting the document by next meeting.
* Subgroups as agreed during S15 meeting are 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 and 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 adjournment: Hemchandra Shertukde proposed and Enrique Betancourt seconded.

Meeting was adjourned at 10:45 am.

Next meeting: Spring 2016, Atlanta, GA, March 20-24.

Respectfully submitted,

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

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

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

**WG P60076-16 Standard Requirements for Wind Power Generator Transformers (Rev 2)**

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

The Working Group on Wind Power Transformers was called to order at 9:30 a.m. CST on Tuesday, April 14, 2015 at The Peabody Hotel in Memphis, Tennessee. There were 135 attendees, 40 members present of a membership of 58 and 81 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.

Jerry D. Allen, Shihkin Electric, Clearwater, FL

Jagdish Burde, Power Distribution Inc., Santa Ana, CA

Hugo Flores, CG Power Systems, Washington, MO

Attila Gyore, M&I Materials, Manchester, UK’

Tim-Felix Mai, Siemens, Kirchheim, Germany

John Mullikin, WEG Electric, Duluth, GA

Rahul Rajendran Palakandy, Black &Veatch, Kansas City, KS

Rakesh Rathi, Virginia Transformer Corp., Roanoke, VA

Raman Subramanian, Georgia Transformer, Rincon, GA

David Walker, ABB, Bland, VA

Joshua Yun, CG Power Systems, Washington, MO

Hemchandra Shertukde made a motion to accept the minutes from the Spring 2015 meeting and was seconded by Dev Walia. The motion passed unanimously.

The secretary gave a summary of the status of the standard. The standard has been through one ballot and received 132 comments. The IEEE comments have been addressed and resolutions recommended to the comments received from IEEE members. The IEC comments have been received but not resolution meeting has been held. The meeting is scheduled to occur in January 3-26 with Casey Ballard, head of the Resolution Committee, will also attend.

After further discussion and a recommendation from Jodi Haasz, it was concluded that a two year PAR extension should be requested immediately.

Alvaro Portillo, Consultant from Montevideo, Uruguay made a presentation of failures occurring on wind turbine transformers located in the nacelle of a wind turbine located near the ocean. Primary failure mode was a creepage failure due to accumulated salt in nacelles open to the outside atmosphere. Similar units with nacelle sealed to the atmosphere did not see the same failure modes.

He also noted that fluid filled transformers were exhibiting leakages early in their life. Cause was determined to be metal fatigue due to repeated pressure cycling caused by repeated dailyload cycling. It was recommended that a test be included in the standard to perform a 10,000 cycle pressure test to determine ability of transformer tank to withstand mechanical cycling due to loading.

Martin Navarro said the he has a new IEEE technical paper just recently published that also addresses the issues raised by Mr. Portillo. Further discussion was held on the presentation by Evan Langran, David Walker and Dev Walia.

It was proposed that the proposed test be included in the standard. It was decided that with the standard in the comment resolution cycle, it may not be possible to add the mechanical test to the standard before approval. The secretary was to research the possibility for inclusion and report back at next meeting.

Joe Mango gave a verbal discussion of recent discoveries of leaks found on 650 wind turbine transformers. His conclusion was similar to Mr. Portillo’s relative to mechanical cycling. Also being examined as to whether units with high hydrogen content have higher leak rates.

Phil Hopkinson asked the question to the group as to whether additional gas space would minimize the mechanical cycling and asked others to think about it. The Chairman will be asked to send out a survey to ask this question and whether other solutions may exist.

Tim Holdway moved and Paul Jarman seconded a motion to adjourn the meeting. The meeting was adjourned at 10:15 CST.

A working group session is planned for the Atlanta meeting.

Respectfully submitted,

Donald E. Ayers

Secretary

### WG on Loss Evaluation Guide C57.120 – R. Verdolin

**Fall 2015 IEEE Transformers Committee Meeting — Memphis, TN, USA**

**PC57.120 LOSS EVALUATION GUIDE FOR DISTRIBUTION AND POWER TRANSFORMERS AND REACTORS**

**Tuesday, November 03, 2015 — (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: D14

1. Attendance
   1. Members: 15
   2. Guests: 81
   3. Guests granted membership: 3
   4. Guests requested membership 13
   5. Total (Members + Guests): 96
2. The meeting was called to order at 11:00 am on Tuesday, November 3, 2015.
3. The chair indicated 16 members at the time and 13 were present during roll call therefore establishing a quorum.
4. A motion was made by Stephen Shull to approve the minutes of meeting from the Working Group Spring 2015 meeting in San Antonio, TX. The motion was seconded by Said Hachich. By unanimous vote, the minutes were approved.
5. The chair went some history and comments from previous meetings to update everyone on current status as the previous chair could not continue after Spring 2015.
6. A request was made for the DOE report discussed in last meeting. Jerry Murphy will try and contact Don Duckett and obtain a copy.
7. Discussion took place on the subject of using dollar values in this document. Previous comments by Don Platts and William Bartley indicated that IEEE legal would not allow dollars to be used. Erin Spiewak (IEEE-SA) read the IEEE response. Dollars can be used provided they are publically available numbers (preferably from government-sponsored sources). If public data are not available, then use arbitrary numbers that bear no relation to reality and that do not reflect actual relative costs or prices. The 1991 published version is an acceptable format. The use of a generic symbol is not preferred.
8. The chair requested help from the Working Group to review the existing list of items in the document. Two volunteers (Ewald Schweiger and Ryan MacMullin) were found.
9. The chair continued reviewing the latest draft and mentioned that members need to review all calculations.
10. Phil Hopkinson asked if anyone had a “magic number” for the cost of transmission and distribution as $/Watt. Said Hachichi offered some factors. Phil then asked for an industry average because those appear to be too high. Another offered a typical that Phil agreed were more to his thinking. [It is not in keeping with the Transformers Committee policy to offer industry financial factors.]
11. As an item of new business, Dan Blaydon asked about the previous meeting comment “Due to timeline, utilities that do not generation anymore, deregulated utilities would not be included in the document.” His concern is that this document doesn’t address non-vertically integrated utilities (no generation) and how to incorporate this document.
12. Don Platts suggested that a group be formed to determine what is needed in the document that will help the utilities as it really belongs to the users.
13. The chair asked if Dan Blaydon would lead getting a group together for this task and other volunteers were requested. The following is a list of these volunteers:
14. Dan Blaydon
15. Wallace Binder
16. Mike Spurlock
17. Jerry Murphy
18. Ryan MacMullin
19. Maria Dlaguekova
20. David Wallach
21. Evan Langran
22. With the short timeframe before the PAR expires on December 31, 2016, a final draft to be sent for ballot by, or at, the Spring 2016 meeting.
23. The next meeting is March 20-24, 2016 in Atlanta, GA.
24. The meeting adjourned at 12:15 PM after Wallace Binder made a motion and Stephen Shull seconded for the subsequent vote.

Respectively submitted,

Rogerio Verdolin, Chair

Rod Sauls, Vice-Chair

### WG 3-ph Transf. Connections C57.105 - A. Bromley

**Fall 2015 IEEE Transformers Committee Meeting — Memphis, TN, USA**

**C57.105 – IEEE Guide for Application of Transformer Connections in Three-Phase Electrical Systems**

**Tuesday, November 03, 2015 — (1:45 PM – 3:00 PM)**

Chair: Adam Bromley

Vice-Chair: Rogerio Verdolin

1. Attendance
   1. Members: 10
   2. Guests: 18
   3. Guests requested membership 1 (Samuel Sharpless)
   4. Total: 28
2. The meeting was called to order at 1:45 pm on Tuesday, April 14, 2015.
3. Chair presented agenda for the meeting. A motion to approve agenda for the meeting was made by Charles Simmons and was seconded by Said Hachichi.
4. A motion was made by John John to approve the minutes of meeting from the Working Group Spring 2015 meeting in San Antonio, TX. The motion was seconded by Alejandro Macias. By unanimous vote, the minutes were approved.
5. Par status: Par expires December 31st, 2019, which represents 7 meetings before we have to conclude the guide before going to ballot.
6. Rogerio Verdolin and David Walker provided a review of their findings related to the references included in the current revision of C57.105. Of the 34 references listed, 9 are general reference textbooks and similar publications, 2 are papers on converting from two to three phase power and vice versa, and 23 are references on ferroresonance. None of these materials are directly referenced in the body of the standard but are included solely to provide additional information for the reader. In general, the cited works are from the 1950’s, ‘60’s, and early ‘70s. Many of them are out of print and difficult or impossible to obtain. In addition, since discussion of ferroresonance is just a small portion of the standard, having 2/3 of the references being information on that topic seems out of balance with the content of the standard. Given these considerations, it was decided to update the references to fewer, more modern, references that would be easy for interested readers to obtain. Examples are the CIGRE guide on ferroresonance and also more modern summary publications on the topic. We have contacted David Jacobson, from Manitoba Hydro, an expert on ferroresonance and one of the authors of the CIGRE guide, and he has agreed to help us 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. John John has reviewed the comments from the excel file presented by the chair which was the previous Reaffirmation balloting comments. John has reviewed the comments attached in excel file, one by one. They are valid in most cases as far as the disposition detail is concerned. A few seem to be already done. Others are yet to be incorporated. We can include those as going forward. However, the comments that all references to reference standard need to have the year updated doesn’t seem necessary. While working in another group, what we decided is there is no need to mention the year or revision year of the reference standard when we refer an ANSI standard as they are continuously revised and no point in mentioning the year. If we refer a document or paper, then original date of the document or paper is still ok, irrespective of how old it is. If in the present context, they are not valid, we can remove reference to those documents. John has marked up what he found out and noted down briefly what need to be done on the hard copy of the file print out, as discussed with Adam Bromley. John has handed over the marked up review to Adam for making the draft modification of the Guide before the next meeting.
8. Adam presented and discussed the keywords from the Abstract section for searching purpose. The word “connections” was included.
9. Adam also presented the additions he made to the Introduction for informational purposes. There was general consensus surrounding the additions.
10. Samuel Sharpless will produce the document drawings in AutoCAD or similar drawing format so that they can be easily edited during the revision.
11. Charles Simmons asked if the draft document would be posted to the Transformer Committee Web site. Chair stated that once we have a document that includes the figures, tables and equations in a viewable format, we would be able to post the draft. The chair’s hope is that this is completed prior to the next meeting in the spring.
12. The next meeting is March 20-24, 2016 in Atlanta, GA.
13. The meeting adjourned at 2:35 PM

Respectively submitted,

Adam Bromley, Chair

Rogerio Verdolin, Vice-Chair

### 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

WG Meeting # 7

Unapproved Meeting Minutes

Memphis, TN, USA

Tuesday, November 3, 2015

AGENDA

1. Roster and Quorum Verification

2. Meeting Agenda Approval

3. Approval of the S2015 San Antonio Meeting Minutes

4. Update on the ballot results of the Guide Draft 6

5. Report of the Comment Resolution Committee

6. Guide Draft 6.1

7. Ballot re-circulation

8. New Business

The Working Group met in the Grand Ballroom C of the Peabody Memphis hotel**.** This was a seventh meeting of the WG.

The meeting was called to order at 1:45 pm by Chairman H. Shertukde.

The meeting was convened with 43 participants present, 16 of them are members (that constitutes a quorum out of 32 current members in the roster).

Old Business

Fall 2015 San Antonio Meeting Minutes were approved.

New business

Meeting Agenda was approved.

1. Secretary A. Levin updated WG on the results of the ballot of the Guide Draft 6:

- pool – 803

- # registered voters – 129

- response rate – 76%

- approved – 84%

- abstain – 4%

- # comments - 206

2. Ballot resolution committee presented it’s report.

Resolution committee concentrated on 66 comments of the technical nature. 23 comments were rejected, but only 13 of these 23 were related to the Disapprove vote and the request for the comments to be resolved (9 out of these 13 are from the same commentator and were rejected based on the fact that the comments have a very generic character and no specific proposals have been provided).

3. The marked Guide Draft 6.1 that incorporates all accepted changes was reviewed.

Several specific aspects were discussed:

1. Single phase inverters (also known as micro-inverters) – multiple inverters of this type can be connected to one transformer LV winding.

* P. Hopkinson moved the proposal to include the note on the importance of the consideration of synchronization of these inverters.
* V. Tendulkar commented that modern inverters are tightly controlled and this is not normally a problem.
* T Hollis also thought this is not an issue.
* P. Hopkinson made a motion to include the note on the discussed topic in the revision of the Guide. A. Portillo seconded. Motion passed, with 1 against and 1 abstain. P. Hopkinson will provide a wording of the comment.

1. Winding connection examples (Fig. 7)

* A. Portillo commented on the Fig. 7 c) (left case) that this is not a feasible Winding arrangement. He made a motion to delete the case. A. Narawane seconded.
* In the discussion, V. Tendulcar was concerned about cases d) and e) as well. It was also proposed to eliminate 7c) left, d) and e) cases.
* E. Betancourt proposed to indicate the central HV lead for cases 7c) left. A. Portillo accepted the friendly amendment to his motion and the motion to include the central lead for the case 7c) has passed unanimously.

1. Harmonic content.

* P. Hopkinson made a motion to include the harmonic level vs. frequency Table from IEEE 518 in the Guide to ease the users access to the data. He described the case where lower level high frequency (3 kHz) harmonic has been generated due to the resonance and was detrimental to the transformer. A. Portillo seconded the motion.
* T. Hollis thought that IEEE 1547 is a more appropriate reference.
* 8 members voted for, 2 against and the rest abstained. Motion passed and the Table will be added.

4. The next revision of the Guide (Draft 6.1) was discussed.

Ballot Comments Resolution Committee has had a conference call on October 29, 2015 and recommended to submit Guide Draft 6.1 for the ballot re-circulation.

S. Som made the motion to approve Guide Draft 6.1 (with the changes approved at this WG meeting) and submit Comment Resolution and Draft 6.1 for the ballot re-circulation. S. Walia seconded. The motion has passed unanimously. Draft 6.1 will be submitted for the re-circulation.

As a new business, H. Shertukde mentioned that the WG will present a tutorial on DPV generation and transformers at the next IEEE TC Spring meeting 2016 in Atlanta. This WG is scheduled to make a tutorial presentation at the next Spring meeting in Atlanta Georgia. Tom Prevost has been intimated to include the topic for the tutorial. Speakers to be included in the team to present the tutorial have been initially contacted.

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

Chairman: H. Shertukde

Vice-Chairman: M. Sauzay

Secretary: S. Levin

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

**TF to Investigate the Interaction between Substation Transients**

**and Transformers in HV and EHV Applications**

**Memphis, TN**

**Tuesday, November 03, 2015**

**3:15 PM – 4:30 PM**

**Ballroom C**

**Chairman – Jim McBride**

**Secretary – Tom Melle**

1. Welcome and Chair’s Remarks. TF objectives were presented.
2. Circulation of Attendance Sheets
3. There were 88 individuals in attendance with 21 members present. Quorum was achieved.
4. Spring 2015 Meeting Minutes presented and approved with no opposition
5. Fall 2015 Agenda presented and approved with no opposition
6. Chair began presentation and discussion of Capacitor Switching Transients

* There was a review of comments submitted by Pierre Riffon on the methods of describing capacitor bank switching operations. The three methods were simple LC circuit, back-back capacitor banks switching, and traveling waves. The Chair remarked that after reviewing the failures in this category, none had been identified as the primary cause of the failure. The Chair presented a few example traces that supported this conclusion.
* Phil Hopkinson commented that a data capture of recorded waves should be presented if conclusions are made; however agreed that Capacitor Switching typically does not cause failures.

Chair briefly reviewed the case studies which are a basis of the TF work and described the failure categories that have been identified in the preliminary task force paper:

A - System faults and capacitor switching produces traveling waves with reflections that excite lightly loaded transformers to resonance.

B – Generator step-up transformers operating in back feed mode are excited to resonance by system transients.

C- High frequency switching operations close to the transformer terminals which excite internal resonance due to multiple re-ignitions and re-strikes.

Chair requested that the members of the TF make a motion on the inclusion of capacitor bank interactions in the TF summary paper. Pierre Riffon restated with capacitors there is no fast collapse to ground. Phil Hopkinson made a motion that capacitor banks be included with indication of factors that may or may not contribute to failure. The motion was seconded by Rogerio Verdolin. Motion passed with 19 approvals.

1. The Chair indicated that new switching transient information on re-strikes during bus de-energization transients had been received from Pierre Riffon (~ 300-500 kHz). This new information was added to Failure Category C: *High frequency switching operations close to the transformer terminals excite internal resonance due to multiple re-ignitions and restrikes.* In addition, Figure 2 was added to the document.
2. General discussion, suggestions and comments regarding the Conclusions / Recommendations section ensued:

* Xose Lopez suggested adding monitoring and mitigation information to the TF paper. This suggestion was discussed by the members of the task force and those present expressed no objections to adding this information. During the discussion of monitoring, modeling, and system studies, Bertrand Poulin suggested that all these tools must be utilized to realize a complete understanding of system interactions.
* Sanjib Som suggested separating the Conclusions and Recommendations sections and also suggested that the TF summary paper be submitted for publication as an IEEE transaction paper
* Rogerio Verdolin mentioned that proper instrumentation is required to measure these high frequency transients in the field. The Chair suggested that these measurement devices should have a bandwidth of at least 2 MHz.
* Waldemar Ziomek indicated that he was involved with transient studies that indicated the stress on a transformer can vary significantly due to the methods of neutral grounding used on the unit. Alvaro Portillo agreed with this statement. Discussion ensued over resonant frequency and the severity to neutral grounding and its effect on the response of the transformer. There was discussion that this may not be material for inclusion in the TF summary paper. Waldemar Ziomek made a motion to include this information as possible material for revision of C57.142. The motion was seconded by Pierre Riffon and passed.

The Chair commented that design reviews be expanded to include these neutral grounding topics, stressing the need for good communication between transformer manufacturers and end-users.

1. An update from the CIGRE Modeling working group presented by Xose Lopez will be made available to the task force.
2. Phil Hopkinson presented possible upstream/downstream interactions of two transformers. Low power factor / highly inductive combinations were emphasized. Again, this presentation will be made available to the task force and might be considered for inclusion in the C57.142 revisions.
3. Chair indicated that some more specific information had been added to the GSU back feed section of the TF Paper. This information was provided by Bertrand Poulin.
4. New Business – none presented
5. A motion to adjourn the meeting was made by Joe Melanson and seconded by Xose Lopez. The meeting was adjourned at 4:30PM.

Respectfully Submitted,

Tom Melle, TF Secretary

11/03/2015

### WG on Neutral Grounding Devices PC57.32 - S. Kennedy

**WG for IEEE Standard Requirements, Terminology, and Test Procedures**

**for Neutral Grounding Devices, PC57.32**

**Neutral Grounding Devices working group**

There was no meeting in Memphis, Tennessee.

The work of this group should be complete.

Balloting started in June of 2015. The first ballot had 246 comments with many negative ballots.

The Ballot Resolution Group attempted to resolve all of those comments.

A Recirculation Ballot and draft was produced in September. It yielded 17 comments with some new negative ballots.

The Ballot Resolution Group attempted to resolve all of those comments.

A second Recirculation Ballot was produced and circulated in early October. All negative ballots were resolved with no comments.

The final recirculation ballot results were:

138 Eligible Voters

117 Returned for a return of 84%

9 Abstentions 7%

108 Affirmative Ballots received 100%

0 Comments

The standard was submitted to REVCOM for the December 2015 meeting. So far, one comment has been received from REVCOM members and has been satisfied.

Respectfully Submitted,

Sheldon P. Kennedy

Chair

Tom Melle

Vice Chair

Fred Elliot

Secretary

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

**Task Force for Semi-Conductor Rectifier Transformers**

**Meeting Minutes – November 3, 2015**

**Memphis, Tennessee**

**Sheldon P. Kennedy - Chair**

The Task Force met on Tuesday, November 3, 2015 at 11:00 AM with 6 members present. Sheldon Kennedy chaired the meeting. This was the first new 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.

There was a lively discussion about problems with newer adjustable speed drive transformers with PWM or AFE drives. Many of these produce uncharacteristic outputs. Other, issues that had previously been discussed, like electrostatic ground shields and phase shifted windings were discussed again.

The meeting turned back to developing a new PAR. A change in title was discussed but rejected. The concern was that the title can make a user of the standard believe it only applies to rectifier transformers and not to inverter transformers or adjustable speed drive transformers. These will be added the Scope of the PAR.

It was requested to lower the Scope of the PAR to “200 kW and above” from “300 kW and above” for single phase loads Also, three phase loads were lowered from “500 kW and above” to “300 kW and above”.

Also, Dhiru Patel 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”. The Chair will check with the Performance Characteristics Subcommittee on whether this is appropriate for the Scope or whether it should be in the body of the document before submitting the PAR to Adcom.

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 December 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 Working Group officers. William Whitehead of Fuji Electric volunteered to be Vice Chair to help with the work. The Chair would still like to also add a Secretary to the future Working Group.

The Chair will complete the PAR form for review by the Task Force and then submit it to the Performance Characteristics Subcommittee to be approved by Adcom.

There were no further comments.

The meeting adjourned at 12:15 PM.

Submitted by;

Sheldon P. Kennedy

Chair

### TF Short Circuit Criteria - D. Buckmaster

**Task Force Short Circuit Criteria**

**Memphis TN, USA – Nov 3, 2015**

Ed teNyenhuis, Nov 3, 2015, Rev 1

* The Task Force met at 4.45 PM in the Grand Ballroom A on Nov 3, 2015
* This was the first meeting of the task force
* The scope of the task force as given by the subcommittee was to: Investigate to have a short circuit design criteria similar to the IEC Annex A, Theoretical evaluation of the ability to withstand the dynamic effects of short circuit, in the IEC 60076-5, Ability to withstand short circuit.
* Dave Buckmaster was not able to attend as Chairman so Ed teNyenhuis acted as Chairman for the meeting
* An attendance roster was circulated with 42 requesting membership and with 36 guests. Since this was the first meeting, all persons requesting membership were immediately granted membership by the Chairman. Thus quorum was achieved for the meeting.
* Joe Foldi first gave the background of his request (he initiated the request at the Spring 2015 PCS meeting):
* Most manufacturers can calculate fault current and forces/stresses however the mechanical material characteristics are only known from testing
* GE Pittsfield has done a lot of short circuit and material testing many years ago and this is the basis for the Annex A
* TC14 has realized that the Annex A needs to be updated and has set up a WG that will start in January 2016
* Question is if IEEE needs to do something similar to Annex A?
* If yes then how would IEEE handle this? Should we do our own guide, do a dual guide with IEC etc?
* There was excellent discussion on this subject from manufacturers and users:
* IEC is looking itself at doing a dual document (Phil Hopkinson)
* IEC document is only presently for oil filled circular core power transformers (Alvaro Portiillo)
* Short circuit testing has an overall 25% failure rate and 40% failure rate for > 100 MVA (Alvaro Portillo)
* IEEE should have better motivation to do something than just the IEC Annex (Waldimar Ziomek)
* IEEE does not tell manufacturers how to design transformers (the IEC Annex A does) (Waldimar Ziomek)
* IEEE should take part in the IEC but should not change IEEE guides (Waldimar Ziomek)
* A new IEEE guide on SC would still allow manufacturers to follow their own rules (Joe Foldi)
* The IEC Annex A shows a disconnect in the interpretation of the reality of short circuit (they need to be revised) (Sanjay Patel)
* The IEC Annex A is not solely based on GE information, but also or more so on CIGRE Brochure-209 (Sanjay Patel)
* IEEE should participate in the IEC to correct the Annex A (Sanjay Patel)
* IEEE needs something to give users a good feeling that manufacturers know what they are doing for SC (Kushel Singh)
* Even though 40% of > 100 MVA transformers failed they all had thorough design reviews (Krzystof Kulasek)
* The quality and tolerances of manufacturing are very important and this should be part of the IEEE guide if done (Krzystof Kulasek)
* Would this inhibit a manufacturer from investing in new technology? (Steve Schroeder)
* This should be a guide, not a standard (Bill Boettger)
* It should not be design specific but should allow freedom to manufacturers (Phil Hopkinson)
* Annex A is informative so it is not a standard (is optional) (Alvaro Portillo)
* Manufacturers should be allowed to do their own simulation to prove the SC worthiness (Arup Chakraborty)
* SC testing is not practical for all transformers so the Annex A is a practical approach (Joe Foldi)
* Even though Annex A is optional, users will take this as gospel truth (Sanjay Patel)
* Manufacturers should have something to comply to (Xose Fernandez)
* IEEE needs to start with something (Amit Sorkay)
* A motion “for IEEE to have a short circuit design criteria similar to the IEC Annex A, Theoretical evaluation of the ability to withstand the dynamic effects of short circuit, in the IEC 60076-5, Ability to withstand short circuit” was initiated by Joe Foldi and seconded by Bill Boettger. This motion passed by 28 to 2 votes.
* The meeting was adjourned at 5.55 pm.