Annex J Performance Characteristics Subcommittee (PCS)

March 22nd, 2023, Hyatt Regency, Milwaukee, WI

UNAPPROVED MINUTES

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

J.1 Introduction / Attendance

Quorum was achieved with 70 members present (66% in attendance). In addition, 98 guests were present at the meeting. The total attendance at the meeting was 168. Guests should contact the Vice Chair to request 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 Kansas City, Missouri, October 22-26, 2023.

J.2 Chairman's Remarks

The Chair was unable to attend so the Vice Chair gave the Chairman's Remarks.

The Vice Chair introduced himself and secretary and provided the below updates and comments.

The Vice Chair discussed that the meeting would be recorded for minutes purposes and then deleted.

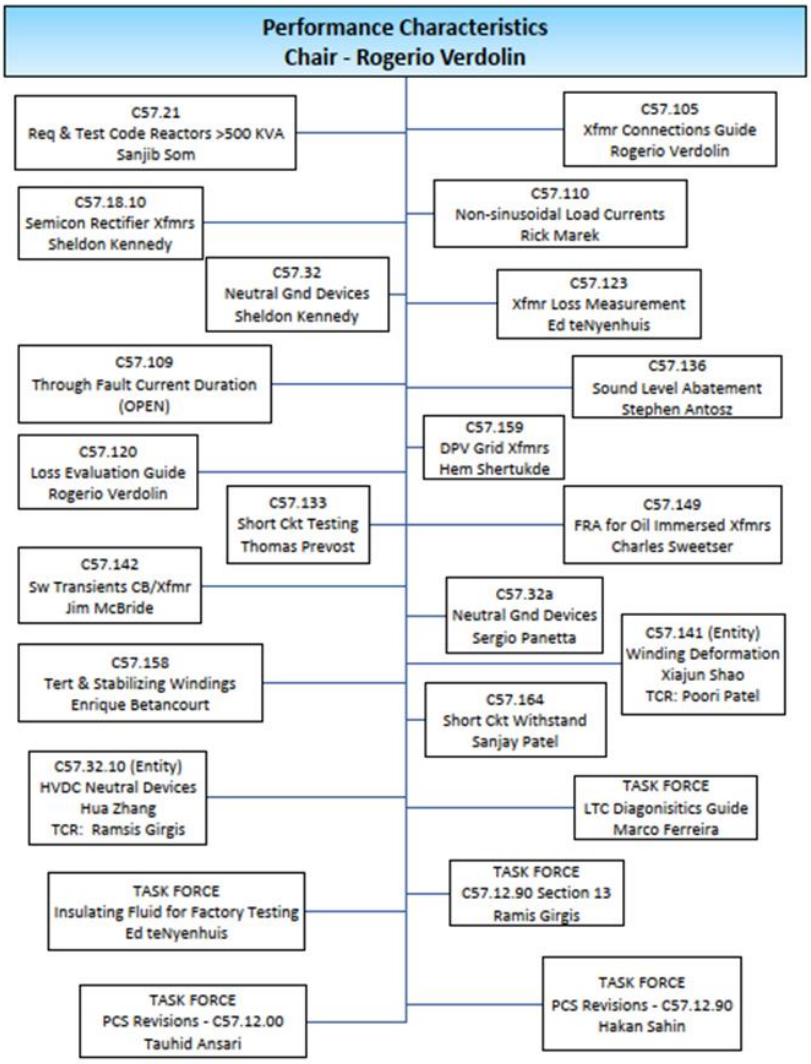
The Vice Chair asked anyone with new business to submit in writing prior to the meeting.

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 – H. Zhang (TCR: R. Girgis)
- C57.105 – Transformer connections guide – R. Verdolin
- C57.109 – Through Fault Current Duration – OPEN
- 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 – S. Antosz

- C57.141 - Entity - Winding Deformation – X. Shao (TCR: P. Patel)
- 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 – Short Circuit Withstand (in development) – S. Patel
- TF for Insulating Fluid for Factory Testing – E. teNyenhuis
- TF for LTC Diagnostics Guide – M. Ferreira
- 60076-16 – Wind Turbine Generator Transformers – P. Hopkinson

Status of Active PAR's:

- 2022 PAR's
  - C57.32.10 Entity WG Guide for the Selection of Neutral-Grounding Devices for HVDC Converter Transformers (PAR Extension Requested)
  - C57.149 SFRA Guide (PAR Extension Requested)
- 2023 PAR's
  - C57.142 Transient Guide (Ballot Invitation Complete)
- 2024 PAR's
  - C57.105-2019/Cor 1 (New WG)
  - C57.149 SFRA Guide (Ballot Invitation Complete)
- 2025 PAR's
  - C57.136 Audible Sound Guide (Recirc Ballot Complete)
  - C57.141 Entity WG Guide for Detection, Monitoring and Evaluation of Winding Deformation
- 2027 PAR's
  - C57.32 Neutral Grounding Devices (New WG)

Status of Standards without active PARs

- 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)
- C57.164-2021 – Short Circuit Withstand Guide (2031)
- C57.21-2021 – Shunt Reactors over 500kVA (2031)
- C57.18.10-2021 – Semiconductor Rectifier Transformers (2031)

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 tc-webmaster@ieee.org.
- 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 7 Members missed the past 2 meetings and have been moved to "Guest" status:

- Raj Ahuja
- Florian Faur
- Said Hachichi
- Brian Penny
- Mohmed Ali Masood Cheema
- Marcos Ferreira
- Vinay Mehrotra

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

The following Guests requested membership at the Fall 2022 meeting and have attended the past 2 of the last 3 meetings.

- Steven Brzoznowski
- Sarama Hoffman
- Markus Schiessl
- David Caverly
- Ramadan Issack
- David Wallach

Attendance / Membership – Quorum determination

- Current breakdown of the Subcommittee:
  - 106 Members
  - 54 are needed for a quorum
- Quorum was established with 71 members in attendance.

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 was made by H. Shertukde and seconded by T. Ansari. The motion passed by unanimous consent.

J.4 Approval of Last Meeting Minutes

The Chair presented the minutes of meeting held in October 2022 and entertained a motion to approve. The minutes had been sent to the members by email several weeks prior to the meeting. The motion was made by M. Roussell and seconded by A. Chakraborty. 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 — Charles Sweetser**
- **WG IEEE Neutral Grounding Devices PC57.32 — Sheldon Kennedy**
- **TF Audible Sound Revs & WG Sound Guide C57.136 (S. Antosz) — Ramsis Girgis**
- **TF Continuous Revisions to C57.12.00 — Tauhid Ansari**
- **TF Continuous Revisions to Test Code C57.12.90 — Hakan Sahin**
- **WG Sw Transients Ind by TR/Bkr Interaction PC57.142 — Jim McBride**

Below are highlights that were discussed at the PCS meeting:

1) WG Guide for FRA for Liquid Filled Transformers C57.149 — C. Sweetser

<u>Highlights</u>:

Meeting held Monday at 9:30 AM

- 62 in attendance, 31 members on the roster, 17 members attended, a quorum was achieved.
- The PAR is extended to 2024. Currently in ballot process. Mandatory Editorial Coordination (MEC) and ballot invitation are complete.
- Created Ballot Resolution Group that will address comments after first ballot is circulated.

2) WG IEEE Neutral Grounding Devices PC57.32 — S. Kennedy

- This is the first meeting of the WG: 27 attendees; 24 requested membership.
- IEEE Patent Policy Slides and Code of Conduct presented
- Introduction of WG officers
- Presentation of Agenda and Minutes from Fall 2022 TF Meeting (approved without objection)
- The Chair requested volunteers for each device covered within the standard and created the following task force leadership:
    - Neutral Grounding Reactors – Camilo Casallas / Saif Hossain
    - Ground Fault Neutralizers – Klaus Pointner
    - Neutral Grounding Transformers – Don Ayers / Jusuf Krvavac
    - Neutral Grounding Resistors – Ryan Hogg / Sergio Panetta / Jusuf Krvavac
    - Combinational Devices – Sergio Panetta
- New Business – liaison with CSA, IEC and other TC groups (C57.12.00 / 12.90, etc.)
- Meeting adjourned at 5:55 PM

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

Meeting Date / Time : March 20, 2023, @ 3:15PM to 4:30PM

- 86 total attendees, consisting of 36 Members (out of 58) and 50 Guests; a quorum was established; 17 Guests requested membership.

Highlights:

- Old Business
  - WG Item 112, Clarification on ±0.5% tolerance of ratio of three phase transformer, originally submitted by Ryan Hogg.
    - Work is not completed. Discussion will resume in next meeting.
  - WG Item 113, Measurement of auxiliary loss, originally submitted by Ajith Varghese: Some disconnect noticed between what different manufactures are doing for measuring auxiliary and control losses – based on how "integral parts of transformers" is interpreted.
    - It was determined the auxiliary losses need to be split. TF was not prepared to do this at the present meeting. A meeting invitation was sent to Utilities and manufacturers; three meetings are scheduled. Verbiage will be established after these meetings and discussed at the next meeting.
- New Business
  - Andrew Larison from Hitachi suggested adding Section 4.1.10 on DC current injection limit on the distribution transformer. R. Girgis presented TF needs to think about the percentage and the DC current injection limit based on differences in current injection. R. Girgis accepted the request to do more work on it. He will present next meeting.
  - New business was brought to the TF by Ryan to address Table 11 of Section 7. The kVA is different from single phase to three phase. It does not match in two rows. S. Patel mentioned a calculation to come up with it. E. teNyenhuis researched and found we have had this table since 1987. TF will address this at the next meeting.
- The meeting was adjourned at 4:30.

4) WG on Noise Guide C57.136 S. Antosz

- Went to ballot at the end of November and closed February 3, 2023, with a 75% return rate (77 of 102) and 98% approval rate (70 approve; 1 disapprove; 6 abstentions).
- 59 comments received and worked through by Ballot Resolution Group (BRG) consisting of working group officers.
- The significant technical comments from the initial ballot were presented for discussion at the WG meeting in Milwaukee.
- New draft was created and recirculated February 27, 2023, with 100% approval rate.
- Two minor comments received from recirc. No additional recirc needed. The guide is finalized and will be submitted to REVCOM.
- This meeting was the last meeting of the working group.
- The WG met as scheduled. The meeting was attended by 32 members (out of 46), and 30 guests, for a total of 87 persons. A quorum was established with 32 / 46 = 70% attendance. The agenda was unanimously approved as was the unapproved minutes from the previous meeting.

5) TF C57.12.90 Cont. Revision to Audible Sound R. Girgis

- Received three comments from original ballot. R. Girgis presented text to address these comments at the scheduled TF meeting.

- First comment regarded no load noise. R. Girgis proposed text for the change, and it was accepted with some changes.
- No standard currently exists for averaging sound pressure measurements. TF decided to add ambient sound pressure measurements logarithmically. There was a request to add the equation for the calculations. This equation will be added to the revision.
- The third comment addressed that there is no current standard for measuring load audible sound level for ONAN-rated transformers. A statement was added to measure ONAN-rated transformers at the ONAN measuring contour.
- Barry Beaster, TF secretary, submitted his resignation. Mats Bernesjo is the new secretary of the TF.
- A motion was suggested to pass the changes made by the TF upon presentation of exact verbiage.

6) TF on Inverter Transf Precautions on Ground Shields C57.159 P. Hopkinson

Highlights:

- Second meeting held on Monday 3/20/23, 4:45 PM
- 100+ attendees
- 2 main issues discussed:
    - Transformers with Y inputs and grounded neutrals failed
    - Moving this activity into C57.159
- P. Hopkinson made a motion and D. Sauer seconded to revise C57.159. It became evident that a revision would not satisfy all of the task force's desires. D. Sauer made a motion and K. Zibert seconded to table indefinitely. D. Sauer moved the previous question with K. Zibert seconding. Motion passed by a show of hands. The motion to table indefinitely passed by unanimous consent.
- Task force will go back and perform a study to create a title, purpose and scope for a revision to C57.159 and bring back a motion to the subcommittee to get a PAR.

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

- Meeting held at 9:30 am to 10:25 am.
- Total attendance = 109
- Members = 27/58; No quorum, Guests = 82
- All old businesses were concluded. TF reviewed Clause "5.1 Determination of cold temperature" with a possibility of bringing clarity to the method for temperature measurement for cold resistance. TF agreed to continue to work on this and propose a revision for next meeting.
- No new business.

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

- Quorum not achieved (23/46 Members present). 67 guests with 11 requesting membership.
- Agenda was approved. The minutes of Fall 2022 meeting were also approved.
- New Draft 11 created from the 305 comments received from ballot. Draft 11 addresses 276 comments.
- Comment Resolution Group went over 29 remaining comments. Group has members from both the Transformers and Switchgear Committees.

- Six of the 29 unaddressed comments were presented and discussed. A proposed resolution to most of these comments was agreed on by those in attendance. Based on discussions, we have approximately 23 comments and 10 figures to resolve and update.
- Mitigation Methods Task Force Update – the full list of mitigation methods were presented. Further consideration is being given to adding *"Redesign of transformers to move resonant point"* as a mitigation method. A suggestion was made to develop a presentation to communicate these methods to the Dielectric Test and Performance Characteristics Subcommittees.
- Meeting adjourned at 12:15 PM.

J.6 Unfinished (Old) Business

Study Group for Continuous Unbalanced Current Operation (Chair: Enrique Betancourt)

- The Group did not meet; the Chair needs to prepare a "critical mass of information" with support of more volunteers before the first meeting.
- Objective of the Group is "To investigate about relevance of considering continuous unbalanced loading of power transformers as subject of standardization within IEEETC"

- Background
  - Power transformers at generation/transmission levels operate with "balanced" currents, as rotary generators can withstand limited amount of unbalance of line currents (in order of a few %).
  - Two types of load unbalance: line-to-line and line-to-neutral; the latter might have impact on transformers (zero-sequence flux). Distribution networks operators deal with this issue at low-power level (see, for instance NREL Rep. "Modeling and Testing of Unbalanced Loading and Voltage Regulation", 2007).
  - Some utility representatives believe that electronic converters would eventually be capable to maintain large-power delivery under unbalanced conditions.
- Highlights
  - C57.12.00 does not consider continuous unbalanced loading as abnormal operating conditions (IEC 60076-1 does consider it); it however provides criteria for default dimensioning of stabilizing windings, in case loading not specified.
  - C57.105 and other documents provide recommendations related to unbalanced loading of specific, sensitive transformer connections.
  - IEEE On-Line Dictionary includes definition for "unbalanced loading" taken from Std. C57.158-2017.
- Next Steps
  - "Unbalanced loading" survey among PCS.
  - Confirm relevance of available information to form a TF (identify co-Chair and Secretary). **On-line meeting** with participation of interested individuals (please send e-mail to ebetanco@ieee.org, before April 30, 2023).

J.7 New Business

- E. Betancourt made a motion to approve creating a PAR for a revision to C57.158, seconded by J. McBride. Motion passed by unanimous consent.
- J. Kazmierczak made a motion to create a Task Force to form a PAR study group to look at creating a new guide that covers CO2 emissions in the construction of transformers. Seconded by T. Ansari.
  - Discussion was had revolving around what the definition of CO2 emissions are, if it belongs in this Subcommittee, etc.
  - After discussion a vote was held and the motion passed by a show of hands.

J.8 Adjournment

- The meeting was adjourned at 4:15PM**.**

J.9 Minutes of Meetings of Working Group (WG) and Task Force (TF) Reports (all unapproved)

J.9.1 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: March 20, 2023 0930 H
Meeting Location: Milwaukee, WI
Chairman: Charles Sweetser [CS] (Omicron)
Vice-Chair: Poorvi Patel (EPRI)
Secretary: James Cross (Kinectrics)

Meeting was convened at 0930 H by Chairman Charles Sweetser with 62 total attendees, consisting of 17 members and 45 guests. A quorum (17/31) was achieved.

AGENDA
1. Introductions and Attendance Sheets
2. IEEE-SA Standards Board Bylaws on Patents in Standards
3. Approval of Minutes from October 17, 2023
4. Approval of Agenda
5. Discussions
    a. Ballot Process Update
    b. Seeking motion to create Ballot Resolution Group
7. Old Business
8. New Business
9. Adjourn

CS reviewed the IEEE Working Group meeting guidelines and the standard patent disclosure info. (No response from attendees to request for patent info.)
The membership list shows 31 WG members.
The agenda and minutes were approved:
Agenda - Diego Robalino moved; seconded Paminder Panesar, carried unanimously.
Minutes - Mickel Saad moved; seconded by Diego Robalino, carried unanimously.

Noted Discussions:
CS reviewed the editorial changes required by MEC.

a. Updating all dates in the copyright statements on the first page, the header, and the footer.
b. Reviewing and revising the use of ensure, ensuring, and minimize.
c. Add the new mandatory Word Usage subclause in Clause 1.

CS reviewed the results of the Ballot Invitation. 102 joined the group and it is balanced.

Motion to create a ballot resolution group:

Mani Kumar moved; seconded Mario Locarno, carried unanimously.

The following individuals have volunteered for the BRG: Wes Schrom, Mario Locarno, Diego Robalino, Kumar Mani, Evgenii Ermakov, Rakesh Patel, Abdulmajid Shaikh

Meeting adjourned at 0950 H

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

Charles Sweetser	Omicron	Member
Poorvi Patel	EPRI	Member
James Cross	Kinectrics	Member
Fernando Leal	Prolec GE	Member
Mario Locarno	Doble	Member
Akash Joshi	Mott MacDonald	Member
Will Knapek	Omicron	Member
Jonathan Sinclair	PPL	Member
Scott Reed	MVA	Member
Kumar Mani	Duke Energy	Member
Evgenii Ermakov	Hitachi Energy	Member
Ajith Varghese	Prolec GE	Member
Diego Robalino	Megger	Member
Mickel Saad	Hitachi Energy	Member
Parminder Panesar	Virginia Transformer	Member
James McBride	JMX High Voltage	Member
Ismail Guner	Hydro Quebec	Member
Anthony Natale	HICO	
Brian Sparling	Dynamic Ratings	
Marco Espindola	Hitachi Energy	
Eric Davis	Burns & McDonnell	
Qasim Khan	NEETRAC-GT	
Bernard LaBean	Consumers Energy	
Raymond Frazier	Ameren	
Michael Richardson	Ameren	
Daniel Crockett	Ameren	
Cole Van Dreel	ATC	
Alaor Scardazzi	Siemens Energy	
Justin Mimikel	Eaton	
Roger Hayes	GE Grid Solutions	
Tommy Spitzer	City Transformer	
Deanna Woods	Alliant Energy	
Mauricio Soto	Hitachi Energy	
Kayland Adams	Waukesha	
Kannan Veeran	Virginia Transformer	
Thrinadha Katapalli	Virginia Transformer	
Jesse Duffy	Nashville Electric Service	
Cameron Vant	Prolec GE	
Vivek Bhatt	Prolec GE	
Jusuf Krvavac	Sargent & Lundy	
Bertrand Poulin	Hitachi Energy	
Chris Slattery	First Energy	
Stephanie Denzer	Weidmann	
Brian McBride	Cargill	

Eduardo Tolcachir	TTE
Monil Patel	PG&E
Jorge Cantu	Alliant Energy
Bruce Forsyth	Bruce Forsyth and Associates, LLC
Abdulmajid Shaikh	Delta Star
Kevin Wirtz	Cargill
Drew Welton	Intellirent
Lorna Gara	Shermco
Juliano Montanha	Siemens Energy
Polo Orozco	GE Grid Solutions
Salahuddin Shaikh	Hitachi Energy
Duvier Bedoya	Hitachi Energy
Evan Knapp	Eaton
Rakesh Patel	Hitachi Energy
Rich Frye	Eaton
Alex Alahmed	Evergy
Gabriel Mamede	Siemens Energy
Fabian Stacy	Hitachi Energy

Respectfully submitted,

Charles Sweetser
Chair
C57.149 WG

J.9.2 WG PC57.32 Neutral Grounding Devices

IEEE Neutral Grounding Devices Working Group Meeting

Meeting Date/Time: March 21, 2023 4:45 PM – 6:00 PM
Meeting Location: Milwaukee, Wisconsin
Chairman: Sheldon P. Kennedy
Vice-Chair: Thomas Melle
Secretary: Ed teNyenhuis

1. Welcome and Chair's Remarks

2. Circulation of attendance sheets. (Quorum achieved – 25 of 25 new Members; 2 Guests present)

3. Patent Call

4. Copyright and IEEE Ethics Policies

5. Approval of minutes from previous Task Force. (Motion to approve by Don Ayers, Second by Klaus Pointner – motion passed without objection)

6. Introduction of New Officers and WG

7. Review of PAR Approval from NESCOM

8. TF Leader Assignments

   Neutral Grounding Reactors – Camilo Casallas, Saif Hossain

   Neutral Ground Fault Neutralizers – Klaus Pointner, Sheldon Kennedy

   Neutral Grounding Transformers – Don Ayers, Jusuf Krvavac

   Neutral Grounding Resistors – Ryan Hogg, Sergio Panetta

   Combinational Devices - Sergio Panetta, Jusuf Krvavac

9. Old Business

   Reminder that all IEEE Standards and Guides require permission for drawings and diagrams. The approval forms can be downloaded from IEEE.org per Maria Zaman.

10. New Business

    - Preliminary discussions of different test sections including impedance of zig-zag transformers (Sergio Panetta); relationship of HVDC and instrument transformers to NGT's and the possible inclusion of the effects of switching transients in the new Standard (Jim McBride and Tom Melle).

- Brief discussion of the importance of the test sections of C57.12.00 and 12.90. Further discussion of whether it may be possible to create a single section for all tables containing test voltages; the Vice-Chair and Chair commented that this was considered in the prior revision of the Standard and found to be difficult considering the variety of Neutral Grounding Devices.

- Brief discussion of relationship to CSA (C22.2 No. 295-15, Neutral Grounding Devices) and IEC (60076-25:2023, Neutral Grounding Resistors). Each TF will review relevant standards and guides.

- The incorporation of active Ground Fault Neutralizers will be looked into by the GFN TF (Klaus Pointner)

- Future remote meeting notices will be clarified and posted on the WG website

11. Next in-person meeting – Fall 2023 (IEEE TC October 23rd-26th in Kansas City, MO)

12. Adjournment at 6 PM CDT (motion by Don Ayers; Seconded by Sergio Panetta)

List of Meeting Attendees from Spring 2023 meeting (including affiliation & member status).

Anton Koshel	Delta Star	Guest
Areeb Wazir	Eaton	Guest
Sheldon Kennedy	Niagara Transformer	Chair
Thomas Melle	HIGHVOLT	Vice-Chair
Robert Arritt	EPRI	Member
Donald Ayers	Ayers Consulting	Member
Sankey Bolar	ONCOR	Member
Susan Bonfiglio	WAPA	Member
Camilo Casallas	Trench Ltd.	Member
Arup Chakraborty	Delta Star	Member
Juan Carlos Cruz Valdes	Prolec-GE Waukesha	Member
Huan Dinh	Hitachi Energy	Member
Ryan Hogg	Bureau of Reclamation	Member
Darren Hoppins	SensorLink	Guest
Saif Hossain	Trench Ltd.	Member
Jusuf Krvavac	Sargent & Lundy	Member
Jim McBride	JMX High Voltage	Member
Sergio Panetta	I-Gard Corp.	Member
Klaus Pointner	Trench Austria	Member
Ulf Radbrandt	Hitachi Energy	Member
Kyle Stechschulte	AEP	Member
Mike Sharp	Trench Ltd.	Member
Cody Vanwyck	Commonwealth Associates	Member
Trenton Williams	Advanced Power Technologies	Member
Alan Washburn	Burns & McDonnell	Member
Maria Zaman	IEEE	Guest
Kris Zibert	Allgeier, Martin & Assoc.	Member

J.9.3 TF PCS Continuous Revisions to Test Code C57.12.90

Working Group "PCS Task Force Continuous Revision to Test Code C57.12.90"
(Performance Characteristics Sub-Committee Working Group Report)

Meeting Date/Time: March 21, 2023 9:30 AM – 10:45 AM
Meeting Location: Milwaukee, Wisconsin
Chairman: Hakan Sahin
Vice-Chair: Pugal Selvaraj
Secretary: Adam Sewell

Meeting was called to order at 9:30 AM, March 21, 2023.

1. Administrative
    a. IEEE Patent Policy and Call for Patents and IEEE SA Copyright Policy
        i. No comments from group
    b. Review of Spring 2023 agenda
        i. No comments from group
    c. Introductions of the attendees
        i. Attendance sheets were passed out. Due to time constraints, chair did not have each attendee announce their name/affiliation. Name/affiliation was announced as attendees spoke during the meeting.
        ii. Secretary asked all who wanted on email distribution for the C57.12.90 PCS Task Force to send him an email at: adamsewell@ieee.org
    d. Updated membership review and count for quorum
        i. 58 members were listed and 23 were counted as present by hand count. Based on the hand count, the chair announced there was NO QUORUM for this meeting.
        ii. Attendance sheets after meeting completed showing 26 members attended.
        iii. **Members are expected to attend and stay in the meeting so business can be conducted.**
        iv. **Member requests should be sent to secretary – adamsewell@ieee.org**
    e. Approvals needed but not made due to lack of quorum – chair will email out to members for approval:
        i. Spring 2022 unapproved minutes
        ii. Fall 2022 unapproved minutes
        iii. Spring 2023 agenda

2. Old Business
    a. All old businesses were completed and no additional new business was brought up from the group

3. New Business
    a. Chair opened up discussion on "Clause 5.1: Determination of cold temperature" with a possibility of bringing clarity to the tools and methods for temperature measurement for cold

resistance to clarify the verbiage; “As accurately as possible”, as seen below from the current document.

5.1 Determination of cold temperature

The cold temperature of the winding shall be determined as accurately as possible when measuring the cold resistance. The precautions in 5.1.1, 5.1.2, and 5.1.3 shall be observed.

5.1.1 General

Cold-resistance measurements shall be made on a transformer only when the liquid or winding temperature is stable. The temperature is considered stable if the top liquid temperature does not vary more than 2 °C in a 1 h period.

Group agreed to continue to work on this and propose a revision.

i. Task force – Hakan Sahin, Kerwin Stretch, Leopoldo Rodriguez

b. Kumar Mani brought up a question/discussion about “Insulation Resistance Test” values to be added to the “Certified Test Report”. Group agreed that this goes under C57.12.00

4. Membership changes
   a. Officers will look at attendance of members and change membership based on attendance before Fall 2023 meeting.
   b. Secretary will work on completing missing information from attendance lists and email lists for this task force until new IEEE TC membership system is functional.

5. **Next meeting: October 24, 2023, at Fall 2023 Transformer Committee Meeting scheduled for October 22-26, 2023, Kansas City, MO, USA.**

6. Close of meeting
   a. Meeting adjourned at 10:45am

7. Attendee’s list is provided in Annexure - A

Submitted by: Hakan Sahin Date: 04/08/2023

Meeting Attendance:

Kayland Adams	Prolec-GE Waukesha	Guest-RM2
Alex Alahmed	Evergy	Guest-RM1
Tauhid Ansari	Hitachi Energy	Guest
Stephen Antosz	Stephen Antosz & Associates, Inc.	Member
Elise Arnold	SGB	Member
Javier Arteaga	Hitachi Energy	Member
Alex Ayala	Power Partners	Guest
Donald Ayers	Ayers Transformer Consulting	Member
Gilles Bargone	FISO Technologies Inc.	Guest-RM2
Chris Baumgartner	We Energies	Member
Duvier Bedoya	Hitachi Energy	Guest-RM2
Mats Bernesjo	Hitachi Energy	Guest-RM2
JeanNoel Berube		Guest

Enrique Betancourt	Prolec-GE Waukesha	Guest
Daniel Blaydon	Baltimore Gas & Electric	Member
William Boettger	Boettger Transformer Consulting LLC	Member
Sanket Bolar	Oncor	Guest
Christopher Borck	Eaton	Guest
Michael Botti	Hyosung HICO	Guest-RM1
Darren Brown	Howard Industries	Guest
Jorge Cantu	Alliant Energy	Guest
Arup Chakraborty	Delta Star Inc.	Member
Vivian Chan	Hitachi Energy	Guest
Thomas Dauzat	AEP	Guest-RM2
Scott Digby	Duke Energy	Guest
Nikolaus Dillon	Dominion Energy	Guest
Jeffrey Door	The H-J Family of Companies	Guest
Jesse Duffy	Nashville Electric Service	Guest-RM2
Samragni Dutta Roy	Siemens Energy	Guest-RM2
William Elliott	AEP	Member
Qusai Elnimri	Vantran Industries	Guest
Marco Espindola	Hitachi Energy	Guest
Florin Faur	Prolec-GE Waukesha	Guest
Hugo Flores	Hitachi Energy	Member
Raymond Frazier	Ameren	Member
Richard Frye	EATON Corporation	Guest
Renjie Fu	ERMCO	Guest
Ramsis Girgis	Hitachi Energy	Member
Jeff Gragert	Xcel Energy	Guest
Bill Griesacker	Duquesne Light Co.	Member
Ravi Gupta	Megger	Guest-RM1
Michael Hall	Mid Central	Guest
Kyle Heiden	EATON Corporation	Guest
Giovanni Hernandez	Virginia Transformer Corp.	Guest
John Herron	Raytech USA	Member
Saramma Hoffman	PPL	Guest
Philip Hopkinson	HVOLT Inc.	Guest
Ramadan Issack	AEP	Guest-RM2
John John	Virginia Transformer Corp.	Member
Christopher Johnson	Oncor	Guest
Sheldon Kennedy	Niagara Transformer	Guest
Stacey Kessler	Ulteig Transformer	Guest
Duritriy Klempner	Southern California Edison	Guest
Anton Koshel	Delta Star Inc.	Guest
Bernard LaBean Jr.	Consumers Energy	Guest
Mark Lachman	Doble Engineering Co.	Member
Andrew Larison	Hitachi Energy	Guest
Fernando Leal	Prolec-GE Waukesha	Member
Weijun Li	Braintree Electric Light Dept.	Guest
Kumar Mani	Duke Energy	Guest
Kenneth McKinney	UL LLC	Guest
Kent Miller	Retired	Guest
Francis Mills	Power Engineers	Guest
Rhea Montpool	Schneider Electric	Guest

Tyler Morgan	Duke Energy	Guest-RM1
Marta Munoz	Hitachi Energy	Guest
Hugo Murillo	The H-J Family of Companies	Guest-RM1
David Murray	TVA	Member
Ismael Naja	Eaton	Guest-RM1
Dwight Parkinson	EATON Corporation	Guest
George Partyka	PTI Transformers	Guest
Monil Patel	PG&E	Guest-RM1
Sanjay Patel	Smit Transformer	Member
Vinay Patel	Consolidated Edison Co. of NY	Guest-RM1
Harry Pepe	Phenix Technologies, Inc.	Member
Sylvain Plante	Hydro-Quebec	Guest
Jarrod Prince	ERMCO	Guest
Ion Radu	Hitachi Energy	Member
Michael Richardson	Ameren	Guest
Leopoldo Rodriguez	Transformer Testing Services LLC	Guest
Hakan Sahin	Virginia/Georgia Transformer	Chair
Fernando Salinas	Power Partners	Guest
Albert Sanchez	KUB	Guest
Markus Schiessel	SGB	Member
Eric Schleismann	Southern Company	Guest-RM2
Dan Schwartz	Quality Switch, Inc.	Guest
Pugal Selvaraj	Virginia Transformer Corp.	Vice-Chair
Adam Sewell	Quality Switch, Inc.	Secretary
Jeremy Sewell	Quality Switch, Inc.	Guest
Jaber Shalabi	Vantran Industries	Guest-RM1
Mike Sharp	Trench Ltd.	Guest
Ibrahim Shteyh	Shteyh	Guest-RM1
Christopher Slattery	FirstEnergy Corp.	Guest-RM2
Sanjib Som	Pennsylvania Transformer	Guest-RM2
Andrew Steineman	Delta Star Inc.	Guest
Kerwin Stretch	Siemens Energy	Guest-RM2
Marc Taylor	JFE Shoji Power Canada Inc.	Guest
Ed teNyenhuis	Hitachi Energy	Member
Scott Thomas	Hitachi Energy	Guest
Reinaldo Valentin	Duke Energy	Guest
Cole Van Dreel	American Transmission Company	Guest-RM2
Jason Varnell	Doble Engineering Co.	Member
Pragnesh Vyas	Sunbelt Solomon	Guest-RM2
Shelby Walters	Howard Industries	Guest
Bruce Webb	KUB	Guest
Fei Yang	Hitachi Energy	Guest-RM1
Anand Zanwar	Siemens Energy	Guest
Waldemar Ziomek	PTI Transformers	Guest-RM2

J.9.4 WG PC57.136 Noise Guide

Unapproved Minutes of Spring 2023 WG IEEE PC57.136, "Guide for Audible Sound of Liquid-Immersed Power Transformers" and TF "Audible Sound Revision to Test Code"

The WG and TF met at 1:45 PM, on Monday, March 20, 2023, as part of the WG PCS Guide for Audible Sound of Liquid-immersed Power Transformers and PSC Audible Sound Revision to Test Code.

Steve Antosz, Chairman of the WG presided over the meeting with Dr. Ramsis Girgis being the Vice-Chair, and Mats Bernesjo, Secretary.

The Chairman welcomed the audience to this meeting, reviewed the agenda, and initiated an applause thanking Barry Beaster for his many years of service as the secretary of the Task Force. He then announced that Mats Bernesjo is taking over this responsibility as the Secretary of the TF.

The WG meeting was attended by 32 out of 46 members and 30 Guests for a total meeting attendance of 87.

The agenda was unanimously approved as was the unapproved minutes of the Fall 2022 WG meeting in Charlotte.

The Chairman of the WG gave an update of status of the Noise Guide and commented on the last recirculation of the Guide, that was initiated February 27, 2022, for a 10-day duration. A few editorial changes were suggested and incorporated. The only previous negative vote on the ballot was changed into an "approve" vote. He reviewed several ballot comments that are technical in nature and the resolutions. With these final notes, the Chairman stated that the Guide will be finalized and submitted for publication by the WG Chair. He thanked everyone who participated in contributing to the Guide. He also announced that this was the last meeting of the WG as the work is finished. He then turned the podium over to Dr. Girgis for the second part of the meeting.

The TF meeting was attended by 23 out of 40 members and a total meeting attendance of 87. A quorum was established. Eight attendees requested membership at this meeting (listed below) **. The agenda was unanimously approved as was the unapproved minutes of the fall meeting of the TF.

The Chairman then presented and discussed proposed text in response to 3 Technical Comments received when C57.12.90 was originally balloted. Below is the approved proposed text in response to these 3 comments. Note that the text in red is the proposed updated / added text:

Item 1: Proposed modified text in response to comment on "Measuring no-load sound level at the highest sound producing tap position"

When measuring no-load audible sound level, the transformer shall be connected and energized at rated voltage and rated frequency and shall be at no load with the tap changer, if any, on the rated tap position, unless otherwise specified.

When a transformer is equipped with a tap changer, the transformer may, on certain tap changer positions, produce sound levels that are higher than the audible sound level at the rated tap position. For these transformers, the measurements shall be made with the transformer on the highest sound producing tap position.

Also, other excitation conditions may occur in service leading to lower, or higher, core noise. For example, transformers designed to operate with variable flux the core audible sound level is strongly impacted by the tapping position. The same is true for SVC transformers when connected to a Capacitive Load; Again, for these transformers, the measurements shall be made with the transformer operating at the highest sound producing condition.

Item 2: Proposed modified text – Clause 13.5.5.1 Measuring ambient sound pressure level

The ambient sound shall be measured at a minimum of four locations around the transformer immediately preceding and immediately following the sound measurements with the transformer energized. The ambient sound pressure level shall be established by calculating the Logarithmic average of measured values of the ambient sound pressure levels. The measuring instruments shall be in conformance with ….

Item 3: Proposed text for Clause 13.3.3.2: Load audible sound level

Proposed added text in red

Since load audible sound becomes a contributor to the total audible sound of the transformer at higher loads, the load audible sound level shall be measured at the ONAF measuring contour. For transformers with only an ONAN rating, load noise is to be measured at the ONAN Sound Measuring Contour.

New business proposed by Ajith Varghese: Look into the IEC Wall Sound Reflection coefficient was developed based on some test results from Prolec GE Waukesha. Vice-Chair Steve Antosz requested that manufacturers of power transformers send him test data, in particular where measurements were made in two different test rooms.

*** They are Gabriel Mamede (Siemens-Energy), Arup Chakraborty (Delta Star), Camilo Casallas (Trench), Subash Tuli (CT&RA), David Murray (TVA), Cole Van Dreel (AEP), Salahuddin Shaikh (Hitachi Energy), and Samson Debass (EPRI).*

With no new additional business raised, the meeting was adjourned upon unanimous approval.

Respectfully submitted,

Mats Bernesjo, WG / TF Secretary

Spring 2022 WG Meeting Attendance and Affiliation is as follows:

Kayland Adams	Prolec-GE Waukesha	Member
Alex AlAhmed	Evergy Wolf Creek	Guest
Carlos Alonso	Arteche	Guest
Stephen Antosz	Stephen Antosz & Associates, Inc.	Chair
Elise Arnold	SGB	Member
Donald Ayers	Ayers Transformer Consultants	Guest
Jason Beaudoin	Weidmann	Guest
Duvier Bedoya	Hitachi Energy	Guest
Mats Bernesjo	Hitachi Energy	Secretary
Enrique Betancourt	Prolec-GE Waukesha	Member
Edwin Betancourt	Siemens Energy	Guest
William Boettger	Boettger Transformer Consulting LLC	Member
Darren Brown	Howard Industries	Guest
Camilo Casallas	Trench Limited	Guest*
Arup Chakraborty	Delta Star	Guest*
Euhyoung Cho	HICO America	Guest
Daniel Crochett	Ameren	Guest
Juan Carlos Cruz Valdes	Prolec-GE Waukesha	Member
Juan Alfredo Cuyrizales	Prolec-GE Waukesha	Guest
Samson Debass	EPRI	Guest*
Scott Digby	Duke Energy	Member
Jesse Duffy	Nashville Electric Service	Guest
Evgenii Ermakov	Hitachi Energy	Guest

Hugo Flores	Hitachi Energy	Member
Eduardo Garcia Wild	Siemens Energy	Member
Ramsis Girgis	Hitachi Energy	Vice-Chair
Ismail Guner	Hydro-Quebec	Member
Derek Hollrah	Burns & McDonnell	Guest
Saif Hossain	Trench Ltd. – Siemens Energy	Guest
Nicholas Jensen	Delta Star Inc.	Member
John John	Virginia Transformer Corp.	Member
Joshi Akash	Mott MaeDonedal	Member
Lee Junho	Hyundai Electric	Guest
Jerzy Kazmierczak	Hitachi Energy	Member
Zan Kiparizoski	Howard Industries	Member
Anton Koshel	Delta Star Inc.	Guest
Rafal Kowalski	Hitachi Energy	Guest
Mark Lachman	Doble	Guest
Fernando Leal	Prolec-GE Waukesha	Guest
So-young Lee	Hyundai Electric	Guest
Jose Machain	Prolec-GE Waukesha	Guest
Gabriel Mamede	Siemens Energy	Guest*
Jim McBride	JMX High Voltage	Guest
Francis Mills	Power Engineers	Guest
Marta Munoz	Hitachi Energy	Guest
David Murray	TVA	Guest*
Joe Nims	Allen & Hoshall	Guest
Sanjay Patel	Smit Transformer	Member
Poorvi Patel	EPRI	Guest
Monil Patel	PG&E	Guest
Klaus Pointner	Trench Austria GmbH	Member
Bertrand Poulin	Hitachi Energy	Member
Ulf Radbrandt	Hitachi Energy	Guest
Ion Radu	Hitachi Energy	Guest
Tim Rocque	Prolec-GE Waukesha	Guest
Leopoldo Rodriguez	TTS	Guest
Ronchi Rodrigo	WEG Transformer	Guest
Hakan Sahin	Virginia/Georgia Transformer	Member
Dinesh Sankarakurup	Duke Energy	Member
Daniel Sauer	EATON Corporation	Member
Markus Schiessl	SGB	Member
Eric Schleismann	Southern Company	Guest
Cihangir Sen	Duke Energy	Member
Abdulmajid Shaikh	Delta Star	Guest
Salahuddin Shaikh	Hitachi Energy	Guest*
Michael Sharp	Trench Ltd Canada	Guest
Andre Simons	JFE Shoji	Member
Christopher Slattery	FirstEnergy Corp.	Member
Jonathan Snalgrass	Texas A&M University	Guest
Jason Snyder	FirstEnergy Corp.	Guest
Sanjib Som	Pennsylvania Transformer	Member
Andrew Steineman	Delta Star Inc.	Guest
Troy Tanaka	Burns & McDonnell	Guest
Marc Taylor	JFE Shoji Power Canada Inc.	Member

Subhash Tuli	CT&DA	Guest*
Cameron Vant	Prolec-GE Waukesha	Guest
Ajith Varghese	SPX Transformer Solutions, Inc.	Member
Kannan Veeran	Virginia/Georgia Transformer	Guest
Dharam Vir	SPX Transformer Solutions, Inc.	Member
Mike Waldrop	Memphis Light, Gas and Water	Guest
David Wallach	Duke Energy	Member
Jeffrey Wright	Duquesne Light	Guest
Fei Yang	Hitachi Energy	Guest
Anand Zanwar	Siemens Energy	Guest
Kris Zibert	Allgeier Martin	Guest

**Requested membership*

J.9.5 TF PCS Continuous Revisions to C57.12.00

PCS Task Force on General Requirements C57.12.00

Performance Characteristics Subcommittee
IEEE / PES Transformers Committee

March 20, 2023
Milwaukee, Wisconsin (USA)

UNAPPROVED MINUTES

The TF PCS Continuous Revisions to C57.12.00 met at 3:15 PM on Monday, March 20, 2023. Chairman Tauhid Ansari presided over the meeting with Enrique Betancourt being the Vice-chair, and Mats Bernesjo acted as Secretary. The meeting was called to order and the Chairman reminded the group of the purpose and scope of this Task Force. The copyright and patent statements from IEEE were presented to the group; none of the members and guests present were aware of any issues related to this TF's activities.

The meeting was attended by 36 members (out of 58), 50 guests, for a total meeting attendance of 86 persons, including 17 requests for membership at this meeting. A quorum was established with 36 / 58 = 62 % attendance.

The agenda was unanimously approved (1st Hugo Flores, 2nd David Wallach) as was the unapproved minutes (1st Sanjib Som, 2nd Eduardo Garcia) from the previous meeting (Fall meeting, Charlotte 2022).

The following 17 guests requested membership:

Alan Traut	Howard Industries
Angela Leigl	Eaton Corp
Charles Sweetser	Omicron Electronic Corp, USA
Cole Van Dreel	American Transmission Company
David Murray	TVA
Edward Orozco	GE Grid Solutions
Elise Arnold	Starkstrom Geretebau GmbH
Ion Radu	Hitachi Energy

Michael Botti	Hyosung HICO
Monil Patel	PG&E
Nick Jensen	Delta Star
Nik Dillon	Dominion Energy
Pugal Selvaraj	Virginia Transformers
Raymond Frazier	Ameren
Ryan Hogg	USBR
Samragni Dutta Roy	Siemens Energy
Subhash Tuli	ET&DA

Next, the Chair briefly provided background and relevance of each item brought up for Group's discussion in the agenda. The Chair started Group's regular business.

Next, the Chair briefly provided background and relevance of each item brought up for Group's discussion in the agenda. The Chair started Group's regular business.

WG Item 112, Clarification on ±0.5% tolerance of ratio of three phase transformer
Originally submitted by Ryan Musgrove.

"During the Spring 2022 meeting in Denver, the motion "Create a TF to review Section 9.1 of C57.12.00 and provide recommendation on phase-to-phase ratio tolerance to this task force by Fall 2022" was proposed by Dan Sauer and seconded by Phil Hopkinson. A short discussion preceded the vote: 14 agree, 9 oppose, and 5 abstain. With only 28 votes (out of 33 members), the validity of the vote to pass the motion was questioned (Sanjib Som) since "abstain" votes does not count towards # of votes. A second quorum check (by raised hands) showed that a quorum was no longer maintained within the TF and hence, the motion to create a TF did not pass. However, Ryan Musgrove will spearhead a group with the support of Sanjay Patel."

Unfortunately, the group was not able to meet. Dan Sauer asked to come back to the Chair of this TF before the next meeting (Fall 2023) in Kansas City.

WG Item 113, Measurement of Auxiliary Loss
Submitted by Ajith Varghese:

"I see there is some disconnect between what different manufacturers are doing for measuring control losses – based on how one interprets 'integral parts of transformers'."

We can't have each and every component listed in IEEE, but I think there needs to be some additional clarity needed. Some of the disconnects:

- Heaters
- When dual temp heaters, many are taking only one stage
- Heaters in Cubicles/bus duct (supplied with transformer) are not included
- Heaters in LTC cubicles
- Breathers
- Power for LTC Motor
- Power consumed by N2 generator
- Power consumed by Oil Filters.

Also – Need clarity of inrush/starting power needed for cooling fans, etc."

Present wording from C57.12.00 Sec 5.9.

> For Class II transformers (see 5.10), control/auxiliary (cooling) losses shall be measured and recorded. All stages of cooling, pumps, heaters, and all associated control equipment shall be energized, provided these components are integral parts of the transformer.

The group did meet prior to the meeting. Unfortunately, the only Utility (ComEd) in this small workgroup could not attend. Hence, only manufacturers participated. The group came up with some new wording, *The recommended additional paragraph.*

> *If the device cannot be energized or not present at the time of auxiliary loss measurement, the power information from the data sheet of device shall be identified and included in the total auxiliary losses*.

A very interesting and informative discussion was held on this topic with input from both Manufacturers and Utilities. The bottom line of the discussion seemed to be that all losses consumed by the transformer including all associated losses drawn by heaters, tap changer motor, fans, light, etc. must be considered in the total losses of the transformer. The consensus was also that the design of the control cabinet electronics must be such that it would not trip when all accessories are loaded.

The participants in the meeting agreed upon that Ajith Varghese & Tauhid Ansari will go through the wording one more time before the TF can vote on this topic. Dan Blaydon (BG&E), Chris Slattery (FirstEnergy), and Subhash Tuli (ET&DA) will also work with the Chairman on this topic.

WG Item 113, Measurement of Auxiliary Loss
Submitted by Andrew Larison:

"Adding Sec 4.1.10 on DC current injection limits".

A quick motion to approve (1st Steve Snyder, 2nd Phil Hopkinson) was not voted upon but rather discussed in detail. It appears that the proposed wording includes a 0.5 % DC. Note that, if this is on the secondary side of the distribution transformer, which in a low secondary voltage (480V or 120 V) could be significant (for example, the DC current could be 35 A in a 7000 A low voltage winding) which is not reasonable. First, DC needs to be written out as "Direct Current" before "injection" and there is a need to specify on which side on the transformer this is for (primary / secondary) for sure.

Dr. Ramsis Girgis will help looking into this topic with the focus on determining whether the 0.5 % should be 0.05 %, or different. The proposed wording, *4.1.10 DC Injection for Distribution Transformers.*

Unless otherwise specified the acceptable DC Injection limit shall be 0.5% for distribution class transformers. DC injection is defined in IEEE 1547. Refer to IEEE 1547.2 for the application guide and background information.

does not describe the scope fully which is very dangerous. Steve Antosz proposed to study this topic a little further to gather enough information to take a vote on this which was verbally approved by the audience.

Chairman Tauhid Ansari asked whether there was any new business. Ryan Hogg suggested to look into the background of Table 11 (section 7) due to that some of the information does not appear to make sense.

It appears that some of the KVA information is not correct and has not been updated since at least before 1987. The Chairman will discuss further with Hogg with the support of Dan Sauer.

With a quiet floor, the Chairman asked for the meeting to be adjourned.

Meeting was adjourned at 4:30 PM.

Respectfully submitted,

Tauhid Ansari	Enrique Betancourt	Mats Bernesjo
WG Chair	Vice-Chair	Secretary

Attendance Spring 2023 Meeting – PCS TF to Revision C57.12.00

Kayland Adams	Prolec-GE Waukesha	Guest
Greg Anderson	GW Anderson & Associates, Inc.	Guest
Tauhid Haque Ansari	Hitachi Energy	Chair
Stephen Antosz	Stephen Antosz & Associates, Inc.	Member
Elise Arnold	Starkstrom Geratebau GmbH	Guest (RM)
Donald Ayers	Ayers Transformer Consultants	Guest
Christopher Baumgartner	WE Energies	Member
Jason Beaudoin	Weidmann	Guest
Mats Bernesjo	Hitachi Energy	Secretary
Enrique Betancourt	Prolec GE	Vice Chair
Daniel Blaydon	Baltimore Gas & Electric	Member
William Boettger	Boettger Transformer Consulting LLC	Member
Christopher Borck	Eaton Corporation	Guest
Michael Botti	Hyosung HICO	Guest (RM)
Jeffrey Britton	Phoenix Tech, Div. of Doble	Guest
Samuel Brodeur	Hitachi Energy	Guest
Darren Brown	Howard Industries	Member
Eric Davis	Burns & McDonnell	Guest
Nikolaus Dillon	Dominion Energy	Guest (RM)
Samragni Dutta Roy	Siemens Energy	Guest (RM)
Qusal Einimri	Vantron Industries	Guest
William Elliott	Prolec-GE Waukesha	Member
Hugo Flores	Hitachi Energy	Member
Raymond Frazer	Ameren	Guest (RM)
Eduardo Garcia Wild	Siemens Energy	Member
Ramsis Girgis	Hitachi Energy	Member
Bill Griesacker	Duquesne Light	Guest
Ravi Gupta	Megger	Guest
Michael Hall	Midcentral Electrical	Guest
John Herron	Raytech USA	Member
Ryan Hogg	USBR	Member
Phil Hopkinson	HVOLT Inc.	Member
Nick Jensen	Delta Star Inc.	Guest (RM)
John John	Virginia Transformer Corp.	Member
Christopher Johnson	Oncor	Guest
Akash Joshi	Black & Veatch Inc.	Member

Kevin Juchem	Hitachi Energy	Guest
Sergiusz Kapka	Hitachi Energy	Guest
Jerzy Kazmierczak	Hitachi Energy	Guest
Sheldon Kennedy	Niagara Transformer	Guest
Rafal Kowalski	Hitachi Energy	Guest
Mark Lachman	Doble	Member
Angela Leigl	Eaton Corporation	Guest (RM)
Kevin Mazzei	Black & Veatch Inc.	Guest
Brian McBride	Cargill	Guest
Tom Melle	HVOLT Inc.	Guest
Juliana Montanha	Siemens Energy	Guest
Marta Munoz	Hitachi Energy	Guest
David Murray	TVA	Guest (RM)
Ryan Musgrove	OG&E	Member
Shankar Nambi	Bechtel Energy, Inc.	Member
Joe Nims	Allen & Hoshall	Member
Rudolf Ogajanov	Hitachi Energy	Guest
Eduardo Orozco	GE Grid Solutions	Guest (RM)
George Partyka	PTI Transformers	Member
Sanjay Patel	SMIT Transformers	Member
Monil Patel	PG&E	Guest (RM)
Harry Pepe	Phoenix Technologies, Inc.	Guest
Bertrand Poulin	Hitachi Energy	Member
Jarrod Prince	ERMCO	Member
Ion Radu	Hitachi Energy	Guest (RM)
Rodrigo Ronchi	WEG Transformers	Guest
Marnie Roussell	Entergy	Member
Hakan Sahin	Virginia / Georgia Transformers	Member
Dinesh Sankarakurup	Duke Energy	Guest
Amitabh Sarkar	Virginia Transformers	Member
Alaor Scardazzi	Siemens Energy	Guest
Markus Schiessl	SGB	Member
Jeffrey Schneider	Power Partners	Guest
Pugal Selvaraj	Virginia Transformers	Guest (RM)
John Sen	Duke Energy	Member
AbdulMajid Shaikh	Delta Star Inc.	Guest
Jaber Shalabi	Vantron Industries	Guest
Hemchandra Shertukde	University of Hartford	Guest
Christopher Slattery	FirstEnergy Corp	Member
Andrew Steineman	Delta Star Inc.	Guest
Tuli Subhash	ET&GA	Guest (RM)
Charles Sweetser	Omicron Electronics Corp USA	Guest (RM)
Ed teNyenhuis	Hitachi Energy	Member
Scott Thomas	Hitachi Energy	Guest
Alan Traut	Howard Industries	Guest (RM)
Cole Van Dreel	American Transmission Co	Guest (RM)
Ajith Varghese	Prolec-GE Waukesha	Member
Dharam Vir	Prolec-GE Waukesha	Member
David Wallach	Duke Energy	Member
Kris Zibert	Allgeier Martin	Member

J.9.6 WG HV & EHV Breaker & Transformer Sw. Transients C57.142

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
Milwaukee, WI
Tuesday, March 21, 2023
11:00 AM – 12:15 PM Central Time Zone – USA
Executive Ballroom (2)
Chairman – Jim McBride
Vice Chair – Xose Lopez-Fernandez
Secretary – Tom Melle

1) Meeting called to order at 11:00 AM Central Daylight Time.
2) Welcome and Chair's Remarks
3) Circulation of Attendance Sheets - 88 Attendees were present (22 Members were present and 66 Guests)
   Quorum was not achieved (24 members present required for quorum)
4) IEEE Patent Policy Slides
5) Approval of Agenda and Minutes from Fall 2022
6) C57.142 SA Ballot and Comment Resolution status – Jim McBride: presentation of open comments before the ballot resolution group (BRG) and discussion of several key comments (latest documents to be posted on WG website).

- Comment on Page 16, Section 5: alignment of Guide with theory in IEC 62271-306, Section 16.4 (Tom Melle to review)

- Comment - Page 20, Section 5.2: magnitude of re-ignition versus load power factor. The Chair provided examples of transients in shunt reactors illustrating 1.2 MV(pp) transients on transformer with 1.4 MV BIL (Jeffrey Britton to review)

- Comment - Page 6, Section 3.4.1: discussion of transient recovery voltages (The Chair and Phil Hopkinson will review/survey with SWG BRG members and any experienced users or manufacturers)

- Comment - Page 34, Section 7.6: de-energizing transformers with disconnectors (Bertrand Poulin suggested to leave the informative paragraph and insert a note that is can be dangerous to de-energize with switch)

- Comment - Page 30, Section 7: mitigation method of "moving" the transformer's resonant frequency (such as with CCVT). A straw ballot was conducted and the results were split. Chair will conduct a survey of the BRG.

- Comment - Page 33, Section 7.3: controlled switching to mitigate reignitions (the sentence will be rewritten to provide more clarity)

- Comment – Page 5, Section 3.3: discussed “ground-fault neutralizer” terminology. Jeff Britton suggested coordination with WG C57.32. Tom Melle is Vice-Chair of that Standard and will coordinate matching terminology.

7) Mitigation Methods Task Force Update – Jim McBride / Phil Hopkinson

All prior mitigation methods proposed by the TF are included in the Guide. The TF will review/consider CCVT, Capacitive Shields and any other potential mitigation methods suggested by comment resolution.

8) New Business – Ajith Varghese suggested preparing an updated presentation for sharing with any liaison groups (SWG, CIGRE, PCS and the TC at-large).
9) Next Meeting (Fall 2023 – Kansas City, MO, Oct. 23, 2023)
10) Adjournment at 12:15 PM CDT

Spring 2023 WG Meeting Attendance and Affiliation is as follows:

James McBride	JMX High Voltage	Chair
Thomas Melle	HIGHVOLT	Secretary
Enrique Betancourt	Prolec GE	Member
William Boettger	Boettger Transformer Consulting LLC	Member
Jeffrey Britton	Phenix Technologies, Inc.	Member
Eduardo Garcia Wild	Siemens Energy	Member
Kyle Heiden	EATON Corporation	Member
Philip Hopkinson	HVOLT Inc.	Member
John John	Virginia Transformer Corp.	Member
Akash Joshi	Black & Veatch	Member
Egon Kirchenmayer	Siemens Energy	Member
Weijun Li	Braintree Electric Light Dept.	Member
Klaus Pointner	Trench Austria GmbH	Member
Bertrand Poulin	Hitachi Energy	Member
Marnie Roussell	Entergy	Member
Amitabh Sarkar	Virginia Transformer Corp.	Member
Cihangir Sen	Duke Energy	Member
Michael Sharp	Trench Limited	Member
Mike Spurlock	Spurlock Engineering Services, LLC	Member
Ajith Varghese	SPX Transformer Solutions, Inc.	Member
Dharam Vir	Prolec-GE Waukesha	Member
Waldemar Ziomek	PTI Transformers	Member
Robert Arritt	EPRI	Guest
Jean-Noel Berube	Rugged Monitoring	Guest
Christopher Borck	EATON Corporation	Guest
Cole Casey	Invenergy	Guest
Vivian Chan	Hitachi Energy	Guest
Alex Cochran	U.S.E.	Guest
Michael Craven	Qualus Corporation	Guest
Gabriel Delgado Zamora	Invenergy	Guest
Scott Digby	Duke Energy	Guest
Nikolaus Dillon	Dominion Energy	Guest
Paul Dolloff	East Kentucky Power	Guest
Evgenii Ermakov	Hitachi Energy	Guest

Marco Espindola	Hitachi Energy	Guest
Esseddik FerdJallah	Trench Group	Guest
Raymond Frazier	Ameren	Guest
Jose Gamboa	H-J Family of Companies	Guest
Lorne Gara	Shermco	Guest
Miguel Garcia	Hitachi Energy	Guest
Carlos Gaytan	Prolec-GE Waukesha	Guest
Detlev Gross	Power Diagnostix Consultant	Guest
John Harley	FirstPower Group LLC	Guest
JC Hernandez	Georgia Tech – NEETRAC	Guest
Saramma Hoffman	PPL Electric Utilities	Guest
Saif Hossain	Trench Limited	Guest
Patrycia Jarosz	IEEE SA	Guest
Thrinadha Katapalli	Virginia Transformer	Guest
Stacey Kessler	Ulteig Engineers	Guest
Qasim Khan	Georgia Tech – NEETRAC	Guest
Dmitriy Klempner	Southern California Edison	Guest
Evan Knapp	EATON Corporation	Guest
Bernard Labean, Jr.	Consumers Energy	Guest
Mark Lachman	Doble Engineering Co.	Guest
Kumar Mani	Duke Energy	Guest
Omar Mendez	Prolec-GE Waukesha	Guest
Marian Mohamed	XCEL Energy	Guest
Juliano Montanha	Siemens Energy	Guest
Paul Mushill	Ameren	Guest
Joe Nims	Allen & Hoshall, Inc.	Guest
Dwight Parkinson	EATON Corporation	Guest
Monil Patel	PG&E	Guest
Uros Pleceyic	Invenergy	Guest
Goran Plisic	Siemens Energy	Guest
Ulf Radbrandt	Hitachi Energy	Guest
Ion Radu	Hitachi Energy	Guest
Bradley Rainbolt	EATON Corporation	Guest
Ana Restrepo	Hitachi Energy	Guest
Michael Richardson	Ameren	Guest
Tim Rocque	Prolec-GE Waukesha	Guest
Rodrigo Ronchi	WEG-Voltran	Guest
Markus Schiessl	SGB	Guest
Salahuddin Shaikh	Hitachi Energy	Guest
Hemchandra Shertukde	University of Hartford	Guest
Ibrahim Shteyh	Consultant	Guest
Stephen Shull	BBC Electrical Services, Inc.	Guest
Fabian Stacy	Hitachi Energy	Guest
Brad Staley	Leeward Renewable Energy	Guest
Andrew Steineman	Delta Star Inc.	Guest
Eduardo Tolcachir	TTE	Guest
Cameron Vant	Prolec-GE Waukesha	Guest
Jos Veens	SMIT Tranformatoren B.V.	Guest
Alan Washburn	Burns & McDonnell	Guest
Eric Weatherbee	PCORE Electric	Guest
Joshua Yun	Virginia Transformer Corp.	Guest

Malia Zaman	IEEE	Guest
Shibao Zhang	PCORE Electric	Guest

J.9.7 TF Inverter Transformer Precautions on Ground Shields C57.159

TF Inverter Transformer Precautions on Ground Shields C57.159
Unapproved Meeting Minutes
Spring 2023 Meeting
Milwaukee, WI
4:45 pm, Monday, March 20

A. Introduction:
1. **PJ Hopkinson. Task Force Leader**
2. **Hemchandra Shertukde: Past Chair of IEEE C57.159 & Proposed New Chair**
3. **Jonathon Stewart: Secretary, NEMA Staff**

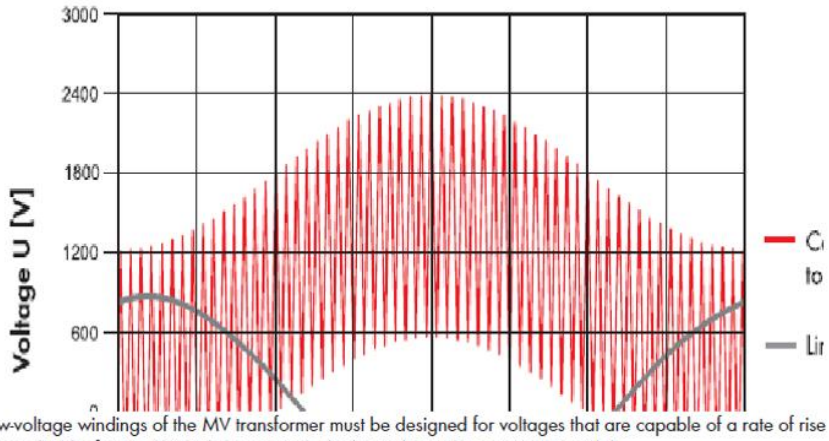
B. Minutes of Meeting held in Charlotte
C. Attendance was recorded on the roll

D. Technical Presentation on Inverter transformer Issues in C57.159

1. **Paragraph 5.1.2**:
   a. Needs to state that inverters are well filtered line to line and line to neutral but are not filtered line to ground.
   b. Needs to provide for inverters for IGBT switching devices that have pulse rates from 2 kHz to 20 kHz, with peak amplitudes from -2500 volts to + 2500 volts.

High Frequency Inverter with grounded neutral

☐ The power connection used must have suitable insulation resistance since voltages to grou
most occur when the inverter is in pulsed mode (see Section 4.1 "Technical data of the inv



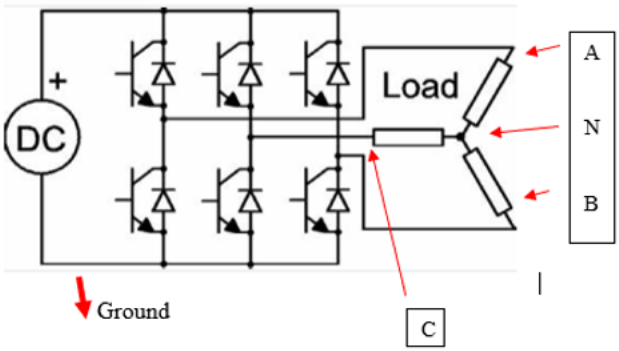
☐ The low-voltage windings of the MV transformer must be designed for voltages that are capable of a rate of rise in voltage dV/dt of up to 500 V/µs to ground. The line-to-line voltages are sinusoidal.

Note depending on inverter maker, commutating pulsed voltages can be 1500-2400 volts

2. **Paragraph 5.1.4** Needs to be revised to state that if a neutral is present that it must not be grounded, not just recommended. The reason for this is to prevent the following:

High Frequency Inverter with grounded neutral

B. The inverter circuit.



Here the Load is actually the 3 LV windings

a. If a Y-connected winding is grounded, then pulsed energy passes only through one winding and goes to ground and does not return through either of the other windings.
b. If the energy, which comes from a dc source passes through only one winding, the core becomes magnetized and saturates.

c. The high frequency pulses from the inverter, shown in figure 5 of paragraph 5.1.2 pass into the inverter transformer and draw high LV current due to core saturation, which result in damage or failure of the inverter transformer.
d. It is not clear whether nameplates need to specify that grounded neutrals are not allowed for inverters, but OK for ac only transformers.
e. Any testing should result in only power frequencies in the output voltage. This would not be the case when the LV is grounded.

3. **Paragraph 5.5.4 Electrostatic shield:**
    a. A shield needs to be included surrounding the core and grounded to prevent capacitive coupling of the core by the LV winding with resulting high interlaminar sheet to sheet core voltages that exceed the dielectric strength of the core sheet insulation
    b. A shield between LV and HV is normally included to prevent pulses to enter the HV winding.
    c. Any testing of core ground currents should be void of pulsed currents.

It was noted that on a Delta or Wye connected winding, pulses show up between neutral and ground or between line and ground. Then the high voltage (and pulses) is going to be at the start of the winding and capacitance will be present, which means that pulse energy will be sent to the core. There will be capacitance from the winding to the outside of the core and on either end. But in the middle there would be a ground current that results from capacitance.

Core material isn't able to take voltages between the laminations that are closest to the outside. Core can take 1/10 of a volt between laminations. For example, in a 3,000kVA transformer the volts per turn are equal to the square root of voltage on a single phase = 30-35 volts per turn.

A shield between the ground and the core makes sense for inverter transformers and mitigates the issue.

The current guide should be a standard. Recommendations should become mandates i.e. you may not ground the neutral.

E. Development of PAR: Hemchandra

Hemchandra introduced himself and further explained the issue. Invited others to join him on working on this issue. He plans to initiate the language for the PAR and will put this on the agenda for the subcommittee at the upcoming PCS meeting. He will try to have the PAR ready by the Fall meeting.

There was a suggestion that the scope should include testing as well.

F. Next Steps

- C57.159: Assigned to Performance Characteristics Subcommittee.
- Chair, proposed to be Hemchandra Shertukde.
- Identification of Secretary:

G. Next Meeting Kansas City October 23, 2023

H. Adjournment

Chair: Phil Hopkinson
Secretary: Jonathan Stewart

J.10 Performance Characteristics Subcommittee Attendance List

First Name	Last Name	Affiliation	Status
Kayland	Adams	Prolec-GE	Guest
Alex	Alahmed	Evergy	Guest
Mihir	Amin	EATON	Guest
Tauhid Haque	Ansari	Hitachi Energy	Member
Stephen	Antosz	Stephen Antosz & Associates, Inc	Member
Elise	Arnold	SGB	Guest
Javier	Arteaga	Hitachi Energy	Member
Alex	Ayala	Power Partners	Guest
Donald	Ayers	Ayers Transformer Consulting	Member
Robert	Ballard	DuPont	Member
Gilles	Bargone	FISO Technologies Inc.	Member
Christopher	Baumgartner	We Energies	Member
Barry	Beaster	H-J Family of Companies	Member
Jean-Noel	Berube	Rugged Monitoring Inc.	Guest
Enrique	Betancourt	Prolec GE	Member
Edwin	Betancourt	Siemens-Energy	Guest
Vivek	Bhatt	Prolec-GE	Guest
Daniel	Blaydon	Baltimore Gas & Electric	Member
William	Boettger	Boettger Transformer Consulting LLC	Member
Sanket	Bolar	Oncor Electric Delivery	Member
Susan	Bonfiglio	WAPA	Guest
Michael	Botti	Hyosung HICO	Guest
Jeffrey	Britton	Phenix Technologies, Inc./Doble Eng.	Member
Juan Alfredo	Carrizales	Prolec GE	Guest
Camilo	Casallas	TRENCH	Guest
Arup	Chakraborty	Delta Star Inc.	Guest
Vivian	Chan	Hitachi Energy	Guest
Eunyoung	Cho	HICO-America	Guest
Rhett	Chrysler	ERMCO	Guest
Craig	Colopy	Retired - EATON Corporation	Member-retired
Michael	Craven	Qualus Power Services	Guest
Daniel	Crockett	Ameren	Guest
Juan Carlos	Cruz Valdes	Prolec GE	Guest
Samson	Debass		Guest
J. Arturo	Del Rio	Siemens Energy	Member
Craig	DeRouen	ERMCO	Guest
Scott	Digby	Duke Energy	Guest
Nikolaus	Dillon	Dominion Energy	Guest
Samragni	Dutta Roy	Siemens Energy	Member

William	Elliott	AEP-SWEP CO	Guest
Evgenii	Ermakov	Hitachi Energy	Guest
Marco	Espindola	Hitachi Energy	Guest
Reto	Fausch	RF Solutions	Member
Marcos	Ferreira	Engineering Consultant Services	Guest
Hugo	Flores	Hitachi Energy	Member
Raymond	Frazier	Ameren	Member
Jose	Gamboa	H-J Family of Companies	Member
Miguel	Garcia	Hitachi Energy	Guest
Eduardo	Garcia Wild	Siemens Energy	Member
Carlos	Gaytan	Prolec GE	Guest
Rob	Ghosh	General Electric	Guest
Ramsis	Girgis	Hitachi Energy	Member
Rafael	Grajeda	EATON	Guest
Bill	Griesacker	Duquesne Light Co.	Member
Ismail	Guner	Hydro-Quebec	Member
Ravi	Gupta	Megger	Guest
Corey	Hanson	Advanced Power Technologies	Guest
Sergio	Hernandez Cano	Hammond Power Solutions	Member
Jean	Hernandez-Myia	Georgia Tech	Guest
John	Herron	Raytech USA	Member
Saramma	Hoffman	PPL Electric Utilities	Member
Ryan	Hogg	Bureau of Reclamation	Guest
Derek	Hollrah	Burns & McDonnell	Guest
Philip	Hopkinson	HVOLT Inc.	Member
Darren	Hoppins	Sensor Link Corp	Guest
Saif	Hossain	Trench Limited	Guest
Nicholas	Jensen	Delta Star Inc.	Guest
John	John	Virginia Transformer Corp.	Member
Akash	Joshi	Mott MacDonald	Member
Jerzy	Kazmierczak		Guest
Sheldon	Kennedy	Niagara Transformer	Member
Christoph	Kerschenbauer	Siemens Energy	Guest
Stacey	Kessler	Ulteig Engineers	Member
Egon	Kirchenmayer	Siemens Energy	Member
Dmitriy	Klempner	Southern California Edison	Guest
Anton	Koshel	Delta Star Inc.	Guest
Jusuf	Krvavac	Sargent & Lundy	Guest
Krzysztof	Kulasek	Delta Star Inc.	Guest
Bernard	LaBean, Jr.	Consumers Energy	Guest
Mark	Lachman	Doble Engineering Co.	Guest

Andrew	Larison		Guest
Moonhee	Lee	Hammond Power Solutions	Member
Weijun	Li	Braintree Electric Light Dept.	Member
Colby	Lovins	Federal Pacific	Guest
Jose Luis	Machain	Prolec GE-Waukesha	Guest
Tim-Felix	Mai	Siemens Energy	Member
Kumar	Mani	Duke Energy	Guest
James	McBride	JMX Services, Inc.	Member
Tim	Menter	Lincoln Electric System	Guest
Kent	Miller	T&R Electric Supply Co., Inc.	Guest
Francis	Mills	Power Engineers	Guest
Juliano	Montanha	Siemens Energy	Guest
Emilio	Morales-Cruz	Qualitrol Company LLC	Member
Hugo	Murillo	H-J Family of Companies	Guest
David	Murray	Tennessee Valley Authority	Member
Ryan	Musgrove	Oklahoma Gas & Electric	Member
Paul	Mushill	Ameren	Guest
Ismael	Naja	EATON	Guest
Aniruddha	Narawane	EATON Corporation	Member
Poorvi	Patel	Electric Power Research Institute (EPRI)	Member
Monil	Patel	Pacific Gas & Electric	Guest
Rakesh	Patel	Hitachi Energy	Guest
Harry	Pepe	Phenix Technologies, Inc.	Guest
Sylvain	Plante	Hydro-Quebec	Member
Klaus	Pointner	Trench Austria GmbH	Member
Bertrand	Poulin	Hitachi Energy	Guest
Jarrod	Prince	ERMCO	Member
Ulf	Radbrandt	Hitachi Energy	Member
Ion	Radu	Hitachi Energy	Member
Adnan	Rashid	Measurement Canada / ISED	Guest
Michael	Richardson	Ameren	Guest
Tim	Rocque	Prolec GE Waukesha	Member
Rodrigo	Ronchi	WEG-Voltran	Guest
Marnie	Roussell	Entergy	Member
Hakan	Sahin	Virginia/Georgia Transformer	Guest
Albert	Sanchez	Knoxville Utilities Board	Guest
Alberto	Sandoval Moreno	EATON Corporation	Guest
Dinesh	Sankarakurup	Duke Energy	Guest
Manish	Saraf	Hammond Power Solutions	Guest
Amitabh	Sarkar	Virginia Transformer Corp.	Guest
Daniel	Sauer	EATON Corporation	Member

Markus	Schiessl	SGB	Member
Ewald	Schweiger	Siemens Energy	Guest
Cihangir	Sen	Duke Energy	Guest
Salahuddin	Shaikh	Hitachi Energy	Guest
Abdul Majid	Shaikh	Delta Star, Inc.	Guest
Michael	Sharp	Trench Limited	Guest
Samuel	Sharpless	Rimkus Consulting Group	Member
Hemchandra	Shertukde	University of Hartford	Member
Stephen	Shull	BBC Electrical Services, Inc.	Guest
Christopher	Slattery	FirstEnergy Corp.	Member
Steven	Snyder	Hitachi Energy	Member
Jason	Snyder	First Energy	Guest
Sanjib	Som	Pennsylvania Transformer	Vice-Chair
Mauricio	Soto	Hitachi Energy	Guest
Brad	Staley	Leeward Renewable Energy	Guest
Kyle	Stechschulte	American Electric Power	Member
Andrew	Steineman	Delta Star Inc.	Guest
Charles	Sweetser	OMICRON electronics Corp USA	Member
Ali	Syed	Comed	Guest
Valeriu	Tatu	Powersmiths	Guest
Vijay	Tendulkar	EATON Corporation	Member
Ed	teNyenhuis	Hitachi Energy	Member
Jacob	Thielbar	WAPA	Guest
Scott	Thomas	Hitachi Energy	Guest
Subhash	Tuli	Electrical T&D Apparatus Consultant Inc.	Guest
Olivier	Uhlmann	Reinhausen Canada Inc.	Guest
Cole	Van Dreel	ATC	Guest
Cameron	Vant	Prolec GE-Waukesha	Guest
Ajith	Varghese		Member
Jason	Varnell	Doble Engineering Co.	Member
Joshua	Verdell	ERMCO	Guest
Dharam	Vir	Prolec-GE	Member
Richard	vonGemmingen	Dominion Energy	Guest
Pragnesh	Vyas	Sunbelt-Solomon	Guest
David	Wallach	Duke Energy	Member
Alan	Washburn	Burns & McDonnell	Guest
Joe	Watson	JD Watson and Associates Inc.	Member
Bruce	Webb	Knoxville Utilities Board	Member
Drew	Welton	Intellirent	Guest
Joe	White	Power Engineers	Guest
Jeffrey	Wright	Duquesne Light Co.	Member

Fei	Yang	Hitachi ABB Power Grids	Guest
Guang	Yuan	Hitachi Energy	Guest
Joshua	Yun	Virginia Transformer Corp.	Member
Malia	Zaman	IEEE	Guest
Kris	Zibert	Allgeier, Martin and Associates	Secretary
Waldemar	Ziomek	PTI Transformers	Member