Annex J Performance Characteristics Subcommittee (PCS)

April 28th, 2021, In the Cloud

UNAPPROVED MINUTES

Chair: Rogerio Verdolin
Vice Chair: Sanjib Som
Secretary: Kris Zibert

J.1 Introduction / Attendance

There were 85 of the 114 PCS members in attendance so quorum was achieved (% in attendance). In addition, 100 guests were present at the meeting. The total attendance at the meeting was 185. There were 20 guests who requested membership. Their requests for membership and past attendance will be reviewed. If they meet the membership requirements, they will be granted membership before the next meeting in Milwaukee, Wisconsin, October 17-21, 2021.

J.2 Chairman's Remarks

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

The Chair asked everyone to mute their microphones unless speaking and reminded everyone to identify themselves and their affiliation when speaking. The Chair discussed that the meeting would be recorded for minutes purposes and then deleted.

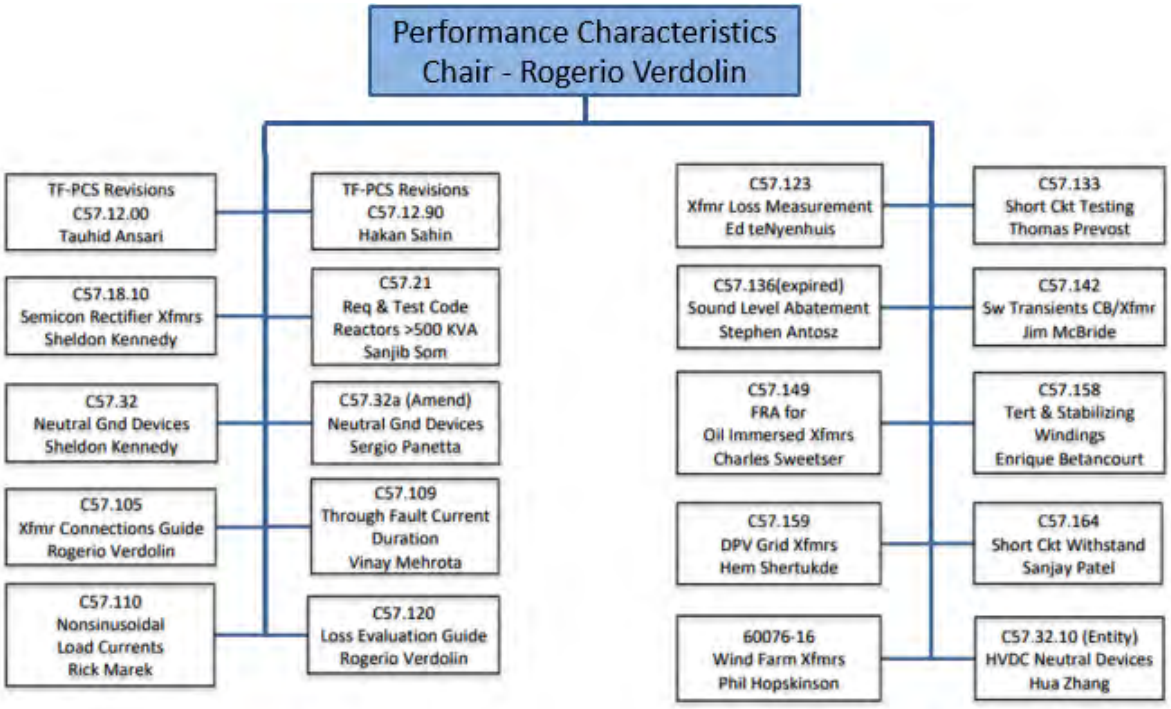
The Chair asked everyone to state any affiliation changes since last meeting in the chat window.

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 – TF to provide PCS revisions – T. Ansari
- C57.12.90-2015 – TF to provide PCS revisions – H. Sahin (test code) & R. Girgis (audible sound)
- C57.18.10 – Semiconductor rectifier transformers – S. Kennedy
- C57.21 – Requirements & Test Code For Shunt Reactors >500kVA – S. Som
- C57.32-2015 – Neutral Grounding Devices (2025) – S. Kennedy
- C57.32a – Neutral grounding devices – S. Panetta
- C57.32.10 - new Entity PAR - WG Neutral Grounding Reactors Guide for HVDC Converter Transformers
- C57.105 – Transformer connections guide – R. Verdolin
- C57.109 – Through Fault Current Duration – V. Mehrotra
- C57.110 – Xfrmr Capability when Supplying Nonsinusoidal Load Currents – R. Marek
- C57.120 – Guide for loss evaluation – R. Verdolin
- C57.123 – Transformer Loss Measurement – E. teNyenhuis
- C57.133-exp – Guide for Short Circuit Testing (Expired – now covered by C57.12.90) – T. Prevost
- C57.136 – Sound Abatement Guide (will let expire, may cover in C57.12.90) – S. Antosz
- C57.142 – Switching Transients Circuit breaker/Transformer – J. McBride
- C57.149 – New SFRA Guide (2022) – C. Sweetser
- C57.158 – Tertiary & Stabilizing Windings (2027) – E. Betancourt
- C57.159 – DPV Transformers (2026) – H. Shertukde
- C57.164-new – Short Circuit Withstand (in development) – S. Patel
- 60076-16 – Wind Turbine Generator Transformers – P. Hopkinson

Status of Active PAR's:

- **2021 PAR's**
  - **C57.21 Shunt Reactors over 500kVA (in Comment Resolution phase)**
  - **C57.142 Transient Guide (awaiting Sponsor Ballot)**
  - **C57.164 Short Circuit Withstand Guide (awaiting Sponsor Ballot)**
- **2022 PAR's**
  - **C57.18.10 Semiconductor Rectifier Transformers (in Comment Resolution phase)**
  - **C57.32.10 Entity WG Guide for the Selection of Neutral-Grounding Devices for HVDC Converter Transformers (WG in draft development)**
  - **C57.149 SFRA Guide (WG in draft development)**
- **2024 PAR's**
  - **C57.105-2019/Cor 1 (New WG)**
- **2025 PAR's**
  - **C57.136 Audible Sound Guide (New WG)**

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 (intentionally allowed to expire)
- C57.32-2015 – Neutral Grounding Devices (2025)
- C57.159-2016 – DPV Transformers (2026)
- C57.120-2017 – Loss Evaluation Guide (2027)
- C57.158-2017 – Application of Tertiary and Stabilizing Windings 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)
- C57.105-2019 – Transformer connections guide (2029)
- C57.123-2019 – Loss Measurement Guide (2029)

Performance Characteristics Subcommittee Membership Requirements

- Voting membership may be requested and granted after attending three of the last five meetings.
- If a voting member misses two consecutive meetings, his or her voting privileges may be revoked. Notification will be sent if voting privileges are revoked.
- Refer to TC P&P 4.3.1 for more information.

Performance Characteristics Subcommittee WG / TF Leaders

- Issue agenda at least 30 days ahead of time
- Minutes are due in 15 days, please get a rough draft of them to us today in MS Word (not PDF) 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 and copyright call must occur at every WG/TF meeting

Performance Characteristics Subcommittee Meeting Minutes

- Name of the group, time, date, and location of meeting
- Officers names, meeting participants, and member status
- Chair's remarks and reminders of IEEE policies (Patent and Copyright)

- Approval of minutes of previous meeting and agenda
- Technical topics: Brief summary (discussions and conclusions, motions exactly as they are stated, including the names of mover and seconder, and the outcome of each motion)
- Action items, items reported out of executive session
- Recesses and time of final adjournment
- Next meeting—date, time, and location

WG / TF Balloting Reminder

- Working Groups must achieve a 2/3 majority to submit a document for Sponsor Ballot.
- The Subcommittee must achieve a simple majority to submit a document for Sponsor Ballot.

Attendance / Membership – moved to Guest status

The following 12 Members missed the past 2 meetings and have been moved to "Guest" status:

- Hamid Abdelkamal
- Jeffrey Britton
- Roger Fenton
- Thang Hochanh
- Alexander Kraetge
- Harry Pepe
- Amitabh Sarkar
- Devki Sharma
- Yong Tae Sohn
- Craig Stiegemeier
- Robert Thompson
- Joshua Yun

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 7 former Guests requested membership at the Fall 2019 meeting and have attended the past 2 of the last 3 meetings:

- Steven Brzoznowski
- Anthony Franchitti
- Moonhee Lee
- Sylvan Plante
- Samragni Dutta Roy
- Kyle Heiden
- Colby Lovins

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

Attendance / Membership – Quorum determination

- Current breakdown of the Subcommittee:
  - 114 Members
  - 58 are needed for a quorum
- Quorum was established.

J.3 Approval of Agenda

The Chair presented the agenda and entertained a motion to approve. The agenda had been sent to the members by email several weeks prior to the meeting. The motion passed by unanimous consent.

J.4 Approval of Last Meeting Minutes

The Chair presented the minutes of meeting held in the Fall 2019 – Columbus, Ohio, October 30th, 2019 and entertained a motion to approve. The minutes had been sent to the members by email several weeks prior to the meeting. The motion passed by unanimous consent.

J.5 Minutes from Working Groups and Task Force

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

- **WG Guide for FRA for Liquid Filled Transformers C57.149** **C. Sweetser**
- **TF PCS Audible Sound Revision to Clause 13 of C57.12.90** **R. Girgis**
- **TF PCS Continuous Revisions to C57.12.00** **T. Ansari**
- **TF PCS Continuous Revisions to Test Code C57.12.90** **H. Sahin**
- **WG 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) WG Guide for FRA for Liquid Filled Transformers C57.149 C. Sweetser

Meeting Date/Time: April 26, 2021 10:10 AM
Vice-Chair: Poorvi Patel (EPRI)
Secretary: James Cross (Kinectrics)
44 total attendees, consisting of 12 members and 32 guests. The WG did not achieved a quorum.
Highlights:

- Collected and Reviewed Case Studies (New)
- 3 - Radial Deformation 2 - Axial
- Proposed new template for collecting additional case studies
- Transportation Issues, Short Circuit Failure, Design Related Issues, Measurement Problems
- New Analysis and Interpretation Template was presented
- This will be used to reformat the Analysis and Interpretation section
- Presented newly reformatted connection tables:

Transformer vector Diagram	Phase	HV winding	Phase group/LV winding connection					
			0	2	4	6	8	10
1ph	A	H1-H2	X1-X2	n/a	n/a	n/a	n/a	n/a
	B	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	C	n/a	n/a	n/a	n/a	n/a	n/a	n/a
YNyn	A	H1-H0	X1-X0	X0-X2	X3-X0	X0-X1	X2-X0	X0-X3
	B	H2-H0	X2-X0	X0-X3	X1-X0	X0-X2	X3-X0	X0-X1
	C	H3-H0	X3-X0	X0-X1	X2-X0	X0-X3	X1-X0	X0-X2
Dd	A	H1-H3	X1-X3	X1-X2	X3-X2	X3-X1	X2-X1	X2-X3
	B	H2-H1	X2-X1	X2-X3	X1-X3	X1-X2	X3-X2	X3-X1
	C	H3-H2	X3-X2	X3-X1	X2-X1	X2-X3	X1-X3	X1-X2

Transformer Vector Diagram	Phase	HV winding	Phase group/LV winding connection					
			1	3	5	7	9	11
YNd	A	H1-H0	X1-X2	X3-X2	X3-X1	X2-X1	X2-X3	X1-X3
	B	H2-H0	X2-X3	X1-X3	X1-X2	X3-X2	X3-X1	X2-X1
	C	H3-H0	X3-X1	X2-X1	X2-X3	X1-X3	X1-X2	X3-X2
Dyn	A	H1-H3	X1-X0	X0-X2	X3-X0	X0-X1	X2-X0	X0-X3
	B	H2-H1	X2-X0	X0-X3	X1-X0	X0-X2	X3-X0	X0-X1
	C	H3-H2	X3-X0	X0-X1	X2-X0	X0-X3	X1-X0	X0-X2

Autotransformer Vector Diagram	Phase	Series Winding	Common Winding	Phase group/Tertiary winding connection					
				1	3	5	7	9	11
1phA	OC	H1-X1	X1-H2X2	n/a	n/a	n/a	n/a	n/a	n/a
	SC	H1-H0X0	*X1-H2X2	n/a	n/a	n/a	n/a	n/a	n/a
1phA+T	OC	H1-X1	X1-H2X2	Y1-Y2	n/a	n/a	n/a	n/a	n/a
	SC	H1-H2X2	*X1-H2X2	n/a	n/a	n/a	n/a	n/a	n/a
	SC	H1-H2X2	n/a	*Y1-Y2	n/a	n/a	n/a	n/a	n/a
	SC	n/a	X1-H2X2	*Y1-Y2	n/a	n/a	n/a	n/a	n/a
YNa	A	H1-X1	X1-H0X0	n/a	n/a	n/a	n/a	n/a	n/a
	B	H2-X2	X2-H0X0	n/a	n/a	n/a	n/a	n/a	n/a
	C	H3-X3	X3-H0X0	n/a	n/a	n/a	n/a	n/a	n/a
	A	H1-H0X0		n/a	n/a	n/a	n/a	n/a	n/a
	B	H2-H0X0	*X1-X2-X3	n/a	n/a	n/a	n/a	n/a	n/a
	C	H3-H0X0		n/a	n/a	n/a	n/a	n/a	n/a

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

- The TF met on Monday.
  - 27 members attended, out of a total of 66 total attendance.
  - The TF has 42 members now.
- First technical item on the Agenda :
  - Discussed resolutions of 3 items previously discussed in the TF to be included in Clause 13 of C57.12.90 which deals with measuring transformer noise.
    - Impact of temperature on core noise
    - Impact of temperature on load noise
    - Impact of tap position on load noise
- For each of the 3 items, the chairman reviewed:
  - Originally proposed text
  - Feedback from the TF
  - Proposed resolution
- These were discussed. It was agreed to:
  - Handle these items in more detail in the new Noise Guide C57.136
    - With the understanding that statements on these 3 items would be considered to be added in a future revision of the C57.12.90 Standard.
- Second technical item on the Agenda:
  - Resolutions of comments received on ballots of the C57.12.00 and C57.90
  - Comment # 1: There is an overlap between:
    - Table C.1 – "No load sound levels of power Transformers", starting at 700 kVA
    - Table C.2: "No load sound levels of Distribution Transformers", covering ratings up to 3000 kVA.
  - Comment # 2: The definition of distribution transformers in IEEE Standards => 10 MVA
  - Resolution:
    - Expand Table C.1 to include sound levels of distribution transformers that were originally included in Table C.2 and refer to it as "No load sound levels of powerand Distribution Transformers"
    - Remove original Table C.2
  - **Comment # 3:**
    - Require measuring transformer noise at the highest noise producing tap position
  - **Resolution**
    - Will be considered as a proposed change in the next revisions of the C57.12.00 and C57.12.90 Standards.
    - In the meantime, impact of tap position on both core and load noise will be explained in detail in the new Noise Guide.
  - Resolution of rest of Comments from the ballot is planned for a virtual meeting of TF
  - Since there are still updates that need to be considered for audible sound revisions in the C57.12.00 and C57.12.90 Standards, this TF will meet again at the Fall 2021
  - Noise Guide WG will have a separate time slot for its meeting

- 39 of the attendees of the TF meeting expressed interest in joining the new C57.136 Noise Guide WG.

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

Meeting Date/Time: April 26th , 2021 14:20 Hr
Acting Secretary: Enrique Betancourt (Prolec GE)

- 81 total attendees, consisting of 35 members and 46 guests. The TF did achieve a quorum (31Members required). 12 Guest requested membership. (Subject to verification from AMS)
- We are requesting a volunteer to join TF as Secretary. Please contact Tauhid or Enrique.

Highlights:

- Old Business
  1. Core information on nameplate was discussed in remote meeting on March 4th , 2021 and continued in Meeting on April 26th.
  2. A motion Not to include the core information was rejected by majority
  3. Second motion to include the core information passed by majority
  4. The table to add in the nameplate was not finalized. Ramsis Girgis is requested to prepare the table. A remote meeting will be held before Fall 2021 meeting to finalize the table and present in Fall 2021 meeting
  5. Meeting adjourned at 15:35 hr.

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

- Quorum was achieved confirmed with a second poll after the meeting started with 36/70 members present in the meeting. Total attendees was 106
- New proposal for Section 7.1.2, Ratio test frequency with new tolerances to the frequency band of the test equipment survey result, which had passed, was presented
- New revised sections 8.7 and 9.6 for OLTC tests were presented with many discussions on abnormal sound and DGA. Chair will send the new test sections proposals for a survey within the Task Force
- New proposal to modernize the section 7.3, Ratio Methods to add Electronic Ratiometer as first option, keeping the voltmeter and comparison methods as 7.3.2 and 7.3.3 was voted and passed as proposed. To be handed over to PCS
- New proposal to revise the section 12.3.4, "Number of Short Circuit test" was discussed. Chair agreed to send the new proposal for survey within the TF
- New business request to bring clarity to sections 9.3.a and 9.3.b were reviewed. Chair agreed to write the new proposal and send to the TF for survey
- Meeting adjourned on time

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

- 81 total attendees, consisting of 38 members and 43 guests. The WG achieved a quorum. 38 / 54
- Agenda and Minutes were Approved.
- IEEE Transactions Paper developed by those in the C57.142 WG has been published and is now available at https://ieeexplore.ieee.org/document/9161400.
- Switchgear Committee Task Force met on April 21, 2021. The group had a quorum and has review changes made in Draft 9B of C57.142. All comments to the drafts have been addressed and resolved. Those present at this meeting voted unanimously that Draft 9B is ready to ballot.

- Draft 9B was posted on the Transformers Committee website last week. This draft contains all changes to the C57.142-2010 highlighted in blue. Most of the content from the TF Transactions Paper and several other additions are included in the draft.
- The working group voted unanimously to take to ballot Draft 9B. (36/0/0)
- We have applied for a PAR extension to be sure to complete the balloting process. The WG approved of this extension.
- Phil Hopkinson gave a presentation on interwinding shields and interaction mitigation methods. Some very good discussion followed after the presentation. This presentation is posted on the Transformers Committee website.
- A paper on Interwinding Shielding influence to FRA resonance point was present by the chair. "Impulse Voltage Distribution and Frequency Response of Inter-shield Windings" Authors: Bagheri, Phung, Naderi
- The WG authorized of the formation of a ballot resolution group.
- Next Meeting: Fall 2021 – Milwaukee, WI the week of October 19.
- The meeting was Adjourned at 3:35pm Central Time.

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

- Draft 6 is the latest draft of C57.164
- The Guide was Approved to Ballot by the WG via email vote
- The Guide was Approved to Ballot by the PCSC via email vote
- C57.164D6 has been sent to IEEE SA for MEC review and Balloting
- The Ballot Pool is currently being formed
- Please join the Ballot pool for C57.164

J.6 Unfinished (Old) Business

- **Status of WG Shunt Reactors C57.21 S. Som**
  - 12/13 RevCom voters have approved, waiting for last vote.
  - S. Som thanks all participants for their hard work.

J.7 New Business

- **Status of new PAR for PC57.136 Audible Sound Guide S. Antosz**
  - First WG meeting will be in the fall.
- **Loading of three winding Transformer (Auto-Transformer) R. Minhaz**
  - R. Minhaz presented example cases of arithmetic, vector and simultaneous loading.
  - S. Patel stated he believes standards are clear about mfr and specifier requirements for loading.
  - S. McNelly stated they have had trouble with the wording of "simultaneous loading".
  - B. Poulin stated that the loading is always vectorally for three winding transformers.
  - Further discussion took place.
  - J. Wright pointed out that these terms do not appear in C57.12.80.
  - D. Sauer made a motion to table the discussion until the next meeting. Seconded by K. Zibert. Passed by unanimous consent.

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

J.8.1 WG Guide for FRA for Liquid Filled Transformers C57.149

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

(Performance Characteristics Sub-Committee)

Meeting Date/Time: April 26, 2021 1010 H
Meeting Location: Virtual – On-Line
Chairman: Charles Sweetser [CS] (Omicron)
Vice-Chair: Poorvi Patel (EPRI)
Secretary: James Cross (Kinectrics)

Meeting was convened at 1010 H by Chairman Charles Sweetser with 47 total attendees, consisting of 12 members and 35 guests. A quorum was not achieved.

AGENDA

1. Introduction and Member confirmation / Attendance poll
2. Meeting Guidelines and Patent information.
3. Review Agenda
4. Approval of minutes of Oct. 19, 2020
5. Discussions
    a. Case Study Collection – Inventory
        i. Mario Locarno (Doble)
        ii. Charles Sweetser (Omicron)
    b. Update/Presentation – Analysis and Interpretation (New Radial Format)
        i. Peter Werelius (Megger) - Lead
    c. Connection Table Discussion – Presentation of Edits and Changes
        i. Diego Robalino (Megger)
6. Old Business
7. New Business
8. Adjourn

CS reviewed the IEEE Working Group meeting guidelines and the standard patent disclosure info. (No response from attendees to request for patent info.)

CS showed a slide showing the WG membership in preparation for the electronic polling of attendance. Attendees of the virtual meeting were instructed to confirm whether or not their name was on the membership roster. CS noted that at the Fall/20 virtual meeting there were two ballots conducted for attendance and it took a lot of effort to cross-reference and sort out the list.

CS waited 5 minutes before triggering the attendance poll to allow people to sign into the meeting.

The membership list shows 32 WG members.

CS noted that three members of the WG were at risk for removal due to non-attendance with the outcome dependent on participation in this meeting.

Only 12 members were present at this meeting, so quorum was not achieved and so no motions are possible.

Lack of quorum means that we could not formally approve the minutes of the Oct. 19/20 meeting. This will have to be done by email later. CS asked if there were any issues with the previous minutes.

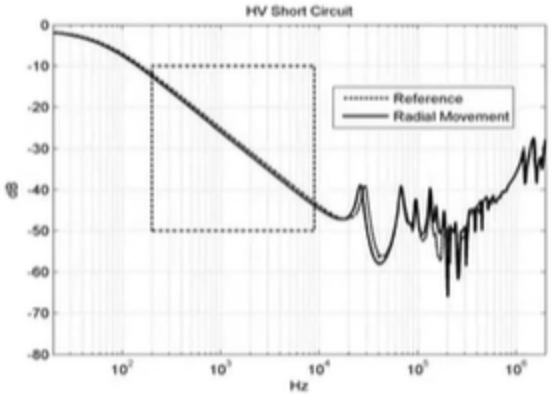
CS noted that there is a 1 ½ years left on the PAR and so we need to get the draft prepared this year for balloting.

Discussions:

- Case Study Collection

- We have a total of five cases studies at the moment.
- Three cases are radial deformation, and two cases are axial deformation.
- CS noted that Radial deformation are the hard cases to determine.
- CS noted that we need people to come forward with more case studies.
- Cases studies need to be reviewed/approved by the working group and would be input for the "Analysis" section.
- Poorvi Patel noted that a lot of case studies (~150) were collected during writing of the CIGRE guide. She submitted a couple of case studies with clear radial deformation.
- Poorvi asked if there would be benefit to develop a kind of template to aid others in coming forward with their case studies.
- CS said that he envisioned data in Excel or ASCII format with full minimum required tests (open-circuit and short-circuit)
- Poorvi noted that photographs of the deformations would be very helpful to relate to the data.
- Poorvi volunteered to put together such a template to guide others in the kind of information required.
- Mario Locarno committed to sending some case studies next week.
- PP noted that it would be helpful to have a list to identify the kinds of case studies that we are looking for.
- Additional cases needed are transportation and core movement related.
- J. Cross offered to look into Kinectrics' database at our High-Current Lab where we perform short-circuit testing on transformers < 2 MVA and always perform before/after SFRA.
- Evgenii Ermakov (Hitachi-ABB) thought that a list of desired case studies would be helpful.
- PP: Case studies with dimensional measurements corresponding to FRA signatures are the best – but the most rare.
- CS offered that if we want to identify four types of different deformation cases we need eight cases studies to support these…but more would be better to be able to choose the best ones.
- Mario Locarno asked about whether a spreadsheet would be used to gather case study data.
- PP: gather many case studies first – identify the missing cases – then identify the associated data in a spreadsheet.
- PP noted that many cases are mixed-mode failures and so identifying specific failure modes require simpler
- PP will create a PPT with a list of cases to share.
- CS noted that he wants a group to review the case studies…PP and Mario L. to participate. Volunteers:
  - Diego Robalino (Megger)
  - Sanket Bolar (Megger)
  - Peter Werelius
  - Evgenii Ermakov
- The list of cases will be reviewed at the fall/2021 meeting.

  - CS stated that the recommendation is to test in the extreme raise tap position unless you are studying a fault situation.
  - PW asked if we had enough cases to include these more specialized cases (buried tertiaries, autotransformers, etc.) in a separate chapter. CS noted that we are just after the basics at this point and that more advanced "tips and tricks" might come later.
- Analysis and Interpretation Template – Peter Werelius
  - Peter had a brief PPT showing Radial Winding deformation definition and a table summarizing the frequency effects observed. The table is the same as the existing standard.
  - He took the LV Open-Circuit test and the HV Short-Circuit test (Figures 2 and 3 in the current guide) and added some verbiage explaining the observed effects in the FRA curve for radial winding deformation.
  - Cases would be added to this section – open for discussion.
  - CS asked the group for feedback on the 0.25 dB deviation noted by PW.
  - ML asked about the short-circuit test…
    - Haven't we concentrated on the low-frequency inductive roll-off region?
    - Many tests come in at < 0.25 dB.
  - PP noted that large variations can occur in different types of transformers. Question: should a number be included?
  - CS noted that the leakage reactance figure is +/- 3%
  - PW noted that measurements are temperature dependent so there is variability, but some guidance should be provided to users of the guide in terms of dB deviation limits.
  - PP wondered if a range of values could be given, still providing guidance without hard limits.
  - ML noted a couple of recent cases where sister units were tested and one showed a 0.38 dB change due to manufacturing tolerances in the leakage channel. How can this be addressed in the guide?
  - E. Ermakov: Do we mean deviation between phases or the fingerprint curve? CS: Phase to phase.
  - ML: It's always been phase-to-phase.
  - PP: We should state that it is phase-to-phase.
  - PW: He will tweak the wording, remove the deviation value, and send the section to CS before going out to the WG.
  - PW: Remove the box in the low-frequency range of the figure in the existing standard



- PW – asked if we should be following the reference measurement if it available, or the phase-to-phase measurement, or both.
- CS: case studies should state clearly that we are looking at Phase-to-Phase deviations.
- ML: The OC and SC analysis are interpreted differently. The short-circuit test is for the phase-to-phase measurement.
- ML: noted an error in the existing document… the Page 39, Figure 9… the figure is SC test but the text calls it a OC test….needs to be corrected.

- Connection Tables – Diego Robalino
  - (Note: at Diego's request, at this point the membership attendance poll was taken again. Number of members on-line now down to 10… still no quorum)
  - Diego showed a PPT slide with the connection table for single-phase and three-phase units with different vector groups, and another for autotransformers.
  - The autotransformer table shows the connections for the series and common windings.

List of meeting participants with membership status at the end of the meeting:

Dinu Amarasinghe		Bruce Power	
Elise Arnold		SGB	
Suresh Babanna		SPX Transformer Solutions, Inc.	
Israel Barrientos		Prolec GE	Member
Sanket Bolar		Megger	
James Cross	(M)	Kinectrics	Member
John Crouse		Roswell Alliance	
Eric Davis		Burns & McDonnell	
Huan Dinh		Hitachi ABB Power Grids	
Evgenii Ermakov		Hitachi ABB Power Grids	
Ismail Guner		Hydro-Quebec	Member
Thang Hochanh		Surplec Inc	
Paul Jarman		University of Manchester	
Megan Kell		EATON Corporation	
Gael Kennedy		GR Kennedy & Associates LLC	
Gary King		Howard Industries	
Will Knapek		OMICRON electronics Corp USA	Member
Donald Lamontagne		Arizona Public Service Co.	
Fernando Leal		Prolec GE	Member
Mario Locarno		Doble Engineering Co.	Member

Darrell Mangubat	Siemens Power Operations Inc.	Member
Jim McBride	JMX Services, Inc.	Member
Matthew Mcfadden	Oncor Electric Delivery	
Tony McGrail	Doble Engineering Co.	
Kris Neild	Megger	
Parminder Panesar	Virginia Transformer Corp.	Member
Poorvi Patel	Electric Power Research Institute (EPRI)	Member
Mark Perkins	D4EnergySolutions LLC	
Cornelius Plath	OMICRON Energy Solutions GmbH	
John Pruente	SPX Transformer Solutions, Inc.	
Sam Reed	EATON Corporation	
Scott Reed	MVA	Member
Perry Reeder	SPX Transformer Solutions, Inc.	
Diego Robalino	Megger	Member
Tim Rocque	SPX Transformer Solutions, Inc.	
Wes Schrom	Carolina Dielectric Maint & Testing Co.	
Cihangir Sen	Duke Energy	Member
Peter Sheridan	SGB USA, Inc.	Member
Kenneth Skinger	Scituate Consulting, Inc.	
Charles Sweetser	OMICRON electronics Corp USA	Member
Tim Tillery	Howard Industries	
Jason Varnell	Doble Engineering Co.	Member
Jos Veens	SMIT Transformatoren B.V.	
Rogerio Verdolin	Verdolin Solutions Inc.	Member
Krishnamurthy Vijayan	PTI Transformers	
Peter Werelius	Megger	Member
Baitun Yang	R.E. Uptegraff	

Respectfully submitted,

James Cross
Secretary
C57.149 WG

J.8.2 TF PCS Continuous Revisions to Test Code C57.12.90

PCS TF C57.12.90 Unapproved Meeting Minutes for Fall 2020 Virtual Meeting

1. The meeting started on time at 8:00 am central US time, over virtual meeting platform.
2. Chair discussed the agenda, provided details of patent policy, copy right policy and membership criteria
3. Chair updated the group about the membership changes. Total number of members in the TF is 70.
4. First poll conducted had 33 members. Agenda and previous meeting's unapproved minutes approved anonymously with no rejection from the group. Quorum requirement is 35. Chair suggested to have another poll later. Later poll conducted had 36 members. Quorum met
5. Chair discussed on the old business related to Ratio tests voltage and frequency updated section and the survey results, which was related to the updating the frequency range during ratio test. He presented the survey results and reported that 31 approved, 7 disapproved, no abstain. During floor discussion David Walker from MGM remarked that the test shall be conducted at rate V/F

or less and his comment back to the survey to be considered. Chair commented on looking into this.

6. Next topic discussed was the old business of OLTC Voltage and current tests. Chair provided background on the OLTC and presented the proposal on the OLTC tap changer test. He opened the floor for discussion on the OLTC test and acceptance criteria comments. Amit Sarkar suggested to provide defined Sound levels instead of general abnormal noise. Joseph Foldi commented to reword the OLTC operation at normal sound level instead of stating abnormal noise.
   Javier Arteaga, Rainer Frischer had comments regarding DGA criteria. Per chair's request, Rainer spoke for 5 minutes giving background on the original DGA study on this topic and different OLTC types. After many discussions, Chair proposed to send the OLTC Test proposal to the TF members for their voting and comments
7. Next topic was on the Ratio test methods section 7.3 to be revised (modernized). Chair presented his new section proposal and reviewed with the group. Tauhid Ansari initiated motion to accept section 7.3 approved as Written. Since we had the quorum, chair asked the meeting host to post a poll to approve the section as written, which was motioned by Tauhid. The poll was to approve or disapprove the section 7.3 Ratio Tests Method to be changed as proposed by the Chair during the meeting. 40 members approved the poll. Since the members at the beginning of the meeting was only 36, chair assured to verify the poll result for accuracy. Once the member vote count on this motion is confirmed by the chair, this section will be handed over to PCS.
8. Next topic discussed was the old business of the number of short circuit tests under section 12.3.4. Chair showed the background and the new number of tests proposal to the group. Javier Arteaga had good comments, which Chair agreed to. Chair proposed to send the short circuit test proposal to the members for survey and comments
9. Chair discussed on the typo error in cl 8.3 in 2015 revision, noted by Waldsmer Z. This was shared during the meeting for information purposes.
10. Chair presented the new business of request to section 9.3a and 9..3 for better clarity. Chair shared Jason Vernell's comments on why these sections may need to be revised for better clarity. Javier Arteaga asked for chair to send the new proposal for survey before the next meeting, which Chair agreed.
11. Meeting adjourned on time at 9:15 am Central US time.

ATTENDANCE

Name	Affiliation
glenn andersen	Anderson Associates
Hossein Nabi-Bidhendi	ABB
Thomas (Tom) Dauzat	GE
Jaber Shalabi	Vantran
Gregory Ante (SCE)	Southern Cal. Edison
Rhett Chrysler	Ermco
jhall@cloverdalepaint.com	Cloverdale Paint
Ken Hampton	BGE
Scott Abbott	PPG
vinay	Coned
Douglas Craig	Richard Manufactring

James Spaulding	FCgov
Paul Chisholm	IFD corporation
Chris Guertin	Cloverdale Paint
Nitesh Patel	Hyundai Power America
Ramadan A Issack	AEP
Will Elliott - Prolec|GE	GE Prolec
Christopher Lianides	SCE
Dwight Parkinson	Eaton
Carlos Gaytan	GE Prolec
Kunal V Shukla	Exelon
Josh Verdell	Ermco
Paul Florida	Howard Industries
Tyler Morgan	Duke Energy
Kristin James	Eaton
Andrew Larison	ABB
Ben Garcia	SCE
Michael S Dahlke	Cenral Moloney
Ali Ghafourian	HJ Enterprises
Jeremy Sewell	Quality Switch
USIORAD	ABB
Travis Spoone	Eaton
Robert Reepe	Southern Company
James Edward Smith	HJ Enterprises
Justin Minikel	Eaton
Mike Thibault	PGE
Martin Rave	Comed
Adrian Silgardo	IFD Corporation
Shelby Walters	Howard Industries
Brad Kittrell	Coned
Chris	Howard Industries
Zoran	Pennsylvania Transformer
Alan Traut	Howard Industries
Darren Brown	Howard Industries
USER	T&R Electric Supply
duy vo	Avangrid
Martin Bachand	Colverdale paint
James Gardner	Compuserve
Michael Zarnowski	Carte Internatioanl
Alejandro Macias	Centerpoint
Audrey Siebert-Timmer (IF	IFD Corpoaration
Ramadan A Issack	AEP
glenn andersen	Anderson Associates

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

Unapproved Minutes of Fall 2020 TF PCS Audible Sound Revision to Clause 13 of C57.12.90

The task force met at 12:55 PM, on Monday, April 26, 2021. 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 2020 meeting, the membership was adjusted to 42 members. There were 27 of 42 members with a total of 66 persons in attendance. A quorum was established with 64.3 % of the membership. A call was made for any objections for an unanimous approval of the Fall 2020 TF minutes; no objections were raised so minutes are approved as written. The proposed agenda was presented without objections for approval. Ten requests for membership have been reviewed.

The first agenda item requiring resolution was the items previously considered to be included in Clause 13 of C57.12.90. The following bullets describe these three subjects with the agreed upon resolution for each item.

1. Impact of temperature on Core Noise:
    - Originally proposed text

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 operating at high operating flux densities.

- Main consideration / feedback

We can't confirm whether the increase in core noise due to temperature, observed in factory tests in the case of some core steels, occurs when the transformer is in operation when the whole temperature of the core is elevated.

- Proposed resolution

More appropriate to include and explain in more detail in the proposed Noise Guide (C57.136). This will also avoid unnecessarily exposing this issue in C57.12.90.

- Discussion and agreed upon resolution

Dr. Girgis suggested that the ability to explain the subject in greater detail would be better covered in the noise Guide rather than in the C57.12.90 Standard. The group unanimously agreed.

2. Impact of temperature on Load Noise
    - Starting point

Load noise data of a number of transformers, measured before and after the heat-run test, showed a small increase in some designs and a small decrease in other designs.

- Main feedback

Need to quantify the impact, ± (1 to 2) dB

- Proposed resolution
    - Introduce a short statement in C57.12.90
    - Can be explained in more detail in the Noise Guide
- Discussion and agreed upon resolution

Krishnamurthy Vijyan, Sanjay Patel, and Enrique Betancourt expressed viewpoints on the need for more detail in the noise guide as well as the merit of having some statement in C57.12.90. It was recognized that the magnitude of this impact is within the range of measuring variability.

Pierre Riffon raised the question why load noise shouldn't be required to be performed on conjunction with the heat-run test. It was commented that there are cases where noise measurements need to be performed in sound rooms not equipped to handle a heat-run. Also, there are other more significant impacts on load

noise levels that cause load noise levels measured on site to differ from what is measured in the factory; for example, transformer mounting. This will be discussed in more detail in the new Noise Guide. Adding a statement on the impact of temperature on load noise should be considered in a next revision of the C57.12.90 Standard

3. Impact of Tap position on load noise
    - Starting point

Load noise data of a number of transformers generally showed an increase of a maximum of 3 dB with all tap turns in versus the neutral tap position. With all tap turns out, the measured load noise level was slightly higher for some transformers and slightly lower for other transformers.

- Originally proposed text

Load sound level experiences small differences with tap position

- Main feedback

Need to quantify the impact, ± (1 to 3) dB. The impact can be much greater in some designs. Already have short encompassing statements in the C57.12.90 Standard regarding testing of core and load noise at other than rated tap changer positions upon purchaser's request.

- Proposed resolution

The impact of tap position can be explained in more detail in the new noise guide. There is much more to say about this item for core and load noise.

- Discussion and agreed upon resolution

Ajith Varghese, Sanjay Patel, Krishnamurthy Vijyan, and Markus Schiess, offered comments that the impact of tap position on Load noise is design dependent. A suggestion offered by Joe Foldi to require measuring load noise at maximum ampere turns loading condition. It was discussed that load noise is not always highest at that condition. Manufacturers would be able to determine what the highest load noise tap position is for a design. It was agreed that the best location for this discussion is in the new noise guide rather than trying to expand this in the C57.12.90 Standard.

The next agenda item was to start with resolution of already received ballot comments on C57.12.00 and C57.90.

Noise sections of C57.12.00

Comment received from Eaton Corporation:

- Comment:
    - Table C.2 for distribution transformers only covers transformers to 3 MVA, but C57.12.36 for distribution substation transformers has a scope up to 10 MVA.
- Proposed Change:
    - Change table C.1 to cover all transformers, or, expand table C.2
- Issue
    - Table C.1 starts at 700 kVA and refers to "Power Transformers" and Table C.2 refers to "Distribution Transformers", covers up to 3000 kVA.
- Suggested Resolutions:
    - Start Table C.1 at 10 MVA and expand Table C.2 to 10 MVA.
    - Start Table C.1 at 3 MVA and refer to Table C.2 as "Small distribution transformers".
- Discussion and agreed-upon resolution
    - After some discussion and a proposal by Javier Arteaga, Dan Sauer, and Sanjay Patel, it was agreed to incorporate the first five rows from Table C.2 into Table C.1 with a starting kVA of $\leq$ 50 kVA. Also, change the title of Table C.1 to "Audible sound pressure levels for No-Load noise of liquid-immersed distribution and power transformers".

Comment received from Westwood Professional Services

- Comment:
  - Table C.3 specifies audible sound levels of load noise without the consideration of BIL, and these levels are much lower than the no-load levels specified in Table C.1.
- Proposed change:
  - Add additional details when these values may be applicable and provide a reason why they are considerably lower than Table C.1.
- Suggested and agreed upon Resolution:
  - To add such an explanation into the Noise Guide with a few clarifying sentences.

Noise sections of C57.12.90

Comment received from Scott Digby – Duke Energy

- Comment:
  - No-Load sound level measurements should be required to be made (and guaranteed) at the highest sound producing tap position combinations and not on the rated tap position.
- Issue:
  - Presently, section 13.3.3.1 No-load audible sound level states that core noise is to be measured at rated tap position and only upon request by the Customer that the transformer is tested at highest noise producing tap position.
- Proposed change:
  - Require the no-load audible sound level measurement to be made and guaranteed at the highest sound producing tap position combination.
- Suggested and agreed upon Resolution:
  - There is a need to consider the proposed change in the next revisions of the C57.12.00 and C57.12.90 Standards. In the meantime, all of the above will be explained in the Noise Guide. The chairman stated that this is most observed in the case of high noise PA typically caused by quality issues with manufacturing PAs.

As the meeting time had expired, it was suggested to continue this ballot resolution process in another virtual meeting to be scheduled in the next few weeks. This will be arranged in accordance with the IEEE Transformers virtual meeting announcement. Details will be communicated with the TF as they are developed.

Since there are still updates that need to be considered for audible sound revisions in the C57.12.00 and C57.12.90 Standards, this Task Force will meet again at the Fall 2021 meeting and the Noise Guide WG will have a separate time slot for its meeting.

Finally, a poll was undertaken requesting attendees of the TF meeting to express their interest in joining the new C57.136 Noise Guide WG. The results were forwarded to Steven Antosz, Chairman. 39 of the attendees expressed interest in joining the new WG.

The meeting was adjourned at 2:12 PM.

Respectfully submitted,
Barry Beaster, TF Secretary

Meeting Attendance on following page:

Role	First Name	Last Name	Company
Guest	Raj	Ahuja	Raj Ahuja Consulting
Member	Stephen	Anthony	--
Member	Elise	Arnold	SGB
Member	Javier	Arteaga	Hitachi ABB Power Grids
Member	Onome	Avanoma	MJ Consulting
Member	Suresh	Babanna	SPX Transformer Solutions, Inc.
Secretary	Barry	Beaster	The H-J Family of Companies
Member	Mats	Bernesjo	Hitachi ABB Power Grids
Member	Enrique	Betancourt	Prolec GE
Guest	Thomas	Blackburn	Gene Blackburn Engineering
Member	William	Boettger	Boettger Transformer Consulting LLC
Guest	Darren	Brown	Howard Industries
Member	Steven	Brzoznowski	Bonneville Power Administration
Guest	David	Calitz	Siemens Energy
Guest	Everton	De Oliveira	Siemens Ltda
Member	Scott	Digby	Duke Energy
Guest	Thomas	Eagle	SPX Transformer Solutions
Guest	Daniela	Ember Baciu	Hydro-Quebec - Laboratoire Haute Tension
Member	Hugo	Flores	Hitachi ABB Power Grids
Guest	Anthony	Franchitti	PECO Energy Company
Member	Eduardo	Garcia Wild	Siemens Energy
Chair	Ramsis	Girgis	Hitachi ABB Power Grids
Guest	Shawn	Gossett	Ameren
Guest	Ismail	Guner	Hydro-Quebec
Member	Thomas	Hartmann	Pepco Holdings Inc.
Guest	Nicholas	Jensen	Delta Star Inc.
Guest	John	John	Virginia Transformer Corp.
Guest	Stephen	Jordan	Tennessee Valley Authority
Member	Akash	Joshi	Black & Veatch
Member	Zan	Kiparizoski	Howard Industries
Guest	Mark	Lachman	Doble Engineering Co.
Member	Fernando	Leal	Prolec GE
Guest	Yaquan (Bill)	Li	BC Hydro
Guest	Dennis	Marlow	DenMar TDS Transformers
Member	Vinay	Mehrotra	SPX Transformer Solutions, Inc.
Guest	Rashed	Minhaz	Transformer Consulting Services Inc.
Guest	Paul	Morakinyo	PSEG
Guest	George	Partyka	PTI Transformers
Member	Nitesh	Patel	Hyundai Power Transformers USA
Member	Sanjay	Patel	Royal Smit Transformers

Member	Christoph	Ploetner	Hitachi ABB Power Grids
Member	Klaus	Pointner	Trench Austria GmbH
Guest	Bertrand	Poulin	Hitachi ABB Power Grids
Member	Afshin	Rezaei-Zare	York University
Guest	Pierre	Riffon	Pierre Riffon Consultant Inc.
Guest	Hakan	Sahin	Virginia and Georgia Transformers
Guest	Dinesh	Sankarakurup	Duke Energy
Member	Daniel	Sauer	EATON Corporation
Member	Markus	Schiessl	SGB
Member	Cihangir	Sen	Duke Energy
Member	Michael	Sharp	Trench Limited
Guest	Kyle	Stechschulte	American Electric Power
Guest	Marc	Taylor	Cogent Power Inc.
Guest	Ryan	Thompson	Burns & McDonnell
Member	Ajith	Varghese	SPX Transformer Solutions, Inc.
Guest	Jason	Varnell	Doble Engineering Co.
Member	Kiran	Vedante	Ritz Instrument Transformers
Guest	Jos	Veens	SMIT Transformatoren B.V.
Member	Krishnamurthy	Vijayan	PTI Transformers
Member	Dharam	Vir	SPX Transformer Solutions, Inc.
Guest	David	Wallach	Duke Energy
Guest	Daniel	Weyer	Nebraska Public Power District
Guest	Jeffrey	Wright	Duquesne Light Co.
Guest	Kris	Zibert	Allgeier, Martin and Associates

J.8.4 TF PCS Continuous Revisions to C57.12.00

PCS Task Force on General Requirements C57.12.00

Performance Characteristics Subcommittee
IEEE / PES Transformers Committee

April 26, 2021 2:20 PM
On-Line Meeting; Virtual, CT Time Zone USA

UNAPPROVED MINUTES

The PCS Task Force on General Requirements for C57.12.00 met on Monday, April 26, 2021. The Chair Tauhid Ansari called the Group to order at 2:20 PM and reminded purpose and scope of the TF. The copyright statement from IEEE was presented to the Group, as well as the essential patents claim; none of the present was aware of issues related to this TF's activities. According to the on-line system (two polls), **33** Members and **48** guests were present. The quorum to conduct regular business was achieved, as **59** members are registered in the Task Force.

The following (identifiable) **11** guests requested membership:

Amitabh Sarkar	Virginia Transformers
Aniruddha Narawane	PDI
Elise Arnold	SGB-Smit
Javier Arteaga	Hitachi-ABB
Mark Lachman	Doble Engineering
Nitesh Patel	Hyundai Power Transformers USA
Phillip Hopkinson	HVOLT Inc.
Samragni Dutta	Siemens Energy
Shawn Gosset	Ameren
Sylvain Plante	Hydro-Quebec
Vinay Mehrotra	SPX Transformer Solutions

The Agenda proposed for the TF Chair was approved by the Group (John K.K., E.Garcia), the Columbus (Fall 2019) minutes and the Fall 2020 minutes were next unanimously approved by the Group.
The Chair gave the Group quick update about status of old business items still open.

1. OLD BUSINESS

A. Inclusion of Core information on Nameplate

The Chair provided brief report from TF's online meeting held on past March 4th. Purpose of that meeting was to share with the Group new material collected from discussions with specialists and users of transformers. The comments were collected by the WG Chair and summarized in form of new version of proposed additions to Table 6 "Nameplate Information" of C57.12.00. On new rows 25, 26 of the Table it would be specified type of core (shell/ 'core') and number of wound legs, only for "C" type nameplate. No other design information would be requested. The floor was open to discussion.

It was explained (D.Sauer/Eaton) that the WG C57.12.80 had not achieved consensus yet regarding a new definition of shell/core type transformers. Other participants expressed opinions against and in favor of providing core type information on nameplate. It was clarified (R.Girgis) that if the expectation was to draw conclusions about GIC performance just from that core information it would not be possible.

The Chair asked for a motion to include the new proposed extensions to C57.12.00 Table 6. Sanjib Som(/Eduardo Garcia) made the motion "not to include core information on C57.12.00" requirements. The Group went to vote with 6 "in favor", 32 votes "against", and 7 abstentions. The motion did not pass.

Next step was discussion about further interest on including the information, for with an alternate format. Ryan Musgrove (/Chris Slattery) made the motion "to include core information on ("C" class) transformer nameplate". The count gave 27 "in favor", 4 "against" and 10 abstentions; the motion passed.

R.Girgis agreed to develop a new text for extension of Table 6 of C57.12.00, with a description of core type.

Next the TF Chair called for Group´s approval for an on-line meeting in approximately one month, to vote on final modifications to Table 6. The request was unanimously approved.

Being at the end of the meeting time slot, the Chair called for a motion to adjourn (Rogerio Verdolin/Eduardo Garcia).

The meeting was adjourned at 15:35 PM.

Respectfully submitted,

Tauhid Ansari
WG Chair

Enrique Betancourt
Co-Chair and Acting Secretary

First Name	Last Name	Company
Gregory	Anderson	GW Anderson & Associates, Inc.
Dennis	Marlow	DenMar TDS Transformers
Bruce	Forsyth	Bruce Forsyth and Associates LLC
Marion	Jaroszewski	Delta Star Inc.
William	Boettger	Boettger Transformer Consulting LLC
Joe	Nims	Allen & Hoshall, Inc.
Bill	Griesacker	Duquesne Light Co.
Joseph	Foldi	Foldi & Associates, Inc.
Mark	Perkins	D4EnergySolutions LLC
Javier	Arteaga	Hitachi ABB Power Grids
Javier	Arteaga	Hitachi ABB Power Grids
Eduardo	Garcia Wild	Siemens Energy
Steven	Snyder	Hitachi ABB Power Grids
Raj	Ahuja	Raj Ahuja Consulting
Dinesh	Sankarakurup	Duke Energy
Bertrand	Poulin	Hitachi ABB Power Grids
Ed	teNyenhuis	Hitachi ABB Power Grids
Shelby	Walters	Howard Industries
Donald	Ayers	Ayers Transformer Consulting
Ramsis	Girgis	Hitachi ABB Power Grids
Philip	Hopkinson	HVOLT Inc.
Sheldon	Kennedy	Niagara Transformer
Christopher	Baumgartner	We Energies
Enrique	Betancourt	Prolec GE
Allan	Bartek	Spruce Run Engineering LLC
Sanjay	Patel	Royal Smit Transformers
Marnie	Roussell	Entergy
Craig	Colopy	EATON Corporation
Vinay	Mehrotra	SPX Transformer Solutions, Inc.
Rogerio	Verdolin	Verdolin Solutions Inc.
Don	Dorris	Nashville Electric Service
David	Wallach	Duke Energy

James	Graham	Weidmann Electrical Technology
James	Graham	Weidmann Electrical Technology
Dharam	Vir	SPX Transformer Solutions, Inc.
Michael	Craven	Phoenix Engineering Services
John	Herron	Raytech USA
Brian	Penny	American Transmission Co.
Zan	Kiparizoski	Howard Industries
Sanjib	Som	Pennsylvania Transformer
Daniel	Blaydon	Baltimore Gas & Electric
Daniel	Sauer	EATON Corporation
Ajith	Varghese	SPX Transformer Solutions, Inc.
Krishnamurthy	Vijayan	PTI Transformers
Ryan	Musgrove	Oklahoma Gas & Electric
Shankar	Nambi	Bechtel
Shankar	Nambi	Bechtel
Darren	Brown	Howard Industries
Roderick	Sauls	Southern Company Services
Sukhdev	Walia	New Energy Power Co.
Mark	Lachman	Doble Engineering Co.
Myron	Bell	Delta Star Inc.
John	John	Virginia Transformer Corp.
Aniruddha	Narawane	Power Distribution, Inc. (PDI)
Jarrod	Prince	ERMCO
Mats	Bernesjo	Hitachi ABB Power Grids
Marc	Taylor	Cogent Power Inc.
Rainer	Frotscher	Maschinenfabrik Reinhausen
Amitabh	Sarkar	Virginia Transformer Corp.
Markus	Schiessl	SGB
Christopher	Slattery	FirstEnergy Corp.
Toby	Johnson	Pacificorp
Kristopher	Neild	Megger
Jason	Varnell	Doble Engineering Co.
Anthony	Franchitti	PECO Energy Company
William	Elliott	General Electric
Thomas	Dauzat	General Electric
Jeffrey	Gragert	Xcel Energy
Kris	Zibert	Allgeier, Martin and Associates
Anton	Koshel	Delta Star Inc.
Sanket	Bolar	Megger
Feras	Fattal	Manitoba Hydro
Cihangir	Sen	Duke Energy

Daniel	Weyer	Nebraska Public Power District
Nitesh	Patel	Hyundai Power Transformers USA
Everton	De Oliveira	Siemens Ltda
Sylvain	Plante	Hydro-Quebec
Shawn	Gossett	Ameren
Olle	Benzler	Megger
Suresh	Babanna	SPX Transformer Solutions, Inc.

J.8.5 WG HV & EHV Breaker & Transformer Sw. Transients C57.142

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

Virtual Meeting
Tuesday April 27, 2021
2:20 PM – 3:35 PM Central Time Zone – USA

Chairman – Jim McBride
Vice Chair – Xose Lopez-Fernandez
Secretary – Tom Melle

1) Meeting called to order at 2:20 PM Central Time.
Welcome and Chair's Remarks
2) Attendance Poll was taken at 2:25 PM.
102 Attendees were present (66 Guests)?
36 of 54 Members present (quorum was achieved)
3) IEEE Patent Policy and Copyright slides (no essential patent claims or copyright issues)
4) It was noted the IEEE Transactions Paper developed by members of the C57.142 WG has been published and is now available on the IEEE website (https://ieeexplore.ieee.org/document/9161400).
5) Approval of meeting Agenda without objection. Approval of Fall 2020 Meeting Minutes without objection (motion to approve by Rogerio Verdolin / 2nd by Phil Hopkinson).
6) Switchgear Liaison Task Force Update – Dave Caverly
The WG continues to receive excellent comments from Switchgear experts via the Switchgear Liaison TF. The present Draft 9B was created to address all prior comments. The Switchgear task force met on April 21, 2021 and reviewed changes made in D9B. All prior comments were resolved to the satisfaction of the SG task force. There was a motion by the SG TF to take the current document to Ballot. The TF had a quorum and the motion passed by consensus with no objections or abstentions (The comments and conclusions were presented to the WG in this meeting and will be posted on the WG website).
7) Status of Draft 9B and comments – Jim McBride
A copy of the present draft of the guide (D9B) was provided to all WG members prior to the meeting and is posted on the WG webpage of the Transformers Committee (PCS) website. In summary, the old guide focused on primarily MV systems. The new guide adds HV systems as well as additional related examples and mitigations. The excitation mechanisms are now based on steep front voltages and/or repetitive "pulse train" excitations which may "line up" and coincide with transformer internal resonance frequencies.
The revision to the Guide is complete and the draft is ready to proceed to ballot. The Chair noted the WG has filed for a PAR extension as a precaution (since all work must be completed by the end of 2021).

A motion was made by Phil Hopkinson / 2nd by Rogerio Verdolin to take the present Draft 9B to ballot. The motion was approved by online ballot with 36 members approving (0 disapproving / 0 abstentions).
8) Mitigation methods task force update and presentation – Phil Hopkinson
The presentation is posted on the WG webpage. Following the presentation there was discussion on several topics, including the DEIS feature article from September 2016 IEEE Electrical Insulation Magazine 32(5):32-40 "Impulse voltage distribution and frequency response of inter-shield windings". There was also a lengthy discussion of the guidance requested from the Switchgear committee for fast/very fast reignition transients from the Transformers Committee.
9) New Business: the WG authorized the formation of the Ballot Resolution Group without objection.
10) Next Meeting: (Fall 2021 – Milwaukee, WI the week of October 17-21)
11) Motion to Adjourn made by Phil Hopkinson / 2nd by Tom Melle. Meeting was adjourned at 3:37 PM without objection.

Respectfully,
Thomas R. Melle
Secretary

Role	First Name	Last Name	Company
Chair	James	McBride	JMX Services, Inc.
Vice-Chair	Xose	Lopez-Fernandez	Universidade de Vigo
Secretary	Thomas	Melle	HIGHVOLT
Member	Israel	Barrientos	Prolec GE
Member	Enrique	Betancourt	Prolec GE
Member	William	Boettger	Boettger Transformer Consulting LLC
Member	Jeffrey	Britton	Phenix Technologies, Inc.
Member	David	Caverly	Trench Limited
Member	Huan	Dinh	Hitachi ABB Power Grids
Member	Eduardo	Garcia Wild	Siemens Energy
Member	Kyle	Heiden	EATON Corporation
Member	Sergio	Hernandez Cano	Hammond Power Solutions
Member	Philip	Hopkinson	HVOLT Inc.
Member	John	John	Virginia Transformer Corp.
Member	Akash	Joshi	Black & Veatch
Member	Egon	Kirchenmayer	Siemens Energy
Member	Moonhee	Lee	Hammond Power Solutions
Member	Colby	Lovins	Federal Pacific Transformer
Member	Nigel	Macdonald	Trench Limited
Member	Ross	McTaggart	Trench Limited
Member	Vinay	Mehrotra	SPX Transformer Solutions, Inc.
Member	Harry	Pepe	Phenix Technologies, Inc.
Member	Klaus	Pointner	Trench Austria GmbH
Member	Bertrand	Poulin	Hitachi ABB Power Grids
Member	Afshin	Rezaei-Zare	York University
Member	Pierre	Riffon	Pierre Riffon Consultant Inc.
Member	Marnie	Roussell	Entergy
Member	Amitabh	Sarkar	Virginia Transformer Corp.
Member	Cihangir	Sen	Duke Energy
Member	Michael	Sharp	Trench Limited
Member	Hemchandra	Shertukde	University of Hartford
Member	Thomas	Sizemore	ABB Inc.

Member	Steven	Snyder	Hitachi ABB Power Grids
Member	Mike	Spurlock	Spurlock Engineering Services, LLC
Member	Shankar	Subramany	KEMA Labs
Member	Vijay	Tendulkar	Power Distribution, Inc. (PDI)
Member	Kiran	Vedante	Ritz Instrument Transformers
Member	Rogerio	Verdolin	Verdolin Solutions Inc.
Member	Dharam	Vir	SPX Transformer Solutions, Inc.
Member	Sukhdev	Walia	New Energy Power Co.
Member	Baitun	Yang	R.E. Uptegraff
Member	Waldemar	Ziomek	PTI Transformers
Guest	Tauhid Haque	Ansari	Hitachi ABB Power Grids
Guest	Suresh	Babanna	SPX Transformer Solutions, Inc.
Guest	Christopher	Baumgartner	We Energies
Guest	Jeff	Benach	Consultant
Guest	Steven	Brzoznowski	Bonneville Power Administration
Guest	Muhammad Ali Masood	Cheema	Northern Transformer
Guest	Michael	Craven	Phoenix Engineering Services
Guest	James	Cross	Kinectrics
Guest	John	Crouse	Roswell Alliance
Guest	Don	Dorris	Nashville Electric Service
Guest	Feras	Fattal	Manitoba Hydro
Guest	Reto	Fausch	RF Solutions
Guest	Raymond	Frazier	Ameren
Guest	John	Harley	FirstPower Group LLC
Guest	Charles	Johnson	Hitachi ABB Power Grids
Guest	Stephen	Jordan	Tennessee Valley Authority
Guest	Laszlo	Kadar	Hatch
Guest	Axel	Kraemer	Maschinenfabrik Reinhausen
Guest	Tim-Felix	Mai	Siemens Energy
Guest	Susan	McNelly	Xcel Energy
Guest	Randolph	Mullikin	ABB Inc.
Guest	Hossein	Nabi-Bidhendi	ABB Inc.
Guest	Anthony	Natale	HICO America
Guest	Sylvain	Plante	Hydro-Quebec
Guest	Christoph	Ploetner	Hitachi ABB Power Grids
Guest	Tejasvi	Prakash	Schweitzer Engineering Labs
Guest	Samuel	Reed	EATON Corporation
Guest	Leopoldo	Rodriguez	Transformer Testing Services LLC
Guest	Andre	Rottenbacher	Ritz Instrument Transformers
Guest	Daniel	Sauer	EATON Corporation
Guest	Brian	Sonnenberg	Instrument Transformers, LLC
Guest	Joseph	Tedesco	Hitachi ABB Power Grids
Guest	Ajith	Varghese	SPX Transformer Solutions, Inc.
Guest	Jason	Varnell	Doble Engineering Co.
Guest	Jos	Veens	SMIT Transformatoren B.V.
Guest	Kannan	Veeran	Georgia Transformer
Guest	Loren	Wagenaar	WagenTrans Consulting
Guest	Alan	Washburn	Burns & McDonnell

Guest	Malia	Zaman	IEEE

J.8.6 WG Short Circuit Withstand Design Criteria C57.164

WG for PC57.164
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 group met on-line on Tuesday, April 27, 2021, 3:45-5:00 PM. The poll of membership showed 26 of the WG's 46 members present and 28 Guests, but the final report showed 26 Members and 54 Guests including 3 unknown attendees. A quorum was achieved.
The patent and copyright questions were addressed with no conflicts noted.
The agenda and previous minutes were approved.
The WG was updated on the status of the Guide. Draft 6 was approved for balloting by the WG and the Performance Characteristics Subcommittee by email ballots in February, March and April with the following results:

	WG Ballot		SC Ballot	
	Number	Percentage	Number	Percentage
WG Members	45	100%	118	100%
Respondents	32	71%	76	64%
Approve	28	87.5%	67	88%
Disapprove	1	3.1%	2	3%
Abstain	3	9.4%	7	9%

The Guide has been submitted to IEEE SA for MEC review and balloting. The ballot pool is being formed at the time of the meeting and all members and guests were encouraged to join the ballot pool.
The meeting adjourned at 4:30PM.
The WG should not need to meet during the Fall 2021 Transformers Committee meeting.
Meeting attendance is listed below. It is a shame that we have modern electronic recording of attendance but the process of producing this attendance information for the Minutes takes several hours of effort; copying the pdf report, pasting it into a pdf program where it can be edited, then copying the names and pasting them into a spreadsheet then deleting all of the duplicates and searching for missing names for the numerous folks who only have single names listed or don't type their name correctly and cleaning up all the entries for people with more than a first and last name, then sorting by last name and printing a table so the information can be used to enter the Members' and previous Guest's attendance into AMS after entering a new meeting into AMS, then identifying new attendees who weren't listed in AMS as Members or previous guests and adding them one-by-one to the AMS roster then going back to the meeting attendance and recording their names, then downloading a meeting attendance report in AMS in .cvs format, converting it to excel and then deleting out extra columns and further filtering and sorting to just include membership status, name and affiliation, then copying and pasting the table into this document. Note that 3 people or entities were listed on the attendance list that could not be identified and are listed at the bottom of the list.

Status	Name	Affiliation
Chair	Sanjay Patel	Royal Smit Transformers
Vice-Chair	Raj Ahuja	Raj Ahuja Consulting
Secretary	Joe Watson	JD Watson and Associates Inc.
Member	Enrique Betancourt	Prolec GE
Member	William Boettger	Boettger Transformer Consulting LLC
Member	Everton De Oliveira	Siemens Ltda
Member	Samragni Dutta Roy	Siemens Energy
Member	Eduardo Garcia Wild	Siemens Energy
Member	Ramsis Girgis	Hitachi ABB Power Grids
Member	Akash Joshi	Black & Veatch
Member	Kurt Kaineder	Siemens Energy
Member	Zan Kiparizoski	Howard Industries
Member	Krzysztof Kulasek	Hitachi ABB Power Grids
Member	Vinay Mehrotra	SPX Transformer Solutions, Inc.
Member	Pierre Riffon	Pierre Riffon Consultant Inc.
Member	Amitabh Sarkar	Virginia Transformer Corp
Member	Markus Schiessl	SGB
Member	Eric Schleismann	Southern Company Services
Member	Cihangir Sen	Duke Energy
Member	Kushal Singh	ComEd
Member	Arthur Speegle	Entergy Services, Inc.
Member	Shankar Subramany	KEMA Labs
Member	Ed teNyenhuis	Hitachi ABB Power Grids
Member	Krishnamurthy Vijayan	PTI Transformers
Member	Dharam Vir	SPX Transformer Solutions, Inc.
Member	Baitun Yang	R.E. Uptegraff
Guest	Onome Avanoma	MJ Consulting
Guest	Suresh Babanna	SPX Transformer Solutions, Inc.
Guest	Mats Bernesjo	Hitachi ABB Power Grids
Guest	Ryan Bishop	Minnesota Power
Guest	Joshua Bohrn	PacifiCorp
Guest	Erich Buchgeher	Siemens Energy
Guest	Juan Carrizales	Prolec GE
Guest	Jorge Cruz	PTI Transformers
Guest	Juan Carlos Cruz Valdes	Prolec GE
Guest	Larry Dix	Quality Switch, Inc.
Guest	Marco Espindola	Hitachi ABB Power Grids
Guest	Hugo Flores	Hitachi ABB Power Grids
Guest	Jose Gamboa	H-J Family of Companies
Guest	Robert Ganser	Transformer Consulting Services, Co.
Guest	Rob Ghosh	GE
Guest	Jeffrey Gragert	Xcel Energy

Guest	Bill Griesacker	Duquesne Light Co.
Guest	Ismail Guner	Hydro-Quebec
Guest	Ryan Hogg	Bureau of Reclamation
Guest	Nicholas Jensen	Delta Star Inc.
Guest	Gael Kennedy	GR Kennedy & Associates LLC
Guest	Anton Koshel	Delta Star Inc.
Guest	Rodrigo Ocon	Industrias IEM
Guest	Nitesh Patel	Hyundai Power Transformers USA
Guest	Monil Patel	Pacific Gas & Electric Company
Guest	Caroline Peterson	Xcel Energy
Guest	Sylvain Plante	Hydro-Quebec
Guest	Christoph Ploetner	Hitachi ABB Power Grids
Guest	Alvaro Portillo	Ing. Alvaro Portillo
Guest	Jarrod Prince	ERMCO
Guest	Tim Rocque	SPX Transformer Solutions, Inc.
Guest	Leopoldo Rodriguez	Transformer Testing Services LLC
Guest	Marnie Roussell	Entergy
Guest	Hakan Sahin	Virginia and Georgia Transformers
Guest	Daniel Sauer	EATON Corporation
Guest	Jaber Shalabi	VanTran Industries, Inc.
Guest	Edward Smith	H-J Family of Companies
Guest	Sanjib Som	Pennsylvania Transformer
Guest	Marc Taylor	Cogent Power Inc.
Guest	Dervis Tekin	Meramec Instrument Transformer Co.
Guest	Jason Varnell	Doble Engineering Co.
Guest	Jos Veens	SMIT Transformatoren B.V.
Guest	Kannan Veeran	Georgia Transformer
Guest	Rogerio Verdolin	Verdolin Solutions Inc.
Guest	Pragnesh Vyas	Sunbelt-Solomon Solutions
Guest	Dieter Wagner	Hydro One
Guest	Hugh Waldrop	Memphis Light, Gas & Water
Guest	Daniel Weyer	Nebraska Public Power District
Guest	Anand Zanwar	Siemens Energy
Guest	Kris Zibert	Allgeier, Martin and Associates
Guest	Waldemar Ziomek	PTI Transformers
Unknown	Balakrishnan ??	Not in AMS
Unknown	Parminder Panesar	Not in AMS
Unknown	USIORAD	Not in AMS

J.9 Adjournment

The Chair entertained a motion to adjourn. D. Sauer made the motion, seconded by A. Joshi. The meeting was adjourned at 3:37PM

J.10 Performance Characteristics Subcommittee Attendance List

Role	First Name	Last Name	Company
Guest	Gregory	Anderson	GW Anderson & Associates, Inc.
Guest	Susan	McNelly	Xcel Energy
Guest	Dennis	Marlow	DenMar TDS Transformers
Member	Bruce	Forsyth	Bruce Forsyth and Associates PLLC
Member	William	Boettger	Boettger Transformer Consulting LLC
Member	Bill	Griesacker	Duquesne Light Co.
Member	Joseph	Foldi	Foldi & Associates, Inc.
Member	Joe	Watson	JD Watson and Associates Inc.
Guest	Paulette	Payne-Powell	Retired
Member	Barry	Beaster	H-J Family of Companies
Guest	Mark	Perkins	D4Energy Solutions LLC
Member	Javier	Arteaga	Hitachi ABB Power Grids
Guest	Michael	Sharp	Trench Limited
Member	Eduardo	Garcia Wild	Siemens Energy
Member	Steven	Snyder	Hitachi ABB Power Grids
Guest	Raj	Ahuja	Raj Ahuja Consulting
Member	Bertrand	Poulin	Hitachi ABB Power Grids
Guest	Alan	Traut	Howard Industries
Member	Stephen	Jordan	Tennessee Valley Authority
Guest	Loren	Wagenaar	WagenTrans Consulting
Member	Donald	Ayers	Ayers Transformer Consulting
Member	Ramsis	Girgis	Hitachi ABB Power Grids
Member	Philip	Hopkinson	HVOLT Inc.
Guest	Paul	Jarman	University of Manchester
Member	Sheldon	Kennedy	Niagara Transformer
Guest	Michael	Franchek	Retired
Guest	Axel	Kraemer	Maschinenfabrik Reinhausen
Member	Jeffrey	Britton	Phenix Technologies, Inc.
Member	Christopher	Baumgartner	We Energies
Member	Enrique	Betancourt	Prolec GE
Guest	Christoph	Ploetner	Hitachi ABB Power Grids
Member	Devki	Sharma	Entergy
Member	Richard	Marek	Retired
Member	Peter	Zhao	Hydro One
Member	Sanjay	Patel	Royal Smit Transformers
Member	Sanjay	Patel	Royal Smit Transformers
Guest	Gael	Kennedy	GR Kennedy & Associates LLC
Member	Reto	Fausch	RF Solutions
Member	Marnie	Roussell	Entergy

Member	Klaus	Pointner	Trench Austria GmbH
Member	Pierre	Riffon	Pierre Riffon Consultant Inc.
Guest	Krzysztof	Kulasek	Hitachi ABB Power Grids
Member	Craig	Colopy	EATON Corporation
Member	Steven	Schappell	SPX Transformer Solutions, Inc.
Guest	Waldemar	Ziomek	PTI Transformers
Member	Vinay	Mehrotra	SPX Transformer Solutions, Inc.
Guest	Eric	Davis	Burns & McDonnell
Chair	Rogerio	Verdolin	Verdolin Solutions Inc.
Member	Hemchandra	Shertukde	University of Hartford
Member	Charles	Sweetser	OMICRON electronics Corp USA
Guest	Scott	Digby	Duke Energy
Member	J. Arturo	Del Rio	Siemens Energy
Guest	David	Wallach	Duke Energy
Member	Ulf	Radbrandt	Hitachi ABB Power Grids
Guest	Neil	Strongosky	Memphis Light, Gas & Water
Member	Marcos	Ferreira	Beale AFB
Member	James	McBride	JMX Services, Inc.
Member	James	McBride	JMX Services, Inc.
Guest	Laszlo	Kadar	Hatch
Member	Dharam	Vir	SPX Transformer Solutions, Inc.
Guest	Rudolf	Ogajanov	ABB Inc.
Member	Kiran	Vedante	Ritz Instrument Transformers
Guest	Markus	Stank	Maschinenfabrik Reinhausen
Guest	Peter	Werelius	Megger
Guest	Marco	Espindola	Hitachi ABB Power Grids
Guest	Hakan	Sahin	Virginia and Georgia Transformers
Member	Brian	Penny	Retired
Member	Said	Hachichi	Hydro-Quebec
Guest	Jose	Gamboa	H-J Family of Companies
Member	Poorvi	Patel	Electric Power Research Institute (EPRI)
Guest	Juan Carlos	Cruz Valdes	Prolec GE
Guest	Juan Carlos	Cruz Valdes	Prolec GE
Vice-Chair	Sanjib	Som	Pennsylvania Transformer
Member	Tauhid Haque	Ansari	Hitachi ABB Power Grids
Member	Daniel	Blaydon	Baltimore Gas & Electric
Member	Robert	Ballard	DuPont
Member	Xose	Lopez-Fernandez	Universidade de Vigo
Member	Daniel	Sauer	EATON Corporation
Guest	Pugal	Selvaraj	Virginia Transformer Corp.
Member	Aleksandr	Levin	Weidmann Electrical Technology

Member	Ajith	Varghese	SPX Transformer Solutions, Inc.
Member	Kenneth	Skinger	Scituate Consulting, Inc.
Member	Baitun	Yang	R.E. Uptegraff
Guest	Huan	Dinh	Hitachi ABB Power Grids
Member	Harry	Pepe	Phenix Technologies, Inc.
Guest	Mario	Locarno	Doble Engineering Co.
Guest	Troy	Tanaka	Burns & McDonnell
Member	Krishnamurthy	Vijayan	PTI Transformers
Member	Ryan	Musgrove	Oklahoma Gas & Electric
Guest	David	Caverly	Trench Limited
Guest	Roderick	Sauls	Southern Company Services
Member	Egon	Kirchenmayer	Siemens Energy
Guest	Leopoldo	Rodriguez	Transformer Testing Services LLC
Guest	Rob	Ghosh	General Electric
Member	David	Murray	Tennessee Valley Authority
Member	Sukhdev	Walia	New Energy Power Co.
Guest	Myron	Bell	Delta Star Inc.
Member	Scott	Dennis	Hitachi ABB Power Grids
Member	Hugo	Flores	Hitachi ABB Power Grids
Member	Weijun	Li	Braintree Electric Light Dept.
Member	John	John	Virginia Transformer Corp.
Guest	Steven	Brzoznowski	Bonneville Power Administration
Member	Jarrod	Prince	ERMCO
Guest	Mats	Bernesjo	Hitachi ABB Power Grids
Guest	Marc	Taylor	Cogent Power Inc.
Guest	Larry	Rebman	EMLS, Inc.
Guest	Christopher	Steineman	Delta Star Inc.
Member	Amitabh	Sarkar	Virginia Transformer Corp.
Guest	Erich	Buchgeher	Siemens Energy
Guest	Markus	Schiessl	SGB
Guest	Rhett	Chrysler	ERMCO
Member	Thomas	Hartmann	Pepco Holdings Inc.
Member	Christopher	Slattery	FirstEnergy Corp.
Member	Kristopher	Neild	Megger
Member	Jason	Varnell	Doble Engineering Co.
Guest	Ismail	Guner	Hydro-Quebec
Member	Jeffrey	Wright	Duquesne Light Co.
Guest	Anthony	Franchitti	PECO Energy Company
Guest	William	Elliott	Prolec GE
Guest	Rashed	Minhaz	Transformer Consulting Services Inc.
Guest	Jeffrey	Gragert	Xcel Energy

Secretary	Kris	Zibert	Allgeier, Martin and Associates
Member	Tim-Felix	Mai	Siemens Energy
Member	Rhea	Montpool	Schneider Electric
Member	Dr. Alexander	Winter	HIGHVOLT Pruftechnik Dresden
Member	Joshua	Yun	Virginia Transformer Corporation
Guest	William	Whitehead	Siemens Energy
Member	Sanket	Bolar	Megger
Guest	Daniela	Ember Baciu	Hydro-Quebec - Laboratoire Haute Tension
Guest	Feras	Fattal	Manitoba Hydro
Guest	Cihangir	Sen	Duke Energy
Member	Stacey	Kessler	Basin Electric Power Cooperative
Guest	Daniel	Weyer	Nebraska Public Power District
Guest	Janusz	Szczechowski	Maschinenfabrik Reinhausen
Guest	Ken	Klein	Grand Power Systems
Guest	Nitesh	Patel	Hyundai Power Transformers USA
Member	Israel	Barrientos	Prolec GE
Member	Ion	Radu	Hitachi ABB Power Grids
Member	Muhammad Ali Masood	Cheema	Northern Transformer
Guest	Dan	Schwartz	Quality Switch, Inc.
Member	Gilles	Bargone	FISO Technologies Inc.
Guest	Jaber	Shalabi	VanTran Industries, Inc.
Member	Everton	De Oliveira	Siemens Ltda
Member	Bruce	Webb	Knoxville Utilities Board
Guest	Perry	Reeder	SPX Transformer Solutions, Inc.
Guest	Dervis	Tekin	Meramec Instrument Transformer Co.
Guest	Kyle	Heiden	EATON Corporation
Guest	Sergio	Hernandez Cano	Hammond Power Solutions
Guest	Colby	Lovins	Federal Pacific Transformer
Guest	Moonhee	Lee	Hammond Power Solutions
Guest	Hugh	Waldrop	Memphis Light, Gas & Water
Guest	Sylvain	Plante	Hydro-Quebec
Guest	Samragni	Dutta Roy	Siemens Energy
Guest	Kyle	Stechschulte	American Electric Power
Member	Shawn	Gossett	Ameren
Guest	Manish	Saraf	Hammond Power Solutions
Guest	Afshin	Rezaei-Zare	York University
Guest	Matthew	McFadden	Oncor Electric Delivery
Guest	Hugo	Avila	Hitachi ABB Power Grids
Member	Tim	Rocque	SPX Transformer Solutions, Inc.
Guest	Ramadan	Issack	American Electric Power

Guest	William	Knapek	OMICRON electronics Corp USA
Guest	Raymond	Frazier	Ameren
Guest	Onome	Avanoma	MJ Consulting
Guest	Alan	Washburn	Burns & McDonnell
Guest	Avijit	Shingari	Pepco Holdings Inc.
Guest	Pragnesh	Vyas	Sunbelt-Solomon Solutions
Guest	Chris	Powell	Intermountain Electronics
Guest	Parag	Upadhyay	ABB Inc.
Guest	Evgenii	Ermakov	Hitachi ABB Power Grids
Guest	Adam	Smith	Commonwealth Associates, Inc.
Guest	Mubarak	Abbas	Siemens Industry
Guest	Olle	Benzler	Megger
Guest	Michael	Warntjes	American Transmission Co.
Guest	Hossein	Nabi-Bidhendi	ABB Inc.
Guest	Tiffany	Lucas	SPX Transformer Solutions, Inc.
Guest	Mauricio	Soto	Hitachi ABB Power Grids
Guest	Suresh	Babanna	SPX Transformer Solutions, Inc.
Guest	Taylor	Gray	Portland General Electric (PGE)
Guest	Ryan	Hogg	Bureau of Reclamation
Guest	Monil	Patel	Pacific Gas & Electric Company
Guest	Giovanni	Hernandez	Virginia Transformers Corporation
Guest	Hampton	Steele	TVA
Guest	Thomas	Eagle	SPX Transformer Solutions
Guest	ANDY	DOWNEY	SPX TRANSFORMER SOLUTIONS