Annex J Performance Characteristics Subcommittee (PCS)

March 27th, 2019, Anaheim, California, USA

UNAPPROVED MINUTES

Chair: Craig Stiegemeier
Vice Chair: Sanjib Som
Secretary: Rogerio Verdolin

J.1 Introduction / Attendance

There were 81 of the 114 PCS members in attendance so quorum was achieved (71% in attendance). In addition, 84 guests were present at the meeting. The total attendance at the meeting was 165. There were 17 guests who requested membership, but only 6 six attended this meeting and last meeting in Jacksonville. They will be granted membership before the next meeting in Columbus, Ohio, USA, on October 30th, 2019.

J.2 Chairman's Remarks

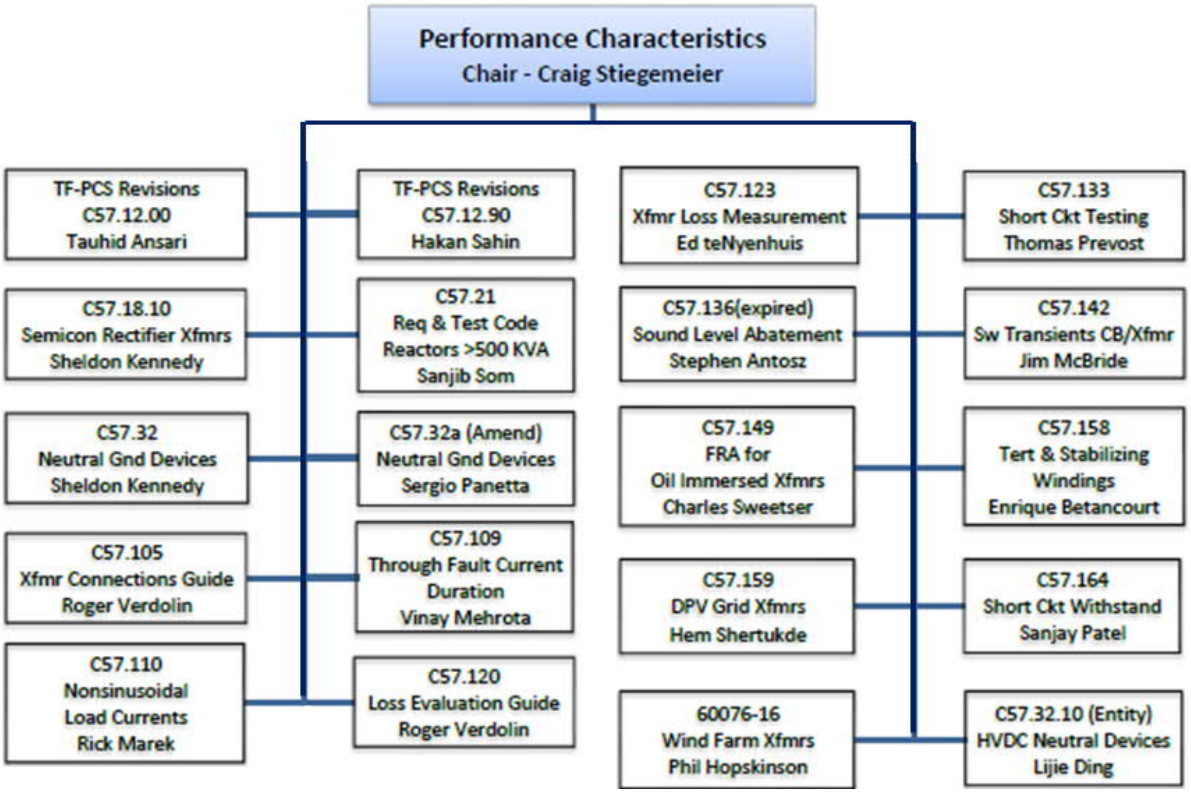
The Chair introduced himself, the vice–chair and secretary and provided the below updates and comments.

PCS Responsibilities: Defined by the Transformers Committee Organization and Procedures Manual.

The Performance Characteristics Subcommittee shall be responsible for the following:

- Studying and reviewing the treatment of loss, impedance, exciting current, inrush current audible sound and vibration, and other performance characteristics and their methods of application, measurement, or test for liquid filled transformers and liquid filled and dry type reactors.
- Studying and reviewing the treatment of the performance characteristics of other special use transformers e.g. photovoltaic, wind, and rectifier transformers.
- Developing and maintaining related standards, recommended practices, and guides for such criteria
- Coordinating with other technical committees, groups, societies, and associations as required

Standards Supported by PCS:



- C57.12.00-2015 (Rev. 2010) – TF to provide PCS revisions – T. Ansari
- C57.12.90-2015 (Corr. 2017) – TF to provide PCS revisions – H. Sahin (test code) & R. Girgis (audible sound)
- C57.18.10-1998 (Amend. 2008) – Semiconductor rectifier transformers – S. Kennedy
- C57.21-2008 (Rev. 1990) – Requirements & Test Code For Shunt Reactors >500kVA – S. Som
- C57.32-2015 (Rev. IEEE Std. 32-1972) – Neutral Grounding Devices (2025) – S. Kennedy
- C57.32a (Amendment) – Neutral grounding devices – S. Panetta
- C57.32.10 - new Entity PAR - WG Neutral Grounding Reactors Guide for HVDC Converter Transformers
- C57.105-2019 – Transformer connections guide – R. Verdolin
- C57.109-2018 – Through Fault Current Duration – V. Mehrotra
- C57.110-2018 (Rev. 1998) – Xfrmr Capability when Supplying Nonsinusoidal Load Currents – R. Marek

- C57.120-2017 – Guide for loss evaluation – R. Verdolin
- C57.123-2010 (Rev. 2002) – Transformer Loss Measurement – E. teNyenhuis
- C57.133-exp – Guide for Short Circuit Testing (Expired – now covered by C57.12.90) – T. Prevost
- C57.136-2000 (Reaff. 2005) – Sound Abatement Guide (will let expire, may cover in C57.12.90) – S. Antosz
- C57.142-2010 – Switching Transients Circuit breaker/Transformer – J. McBride
- C57.149-2012 – New SFRA Guide (2022) – C. Sweetser
- C57.158-2017 – Tertiary & Stabilizing Windings (2027) – E. Betancourt
- C57.159-2016 – DPV Transformers (2026) – H. Shertukde
- C57.164-new – Short Circuit Withstand (in development) – S. Patel
- 60076-16-2018 – Wind Turbine Generator Transformers – P. Hopkinson
- Moved TF to determine if a new guide for field testing OLTCs is needed is now preparing a
- PAR under the Standards SC as TF PC12.152 – M. Ferreira

Status of Active PAR's:

- **2019 PAR's**
  - C57.105 3-ph Transf. Connections (complete)
  - C57.109 Through-Fault-Current Duration (complete)
- **2020 PAR's**
  - C57.18.10 Semiconductor Rectifier Transformers (WG in draft development)
  - C57.21 Shunt Reactors over 500kVA (filed PAR extension in May 2018, sponsor ballot open, closing today)
  - C57.164 Short Circuit Withstand Guide (WG in draft development)
- **2021 PAR's**
  - C57.142 Transient Guide (WG in draft development)
  - C57.32a Neutral Grounding Devices amendment (Sponsor Ballot complete: in Comment Resolution phase)
  - C57.123 Loss measurement guide (WG in draft development)

- **2022 PAR's**
  - C57.32.10 Entity WG Neutral Grounding Reactors Guide for HVDC Converter Transformers
  - C57.149-2012 – SFRA Guide (WG in draft development)

Status of Standards without active PARs

- C57.133 Guide for Short Circuit Testing (Expired, now covered by C57.12.90)
- C57.136-2000 Sound Abatement Guide (2018 – may let expire)
- C57.149-2012 SFRA Guide (2022)
- C57.32-2015 Neutral Grounding Devices (2025)
- C57.159-2016 DPV Transformers (2026)
- C57.120-2017 Loss Evaluation Guide (2027)
- 60076-16-2018 – Wind Turbine Generator Transformers (2028)
- C57.109-2018 – Through Fault Current Duration (2028)
- C57.110-2018 – Xfrmr Capability when Supplying Nonsinusoidal Loads (2028)
- C57.105-1978 (Reaff. 2008) – Transformer connections guide (2029)

Working Group / Task Force Leaders

- Issue agenda at least 30 days ahead of time
- Minutes are due in 15 days, please get them to us today in MS Word format
- Please keep your webpages up to date – review regularly and send any content/files to Sue
- Must track attendance in AM System
- A patent call must occur at every WG meeting
- No photography or recording of any kind is allowed
  - Except by officers to support accurate minutes
  - It must not be shared and deleted immediately after use

WG / TF Leaders – Process Requirements

- AdCom discussed and agreed that the Comment Resolution Group (CRG) should vote at a simple majority when reviewing comments
- AdCom also agreed that if the comments were brought back to the WG for consideration the voting requirements would also be a simple majority.

- Virtual meetings between physical meetings help move things along, but you must announce them by circulating an Agenda to the entire PCS using the AM System at least 15 days before the meeting
- Every meeting's minutes must record both member & guest attendance using the AM System and must include: Attendance; Quorum; Motions (with names) and Voting results
- The minutes from every meeting (physical and virtual) must be provided to the PCS secretary within 15 days
- Minutes will be posted on the Transformers Committee website

Attendance / Membership / Quorum

- Please record your attendance on one of the Sign-in Sheets being circulated – we only need your name if you are not on the Sign-in Sheets being circulated
- 9 "Corresponding Members" are counted as "Guests" in terms of attendance for a quorum
- Requests for membership will be granted after the meeting if you've made the past 2 or 3 of the last 5 meetings
- PCS now has 114 members after a review of the Spring 2018 meeting attendance, along with the 4 previous meetings
- A meeting quorum will be reached if 58 members are in attendance

Attendance / Membership – moved to Guest status
The following 9 Members missed the past 2 meetings and have been moved to "Guest" status:

- Jose Gamboa
- Rob Ghosh
- Ismail Guner
- Paul Jarman
- Deepak Kumaria
- Shankar Nambi
- Mathieu Sauzay
- Sukhdev Walia
- Dr. Alexander Winter

Please contact Sanjib by sending him a message or see him after the meeting if you believe your membership status is not accurate.

Attendance / Membership – New Members
These 11 former Guests requested membership at the Spring 2018 meeting and have attended the past 2 or 3 of the last 5 meetings:

- Roger Fenton
- Jose Antonio Gonzalez Ceballos
- Raka Levi
- Mark Lowther, Jr.
- Steven Schappell
- Bruce Webb
- Jeffrey Wright

Welcome the New Members: We look forward to your contributions to the Subcommittee

Attendance / Membership – counted as Guest status
These 9 Corresponding Members are being counted as guest status to support reaching the meeting quorum. They continue to receive communications and their guidance for the working group is most welcome.

- Donald Chu
- Larry Coffeen
- Jerry Corkran
- Richard Dudley
- Tamyres Machado Junior
- Dennis Marlow
- Bipin Patel
- Paulette Powell
- Loren Wagenaar

Attendance / Membership – Quorum determination

- Current breakdown of the Subcommittee:
  - 108 Members
  - 55 are needed for a quorum

J.3 Approval of Agenda

The Chair presented the agenda and requested if there was any objection to unanimous approval of the agenda - hearing none the agenda was unanimously approved. The agenda had been sent to the members by email several weeks prior to the meeting.

J.4 Approval of Last Meeting Minutes

The Chair presented the minutes of meeting held in the Fall 2018 - Jacksonville, Florida, USA, on October 17th, 2018 and requested if there was any objection to unanimous approval of the agenda - hearing none the minutes was unanimously approved. The minutes had been sent to the members by email several weeks prior to the meeting. James McBride made 1st motion to approve Fall 2018 meeting, which was seconded by Robert Thompson.

J.5 Minutes from Working Groups and Task Force

The following WG and Task Force reports were received (the reports are appended later).

- **TF on PCS Continuous Revisions to Test Code C57.12.90 H. Sahin**
- **WG Guide for FRA for Liquid Filled Transformers C57.149 C. Sweetser**
- **TF on Audible Sound Revision to Clause 13 of C57.12.90 R. Girgis**
- **WG on Loss Measurement C57.123 E. teNyenhuis**
- **TF on PCS Continuous Revisions to C57.12.00 T. Ansari**
- **WG on Amendment to Neutral Grounding Devices PC57.32a S. Panetta**
- **WG Shunt Reactors C57.21 S. Som**
- **WG on C57.18.10 Semiconductor Rectifier Transformers S. Kennedy**
- **WG on HV & EHV Breaker & Transformer Sw. Transients C57.142 J. McBride**
- **WG Short Circuit Withstand Design Criteria C57.164 S. Patel**

Below are highlights that were discussed at the PCS meeting:

1) **TF on PCS Continuous Revisions to Test Code C57.12.90 H. Sahin**

Testing the transformer with the same liquid as it would have in service will be handled by a task force under standards subcommittee.
Continue updating section 12.3.4 for the number of short circuit tests.
A new business was agreed to be worked on to update the section 7.1.2 Voltage and Frequency of the ratio test to give a larger bandwidth for the acceptable frequency.

2) **WG Guide for FRA for Liquid Filled Transformers C57.149 C. Sweetser**

A brief presentation was conducted on recommended FRA measurement test parameters.
More specifics about grounding practices should be discussed. Input from SFRA equipment manufacturers for their recommended practices.
Discussion about frequency limits.
Test connections diagrams. Possible vector diagrams for the open circuit tests.
Analysis section it would be helpful to end users to know if they have a problem by calculating indices which are the interpretation of the difference between two curves so they can see a "number".

3) TF on Audible Sound Revision to Clause 13 of C57.12.90 R. Girgis

The first item presented was the proposed revisions to Table 17 and Annex C in C57.12.00 which were recently approved through Survey at the PCS Subcommittee level.
These items were recently submitted by the Chairman to Mr. Steve Snyder to be included in the 2020 Revision of C57.12.00.
A new survey was issued to TF members on proposed text on "Impact of temperature on core noise" and on "Impact of temperature & tap position on load noise" to be added to Clauses (13.3.3.1 No-load audible sound level) and (13.3.3.1 load audible sound level); respectively.

4) WG on Loss Measurement C57.123 E. teNyenhuis

The Chair presented all comments received from the PCS survey sent out after the Fall 2018 meeting.
It was generally agreed that the draft guide is complete.
The chair made the motion that PCS approve to move forward the C57.123 draft guide on for balloting.
The motion was made by Ed teNyenhuis and seconded by Ramsis Girgis. It was approved unanimously by the SC.

5) TF on PCS Continuous Revisions to C57.12.00 T. Ansari

Motion # 1 - Add details on the specific type of core on the nameplate
• Type 2, 3, or 5 limb Core
• Design = Shell or Core type
It was approved unanimously.
Motion # 2 — A change in the definition of rated current was approved by the Task Force with the following recommendation:
Proposal: To modify the requirements noted in the comments column for the impedance voltage and load loss tests in C57.12.OO Table 17 as follows:
Current: These measurements shall be taken only at the rated voltage connection for a two-winding unit, and at all rated voltage connections for units with three or more windings.
Proposed: These measurements shall be taken only at the rated voltage connection for a two-winding unit, and at all rated voltage connections for units with three or more windings. At least one test shall be performed at the minimum kVA rating and one test at the maximum kVA rating.
Result of the motion:
Objections: 8, Abstention: 7, Approval: 45

6) WG on Amendment to Neutral Grounding Devices PC57.32a S. Panetta

The meeting was great. There were people from Turkey, England, Mexico, and the US. The WG is planning to conclude the document in a couple of months. The WG will re-circulated the draft.

7) WG Shunt Reactors C57.21 S. Som

The draft 4.2 of the document is now in the balloting process, closing on March 27, 2019.
There are no plans to extend the ballot closing date.

The Chair requested additional volunteers to join the BRG: Mike Sharp, Dharamvir and Ulf Radbrandt have volunteered to the BRG.
Next step is to resolve the comments and recirculate the document. Target date is end of May 2019.

8) WG on C57.18.10 Semiconductor Rectifier Transformers S. Kennedy

Discussion of Draft 5 Revisions: Draft 5 had a 73.3% WG Survey approval, but with comments.
There were several discussions regarding if FEA should be required for strays and eddies. The chair committed to reviewing the IEC standard and proposing text for C57.18.10 to be circulated for online voting.
Draft 5 had no negatives but several comments that need to be included in Draft 6 for a WG survey. If this survey, which will be conducted in a month or two, is successful we would like PCS permission to move on to submitting an IEEE ballot.

9) WG on HV & EHV Breaker & Transformer Sw. Transients C57.142 J. McBride

The present draft of the Guide is posted on the Working Group website.
Review of C57.142 Draft 6: The chair requested that the members and guests please continue to review and comment on the existing draft over the next few weeks before the draft is handed to the IEEE Switchgear Committee for review.
Mitigation Methods Task Force Update: The Chair added that more communication is required between the end-user of the transformer and the manufacturer with regard to the potential for exposure to high-energy transients in the field. Multiple mitigation methods are also being discussed and will be addressed in the Guide.
Switchgear Liaison Update: The C57.142 Guide is a co-sponsored document between Switchgear and Transformers and run by Transformers Committee. The next IEEE Switchgear Committee Meeting will be held April 28-May 2, 2019 in Burlington, VT.

10) WG Short Circuit Withstand Design Criteria C57.164 S. Patel

TF on PCS Continuous Revisions to Test Code C57.12.90
WG Guide for FRA for Liquid Filled Transformers C57.149
This was the second meeting since the PAR was approved. They had quorum.

J.6 Unfinished (Old) Business

None

J.7 New Business and Motions

None

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

J.8.1 Task Force on PCS Continuous Revisions to C57.12.90

Meeting Summary
Task Force on PCS Continuous Revisions to C57.12.90
March 25, 2019; 11:00 to 12:15 pm

Hilton Anaheim Hotel
Meeting Room "California Ballroom (B)"
Anaheim California, USA
Chair: Hakan Sahin Secretary: Hamid Abdelkamel

The TF Chair called the meeting to order at 11:00am in the California Ballroom (B). Meeting attendees stood up and introduced themselves.
The chair went through a review of the purpose of the task force and the proposed agenda for the meeting.
There were 55 of the 83 TF members in attendance making this meeting "official" as a quorum of 66% was reached.
7 new guests requested membership that met requirements and were added to the membership list.

2 guests requested membership, but they did not meet the requirements.

The meeting agenda was approved.

Fall 2018 meeting minutes were approved.

The Chair then moved on to the discussion on old and new businesses.

- Testing the transformer with the same liquid as it would have in service will be handled by a task force under standards subcommittee.
- Continue updating section 12.3.4 for the number of short circuit tests
- A new business was agreed to be worked on to update the section 7.1.2 Voltage and Frequency of the ratio test to give a larger bandwidth for the acceptable frequency.

The meeting was adjourned at 11:57am.

J.8.2 WG Guide for FRA for Liquid Filled Transformers C57.149

Title: Guide for the Application and Interpretation of Frequency Response Analysis for Oil-Immersed Transformers

Working Group "Guide for FRA for Liquid-Filled Transformers" C57.149

(Performance Characteristics Sub-Committee)

Meeting Date/Time: March 25, 2019 1:45 PM
Meeting Location: Capistrano A – Hilton Anaheim
Chairman: Charles Sweetser [CS] (Omicron)
Vice-Chair: Poorvi Patel (EPRI)
Secretary: James Cross (Kinectrics)
Meeting was convened at 1:45 PM by Chairman Charles Sweetser with 56 total attendees, consisting of 11 members and 45 guests. The WG achieved a quorum.
Charles Sweetser reviewed the standard patent disclosure info.
Peter Werelius made a motion to approve minutes and agenda. Mario Locarno seconded. Carried unanimously.
Review of Suggestions:
1. Scope/Application – Steve Schappell (SPX Transformer Solutions)
2. FRA Test Parameters – Peter Werelius (Megger)
3. Making an FRA Measurement – Diego Robalino (Megger)
4. Test Records – Alex Kraetge (Omicron)
5. Analysis & Interpretation
    - Mario Locarno (Doble)
    - Luiz Cheim (ABB)
    - Hemchandra Shertukde (UHart)
    - Peter Werelius (Megger)
    - Mark Lachman (Doble)

Steve Schappell had not had a chance to prepare draft on scope and application.

Peter Werelius (Megger) made a brief presentation on recommended FRA measurement test parameters. He offered that the document should be updated to make more specific recommendations. It also needs more specifics about grounding practices. Peter will offered to prepare some words around these topics, but he is looking for input from other SFRA equipment manufacturers for their recommended practices. Mario Locarno volunteered, and Charles Sweetser offered to provide grounding information to Peter Werelius.
Discussion about frequency limits. Mario commented about the impulse guide frequency limits. Peter Werelius is suggesting 20 Hz to 2 MHz frequency range. Charles Sweetser, Mario Locarno, and Poorvi Patel agree to these limits. Charles Sweetser offered that some test cables (18 meters long) exhibit strange performance characteristics in the 1 – 2 MHz range. Poorvi Patel offered that the guide should differentiate between good and poor grounding practices and what the impact is on the response traces.
Diego Robalino made a presentation on Section 4 on making a FRA measurement. 4.2 par. 5 safety consideration about excessive voltages in a combustible environment…should be defined.
4.4 par 1 and par. 2 – grounding practices. Ground loop verification.
4.5 par. 3 "insulated" vs "isolated" from ground.
Test connections – Diego Robalino showed a table of possible vector diagrams for the open circuit tests. Roger Verdolin said that C57.105 has been recently approved and shows transformer connections and so can be used as a reference for vector groups.
Peter Werelius noted the difference between IEC and C57.149 in terms of the test connections relative to the vector groups. Charles Sweetser offered that the test data should be organized phase A, B, C head to tail in a consistent manner to allow for easier data interpretation to aid in future data comparisons to baseline testing, the test connections must be clearly defined and recorded.
Peter Werelius noted that test connections from previous test measurements should take precedence over connection diagrams in the guide (i.e. consistency in making connections is more important than what the guide might recommend).

Jason Varnel from SPX is working group chair for IEEE C57.12.70 and asked whether the FRA guide should follow that document. Should Diego's information on connections and vector groups be included as an informative addendum to the Guide with examples?
Poorvi Patel suggested that the information should be included for now and a decision made later as to whether it should be moved to an Addendum.

Mario Locorno (Doble) made a presentation on presentation on grounding topics and the quality of the grounding circuit. CIGRE interpretation guide is going to be published later this year and perhaps some of this information can be incorporated into C57.149. We would need CIGRE's permission to do so. Luiz Cheim noted that we should not duplicate CIGRE info in our document and that hopefully we might incorporate new developments and algorithms for movement detection in our document (use of calculated indices). Charles Sweetser noted that we should focus on axial, radial and bulk winding movement.
Peter noted that in the analysis section it would be helpful to end users to know if they have a problem by calculating indices which are the interpretation of the difference between two curves so they can see a "number".
Mario asked if there were new test techniques that have been developed that might help improve the test interpretation e.g. FRA ratio tests.
Charles Sweetser asked for a volunteer to lead Section 5 (Analysis and Interpretation) by having a couple of meetings before the fall/2019 meeting. Peter Werelius volunteered.
Mario Locarno will take the lead on the grounding issue with Peter Werelius and Charles Sweetser.
Mario Locarno has not received any data from anyone on SFRA measurements to date. He volunteered to continue to shepherd the data gathering process. He may be contacted at mario.locarno@doble.com.
Poorvi Patel noted that we were to create a template for the data collection. Poorvi Patel will check to see what was used in the CIGRE project.
Motion to adjourn… Mario moved, Diego seconded. Adjourn at 2:50 PM.
James Cross
Secretary
C57.149 WG

J.8.3 TF on Audible Sound Revision to Clause 13 of C57.12.90

Title: Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

Unapproved Minutes of Spring 2019 Meeting of TF "Audible Sound Revision to Test Code C57.12.90", in Anaheim, CA

The TF met at 1:45 PM, on Monday, March 25, 2019. Chairman Dr. Ramsis Girgis presided over the technical part of the meeting and Secretary Barry Beaster handled the administrative duties of the meeting.

After the Fall 2018 meeting, the membership was adjusted to 48 members. This meeting was attended by 26 of the 48 members and 54 guests for a total of 102 participants. A quorum was established after the final attendance was recorded in the AMS system due to some initial issues with the Cloud-In-Hand badging system. During the meeting, a call was made for any objections for a tentative unanimous approval of the Fall 2018 TF minutes; no objections were raised so we have a post-meeting official approval. The proposed agenda was presented without objections for approval. The circulated attendance sheets had thirteen requests for TF membership; which will be reviewed based on previous meeting attendance.

The first item presented was the proposed revisions to Table 17 and Annex C in C57.12.00; which were recently approved through a Survey at the PCS Subcommittee level. These proposed revisions are as follows:

- Incorporated NEMA TR1 Tables 1 & 2 for No-load sound levels into Annex – C with improvements (Tables C1 & C2)
- Replaced the formulas presently in Annex – C, for calculating reference load Sound Power levels, with tables of corresponding Sound Pressure levels (Table C3)
- Modified reference to the revised Annex – C in Table 17

These items were recently submitted by the Chairman to Mr. Steve Snyder to be included in the 2020 Revision of C57.12.00.

Prior to this TF meeting, a survey was issued to TF members on proposed text on "Impact of temperature on core noise" and on "Impact of temperature & tap position on load noise" to be added to Clauses (*13.3.3.1 No-load audible sound level*) and (*13.3.3.2 load audible sound level*) in C57.12.90; respectively. The results of the survey had 14 returned ballots, 8 approved, and 6 approved with comments. The proposed text on "Impact of core temperature on core noise" was as follows:

- *Generally, core temperature has a small impact on core noise. However, cores made of core materials that have lower quality coating with lower surface tension have been seen to experience an increase in core sound level of several dBs at higher core temperatures. This is more noticeable for high loss core steels at high operating flux densities.*

Other than editorial suggestions, the main comments received on this proposed text are as follows:

- Need for more quantitative description of words like: Small impact, lower quality coating, higher core temperatures, high loss core steels, and high operating flux densities
- Wouldn't such information belong to a Guide?
- Is there a need to perform the core noise test at a higher core temperature?

Based on some of the comments from the TF members, the following revised text was proposed in the meeting:

> *"Generally, core temperature has no, or small (1 – 2 dB), impact on core noise. However; depending on the type of core steel and the core lamination coating, several decibels (dB) higher core noise levels are likely at core temperatures that are higher than design values".*

The Chairman then opened the forum for a discussion of this item requesting feedback from core steel suppliers, transformer manufacturers, and transformer purchasers in attendance.

Some of the main feedback received were as follows:

- The present test code doesn't state a temperature for the sound test, so, at what temperature should core noise be tested at?
- Operating at 110 % voltage excitation at no load is part of the Standard requirements for transformer designs
- Is the effect of core temperature on core noise the same when the whole transformer core temperature is higher during regular operation?

- Since impact of core temperature on core noise cannot be defined better, perhaps this should be in a guide rather than in the Standard?
- How is the magnitude of this "effect of temperature on core noise" dependent on the B800 value (value that defines the degree of magnetic grain orientation of core steel)?

The Chairman answered ~~to~~ these questions / comments. He suggested that the TF will need to first understand how the magnitude of this effect, as observed at core noise test in the factory, compares with that when the transformer is in operation with the whole core temperature elevated. The Chairman also requested transformer manufacturers to conduct the following test in order to quantitatively evaluate this phenomenon:

- Perform the no-load test at 110 % excitation and measure core loss & core noise over a period of 4 hours, record the measured values at intervals of 15 minutes for the first hour, and every hour for the remaining 3 hours.
- Repeat the core loss & core noise test at 110 % excitation after the heat-run test (s) with the oil temperature elevated and compare measurements with the original measurements made at room temperature.
- Perform above tests on transformers with cores made of core steels from different suppliers.

The first priority would be to perform above tests on 3-phase core-form transformers with the 3-limb core and, if possible, perform the same tests on 3-phase core-form transformers with the 5-limb core type, and on at least one 1-phase transformer. Manufacturers are to share this test data with the chairman on a proprietary basis. No design information of these transformers will need to be shared with the Chairman.

As the meeting time had expired, the meeting was adjourned at 3:00 PM.

Respectively submitted,

Ramsis Girgis, TF Chairman

Barry Beaster, TF Secretary

J.8.4 WG on Loss Measurement C57.123

Title: Guide for Transformer Loss Measurement

Minutes of Meeting
Working Group C57.123 Loss Measurement Guide
Anaheim, CA – Mar 25, 2019

- The Working Group met at 15:15 in the Capistrano Meeting room at the Hilton Hotel on Mar 25,2019. This was the fourth meeting since receiving the PAR for revision of the guide. This guide was first published in 2002, revised in 2010 and there is now a PAR for revision that expires in 2021.

- The Chair, Ed teNyenhuis, led the meeting; The secretary, Tony Franchitti, recorded the attendance and meeting minutes.

- The following persons were present

- Ricardo Lopes
- Ed teNyenhuis (member)
- Vladimir Khalin
- Adnan Rashid
- Jarrod Prince (member)
- Dominique Bolliger
- Jill Holmes
- Richard Simonelli
- Jorge Cantu de Leon
- Darren Brown
- Craig Stiegemeier (member)
- Dhiru Patel
- Nigel Macdonald
- Tony Franchitti (member)
- Mats Bernesjo
- Ramsis Girgis (member)
- Andy Steineman (member)

Chao Li
Tim-Felix Mai
Mathiyalagan Pitchai
Ion Radu
Anthony Ricci
Manish Saraf
Mathieu Sauzay
Brian Sonnenberg
Vijay Tendukar
Sukhdev Walia
Malia Zaman
Robert Zaretsky
Meng Zhao
Reto Fausch (member)
Joaquin Martinez (member)
Jerzy Kamierczak
Antoine Lecomte

- Five of the nine members were present. Therefore, a quorum was reached.
- The Agenda was presented and a motion to approve the agenda was made by Craig Stiegemeier and seconded by Andy Steineman. There were no comments and the agenda was approved unanimously.
- A motion to approve the meeting minutes was made by Rito Fausch and seconded by Andy Steineman. There were no comments and the minutes were approved unanimously.
- The Chair presented all comments received from the PCS survey sent out after the Fall 2018 meeting.
- There fifty-five (55) respondents to the survey with fifty-four (54) approvals and one (1) disapproval.
- The draft guide was presented with all comments incorporated from the survey. No additional comments were made.
- It was generally agreed that the draft guide is complete. A motion was made by Ramsis Girgis and seconded by Reto Fausch to send the draft guide to ballot. There were no comments and the motion was approved unanimously. The chair will make a motion in the Wed March 27, 2019 PCS meeting for SC approval for ballot.

New Business

- There was no new business to discuss.
- The meeting was adjourned at 16:10

J.8.5 TF on PCS Continuous Revisions to C57.12.00

Title: Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

PCS Task Force on General Requirements C57.12.00

Performance Characteristics Subcommittee
IEEE / PES Transformers Committee

March 25, 2019 4:45 PM
The Hilton Anaheim Hotel
Anaheim, California USA

UNAPPROVED MINUTES

The PCS Task Force on General Requirements for C57.12.00 met on Monday, March 25, 2019. The Chair Tauhid Ansari called the Group to order at 4:50 PM and reminded purpose and scope of the TF. According to the automated RFID system, **48** Members and **60** guests were present. Paper rosters were distributed as a backup. The quorum to conduct regular business was established as **88** members are registered in the Task Force. The following **4** guests requested membership:

Alexander Winter	HIGHVOLT Pruftechnik Dresden
Christopher Slattery	FirstEnergy Corp.
Everton De Oliveira	Siemens LTDA
Zan Kiparizoski	Howard Industries

The Chair introduced **5** new Members to the Group. The Jacksonville (Fall 2018) minutes were reviewed (correct spelling for Ryan Musgrove's name) and approved (Amitabh Sarkar, Sanjib Son) by the Group.
The Agenda was approved (Eduardo Garcia, Rogerio Verdolin) with no amendments.
Agenda Items were covered as follows.
Agenda was approved as written. Ryan Musgrove pointed a spelling correction of his name in minutes of meeting (Fall 2018). Chair corrected the minutes, and then the minutes was approved unanimously

1. OLD BUSINESS
   A. WG Item 110, Table 17: Daniel Blaydon (Baltimore Gas & Electric) proposed a clear definition of the "rated current" during load loss test.

   Discussion on the subject started in the Jacksonville meeting and was not concluded.
   A new proposed text was presented by Daniel and the Chair opened the floor for discussion.
   The new text requested measurement of impedance and load losses at minimum and maximum kVA rating of a transformer.
   It was questioned if dual voltage transformers would require measurements at each rated voltage, which would depend on users' specification. Don Ayers pointed out to cases where test capacity does not reach for transformer´s maximum rating. S. Patel remarked that every transformer should be tested mainly at guaranteed kVA rating. Daniel brought up that other C57 standards call up for different kVA ratings for specific tests.

   Sanjib Som explained that measuring at different kVA ratings can yield different losses, from unaccounted leakage flux effects, he proposed to add losses at maximum rating. Amitabh Sarkar pointed out that losses at maximum rating are currently measured for heat run test, although that is not a routine test. B. Yang recommended to set in Table 17 loss measurement at base rating, as measurement error can be magnified at higher currents.
   It was mentioned that the WG Continuous revision of C57.12.90 had also discussed the subject and proposal (not further explained).

   Daniel Blaydon made a motion (second H. Shertukde) for a new text to be included in C57.12.00. An amendment was proposed to the motion and rejected by the Group, so the motion was voted with count of 25 members in favor, 8 opposed and 5 abstains.
   Chair will request PC Subcommittee to circulate the survey in PC subcommittee.

B. WG Item 111, change ratio tolerance to 1% or less than 1/10th of the transformer impedance. – Submitted by S. Hakim.
The Chair passed discussion of the subject for the next WG´s meeting as Hakim could not attend this time.

2. NEW BUSINESS
   A. The Chair presented a question from Ryan Musgrove, regarding ratio tolerance on 3 phase power transformers. As C57.1.200 is written now, there could be a 1% difference between one phase and another. Example, a phase is -.49% and c phase is +.49 percent. Technically both are within 0.5% of nameplate voltage. The floor was open for discussion.

   Jason Varnell mentioned that current tolerance should be considered acceptable, as long as explained, to avoid unnecessary rework. Ajit Varghesse pointed out that higher than 1% difference should be considered relevant for investigation. Lpizra Aymen explained that such a low difference between phase voltages can be relevant for specific projects. Ryan further explained that a 1% turns ratio difference between phases can imply several turns and have an impact on sensitive equipment. Sanjay Patel pointed out that allowable differences can have an impact for parallel connections.

   The Chair proposed to continue discussion on the subject in the next WG's meeting.

With no other new business brought up from the attendance, the meeting was adjourned at 5:55 PM (H.Shertukde, S.Som)

Respectfully submitted,

Tauhid Ansari
TF Chair

Enrique Betancourt
Secretary

J.8.6 WG on Amendment to Neutral Grounding Devices PC57.32a

Title: Standard for Requirements, Terminology, and Test Procedures for Neutral Grounding Devices Amendment: Neutral Grounding Resistor Section

Unapproved Meeting Minutes
IEEE / PES Transformers Committee
IEEE PC57.32a Comment Resolution Committee
March 2019 Spring Meeting Anaheim
Tuesday, March 26, 2019
8:00 AM – 9:15 AM
Chair – Sergio Panetta
Vice Chair – Yann Elassad
Secretary – Thomas Yingling

Call to Order
Patent Announcement
Quorum: Attendance by roll call
The committee has 17 voting members, 13 were present:
1. Present Andrew Keith: Cressall/Telema
2. Bernard Audouard: MS Resistances/Knorr Bremse

3. Present Bob Berger: Post Glover/Telema
4. Present Edmundo Perich: I Gard/Telema
5. Present Federico Turner: MegaResistors/Mega Resistors
6. Lodovico Mascardiv: Telema
7. Present Pablo Sanchez: Controle Servicios
8. Present Sheldon Kennedy: Niagara Transformer/Niagara Transformer
9. Present Richard Field: Post Glover/Telema
10. Present Sedat Corapsiz: Hilkar Elektrik/ Hilkar Elektrik
11. Present Sergio Panetta: I-Gard/Telema
12. Present Sinan Balban: Ozdirenc/Ozdirenc
13. Present Stuart Gibbon: Post Glover/Telema
14. Todd Locker: Mosebach/Telema
15. Present Tom Yingling: Powerohm Resistors/Hubbell
16. Yann Elassad: MS Resistances/Knorr Bremse
17. Present Susan McNelly: Xcel Energy

Guest Present Craig Stiegemeier: PCS Chair
Guest Present Malia Zaman: IEEE Staff
Guest Guido Hiertz: IEEE
Waiting for attendance list from meeting RFID attendance system to add guest attendance.
13 of 16 members attended, we have a quorum. (Susan does not count towards a quorum)
A Call for Patents was made. No issues presented.
Approved previous meeting minutes. Motion by Tom, seconded by Edmundo. Motion passes unanimously.
Add section to section applied voltage test drawing to the draft. Make drawing terminal labels readable in draft. It is agreed section to section applied voltage test text agrees with the drawing.
Federico presents new table for altitude correction. Discussion.
Motion by Tom to remove column Current column. Sheldon seconded. That the altitude is cooler it compensates for the thinner air for convection cooling. Motion passes unanimously. Add table to draft.
Describe divide by correction factor to achieve a higher test voltage at sea level than at altitude.
Motion to show System voltage as L-N voltage / L-L Voltage Wye on the nameplate by Tom, seconded by Federico, No vote (3,4,12,14), Yes (5,7,8,10,11,15), Motion passes.
Motion to remove System Voltage from the nameplate by Sinan, seconded by Bob. No vote (3,4,5,12,14), Yes (5,7,8,10,11,15), Motion passes.
Motion to show Rated voltage as L-N voltage / L-L Voltage Wye on the nameplate by Tom, seconded by Sheldon, No vote (3), Yes (4,5,7,8,10,11,12,13,15), Motion passes.
Motion to adjourn not required as the motion is in the agenda. Meeting adjourned at 9:15.
Next meeting will be a WebEx tentatively week of April 8th..
Respectfully Submitted,
Tom Yingling - Secretary
4/1/2019 Unapproved

J.8.7 WG Shunt Reactors C57.21

Title: Standard Requirements, Terminology, and Test Code for Shunt Reactors Rated Over 500 kVA

IEEE Standard Requirements, Terminology, and Test Code for

Shunt Reactors Rated Over 500 kVA C57.21

Anaheim, CA
Hilton Anaheim Hotel

Tuesday March 26, 2019

The working group met in the California Ballroom B (2) of the Hilton Anaheim Hotel on Tuesday March 26, 2019, at 9:30 AM.

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

There were total of 47 participants: 14 Members and 33 Guests out of which 10 Guests requested membership. Based on attendance record, 4 new memberships will be granted membership after this meeting.

- The meeting was opened with the Chairman remarks and the circulation of attendance rosters.
- 14 of the current 16 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 1, 2019 by email, was presented to the audience.
    - There were no objections or comments and the agenda was approved unanimously.

- **Minutes from previous meeting**
    - The minutes from the F18 meeting in Jacksonville, which were circulated on March 1, 2019 by email, were presented to the audience.
    - There were no objections or comments and the F18 meeting minutes were approved.

- **Document status:**

    - The draft 4.2 of the document is now in the balloting process, closing on March 27, 2019.
    - There are no plans to extend the ballot closing date.
    - The registered balloters up to this date are composed of 12 different interest groups, mainly of consultants at 29.51% of the total. Still below the 33.33% maximum for a single group.
    - No balloter names were disclosed.
    - At this point and with one day remaining before closing the ballot, the responses obtained have been as follow:

        - 76 registered
        - 61 voters, at 80% return rate
        - 55 approved
        - 5 negatives with comments
        - 1 abstain
        - 0 negatives with no comments.

    - The list of comments was reviewed.

- 207 comments were received; 108 of these comments must be satisfied.
- 32 comments are technical comments.
- The Chairman requested additional volunteers to join the BRG: Mike Sharp, Dharamvir and Ulf Radbrandt have volunteered to the BRG.
- Next step is to resolve the comments and recirculate the document. Target date is end of May 2019.
- Pending question: does the revised document have to be approved by the WG before recirculation - Chairman will follow up with Malia Zaman (IEEE).

No new businesses were presented.

The meeting was adjourned at 10:15 am.

Next meeting: Fall 2019, Columbus, OH, October 27-31, 2019.

Respectfully submitted,

Chairman: Sanjib Som (ssom@patransformer.com)
Vice Chair: Arturo Del Rio (a.delrio@ieee.org)
Secretary: Kris Zibert (kris.zibert@amce.com)

J.8.8 Working Group on Semiconductor Power Transformers – C57.18.10

Title: Standard Practices and Requirements for Semiconductor Power Rectifier Transformers

Working Group on Semiconductor Power Transformers – C57.18.10

Unapproved Meeting Minutes

Anaheim Hilton, Anaheim, CA
California Ballroom B
11:00 am, March 26,2019

The Working Group met in the California Ballroom B meeting room

Sheldon Kennedy called the meeting to order at 11:03 am and the group did introductions.

There were 18 members and 35 guests/other present. A quorum was present (18 of 30 members).
John John moved for approval of the agenda. Sanjib Som seconded. Agenda approved.
The Pittsburgh minutes were approved by email vote. Sheldon asked for motion to approve Jacksonville minutes. Mike Iman so moved. Dhiru Patel seconded. Minutes unanimously approved.
The patent call was given. Nobody replied with any patent issues.

Discussion of Draft 5 Revisions-Draft 5 had a 73.3% WG Survey approval, but with comments.

Review of online vote comments:

Line 17, Pg19- Should we refer to C57.12.00 and C57.12.01 instead of C57.12.90 and C57.12.91? D. Walker was in favor of replacement. Vote was 17 in favor. No opposed. Motion passed.

Clause 10.2 Table 2 and 3- should refer to C57.12.00 and C57.12.01 rather than duplicate in C57.18.10? 17 in favor. No opposed. Motion passed.

8.6.2- Should FEA be required for strays and eddies? D. Walker suggest that it be "recommended" rather than "required". Muhammad Cheema suggested that FEA doesn't always work for foil, high current, windings. Subhas Sarkar suggested referring to old method. Sheldon suggested referring to Annex with old method in it. Sanjib Som wondered how we can require FEA since many different tools are available and produce different results. Don Ayers said we can't require a specific program but should recommend a general type. Sanjib Som should we mention validating via test results. Sheldon suggested improving verbiage to improve clarity. Muhammad Cheema said that difference is how eddy are evaluated and how the program worked. Much discussion continued. Sheldon proposed looking at IEC standard requirements since they require FEA and see how it is stated. Subhas Sarkar suggested that FEA on every job is too time consuming and rules of thumb are useful for everyday use. Aniruddha Narawane thinks FEA discussion should be informative rather than normative. Sasha Levin reminded that C57.110 discusses stray and eddies in annexes. Don Ayers suggests that FEA is preferred and that in the absence of FEA other methods may be used. Sheldon committed to reviewing the IEC standard and proposing text for C57.18.10 to be circulated for online voting.

C57.12.51 title is incorrect and doesn't match latest version. Similar to C57.12.01. Make sure that references match today's title. Bill to update Draft.

Sheldon reviewed the sections of the Draft that had major revisions:

Traction Overload Definitions- 1653.2 is changing the definitions and they are different than C57.18.10. D. Walker moved that we remove the traction overload definitions from C57.18.10 and instead refer to 1653.1 and 1653.2 instead. Subhas Sarkar seconded. Approved unanimously.

Phil Hopkinson mentioned that some inverter/drive manufacturers short all secondaries of the transformer in a IGBT failure and then open a breaker. This creates a transient voltage in the transformer. At least two other drive manufacturers also do this. Phil to write up a note on this problem.

New Business:

- No new business

With no further business, the meeting was adjourned at 12:05am.

The Working Group will meet again at the Fall 2019 meeting in Columbus, OH

Chairman: Sheldon Kennedy
Vice Chairman: Bill Whitehead
Secretary: David Walker

J.8.9 Working Group for the revision of C57.142

Title: Guide to Describe the Occurrence and Mitigation of Switching Transients Induced by Transformers, Switching Device, and System Interaction

MEETING MINUTES

IEEE / PES Transformers Committee Performance Characteristics Subcommittee

WG to Investigate the Interaction between Substation Transients And Transformers in HV and EHV Applications and Revision of C57.142

Anaheim, CA
Tuesday, March 26, 2019
3:15 PM – 4:30 PM
California Ballroom B
Chairman – Jim McBride
Vice Chair – Xose Lopez-Fernandez
Secretary – Tom Melle

1) Meeting called to order at 3:15 PM.
Welcome and Chair's Remarks

2) Circulation of Attendance Sheets
97 Attendees were present (546Guests)

43 of 53 Members present (quorum was achieved)

3) No essential patent claims made

4) Approval of Agenda (motion by Pierre Riffon and 2nd by Deepak Kumaria) and meeting minutes from Fall 2018 (motion by Klaus Pointner and 2nd by Akash Joshi) without objection.

5) Status of Current Draft and Comments – Jim McBride
The present draft of the Guide is posted on the Working Group website

Review of C57.142 Draft 6 – The Chair noted that editorial changes continue, but the WG members and guests have not provided many comments since Draft 5. Some additional editing / cleanup may be needed and continued review by the WG is appreciated. Additional examples are included in D6 (GSU in backfeed mode, failing autotransformers, instrument transformers, and reactor switching).

The chair requested that the members and guests please continue to review and comment on the existing draft over the next few weeks before the draft is handed to the IEEE Switchgear Committee for review.

6) Status of Task Force Paper – Jim McBride
IEEE requested the TF paper be reformatted to include CV's for the paper authors. This will be handled by WG Vice Chair Xose Lopez-Fernandez.

7) Mitigation Methods Task Force Update – Phil Hopkinson

In the past, EHV reactors that were failing in the field were passing factory test levels. Special Terminated Lightning Impulse Tests (STLI) were then incorporated and failures reduced dramatically.

Phil requested manufacturers data using RSG (recurrent surge testing) in order to understand the stresses on windings. Phil reminded the WG that many old transformers had electrostatic shields. Line shields increase series capacitance and greatly reduce capacitance to ground. In the past (for 34.5 kV and below) static shields added to the winding seemed to increase probability of surviving re-strikes

Shielding solves many issues with series resonance and is relatively easy to apply. The conclusion is that increasing the series capacitance and reducing the capacitance to ground should improve the design. Phil urged the group to focus on improving transformer designs and developing new test methodologies.

Mitigation methods with some success have included: higher BIL, open terminal special impulse test, and fast-front switching surge with a long tail time.

The Chair added that more communication is required between the end-user of the transformer and the manufacturer with regard to the potential for exposure to high-energy transients in the field. Advanced modeling will be necessary in order to mitigate these issues. Experts who can model/analyze disc and layer winding designs are necessary in order to move the WG efforts forward. Multiple mitigation methods are also being discussed and will be addressed in the Guide.

8) STLI Presentation by Mike Spurlock of AEP (will be posted on the WG website) using standard impulse waveforms (1.2 x 50 us)

Pierre Riffon asked if arrestors are used in the testing (on the X terminal) and if full voltage is applied on the H terminal. No arresters were used and full voltage was applied.
Phil Hopkinson commented there was significant focus on the current traces in the presentation, but pointed out some significant collapse on the non-impulsed terminals. The chair commented that the significant point is how quickly the voltage appears on the non-impulsed terminals and that the arrestors are clamping.

Mike Spurlock added that the manufacturers tests show the stresses are higher and deeper into the winding than a standard impulse test. The chair added the STLI test better represents how the transformer is connected in service. Phil agreed this assessment matches prior failure modes and mitigation. Discussion by Amitabh Sarkar and others ensued regarding various testing arrangements (open versus terminated windings for example).

Manush Safar asked a question regarding whether an opening breaker versus closing breaker scenarios have been investigated and included in the Guide. Phil commented that different phenomenons (pre-strike and re-strike?) cause different stresses when opening or closing. The energy following a strike/restrike tends to move back-and-forth between the internal inductance and capacitance The Chair added that re-strike/re-ignition can cause severe issues and several examples are included in the draft guide.

Phil Hopkinson suggested shielded versus unshielded winding designs should be modeled and studied and further tested with the different STLI test configurations to gather more data. Mike Spurlock further commented that rather than arrester terminated, testing with capacitor terminated windings can be used to better simulate certain circuits (GSU's for example).

9) Switchgear Liaison Update – Dave Caverly

The C57.142 Guide is a co-sponsored document between Switchgear and Transformers and run by Transformers Committee.
The last Switchgear liaison meeting was held with 50 people present,
There is now an official liaison TF between the Switchgear and Transformers committees. The next IEEE Switchgear Committee Meeting will be held April 28-May 2, 2019 in Burlington, VT.

10) JWG A2/C4.52 HF TDSF Modeling principles – Xose Lopez-Fernandez/Jim McBride
TDSF for Transformer Modeling has been added to the monitoring circuit utilized by Jim McBride for High Frequency Transient Measurements.

Presentation topics included transformer modeling during Transformer Impulse Transients. Measured transients were then imposed on a detailed model of the transformer. The presentation will be posted on the WG website.

11) New Business: none

12) Next Meeting: (Columbus, OH)

13) Adjournment at 4:35 PM without objection

Respectfully,
Thomas R. Melle
Secretary

J.8.10 WG Short Circuit Withstand Design Criteria C57.164

Title: Guide for Establishing Short Circuit Withstand Capabilities of Liquid Immersed Power Transformers, Regulators, and Reactors

The Working Group for C57.164, the Guide for Establishing Short Circuit Withstand Capabilities of Liquid Immersed Power Transformers, Regulators, and Reactors:

Sanjay Patel – Chair, Raj Ahuja, – Vice Chair, Joe Watson - Secretary

The Working Group met Tuesday, March 26, 2019, 4:45-6:00 PM in the California Ballroom B with 31 guests and 22 of the 42 WG members present for a quorum. The agenda and minutes of the previous meeting were approved with no changes. The Patent question was asked with no responses.

A method of calculating short circuit forces was presented by Muhamad Ali Masood Cheema as a proposed addition to an Annex to the Guide. The method utilizes a flexible 2-dimensional model to calculate short circuit forces on windings. The details of the method were discussed and it was agreed to present a comparison of this method and the Andersen program and several other manufacturers' methods at the next meeting. Volunteers from SPX, Hyundai and Smit agreed to help in these efforts.

The group voted to include the information on calculating short circuit currents, forces and stresses in the Guide. Whether all of these details will be included in the main body of the Guide or in Annexes, and the content of the force and stress sections has not yet been determined.

The group will meet again in Columbus.

The meeting adjourned shortly after 6:00 PM.