Annex J Performance Characteristics Subcommittee (PCS)

October 19th, 2022, Sheraton Charlotte, Charlotte, NC

UNAPPROVED MINUTES

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

J.1 Introduction / Attendance

Quorum was achieved with 77 members present (71% in attendance). In addition, 86 guests were present at the meeting. The total attendance at the meeting was 163. 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 Milwaukee, WI, March 19-23, 2023.

J.2 Chairman's Remarks

The Chair gave the Chairman's Remarks.

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

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

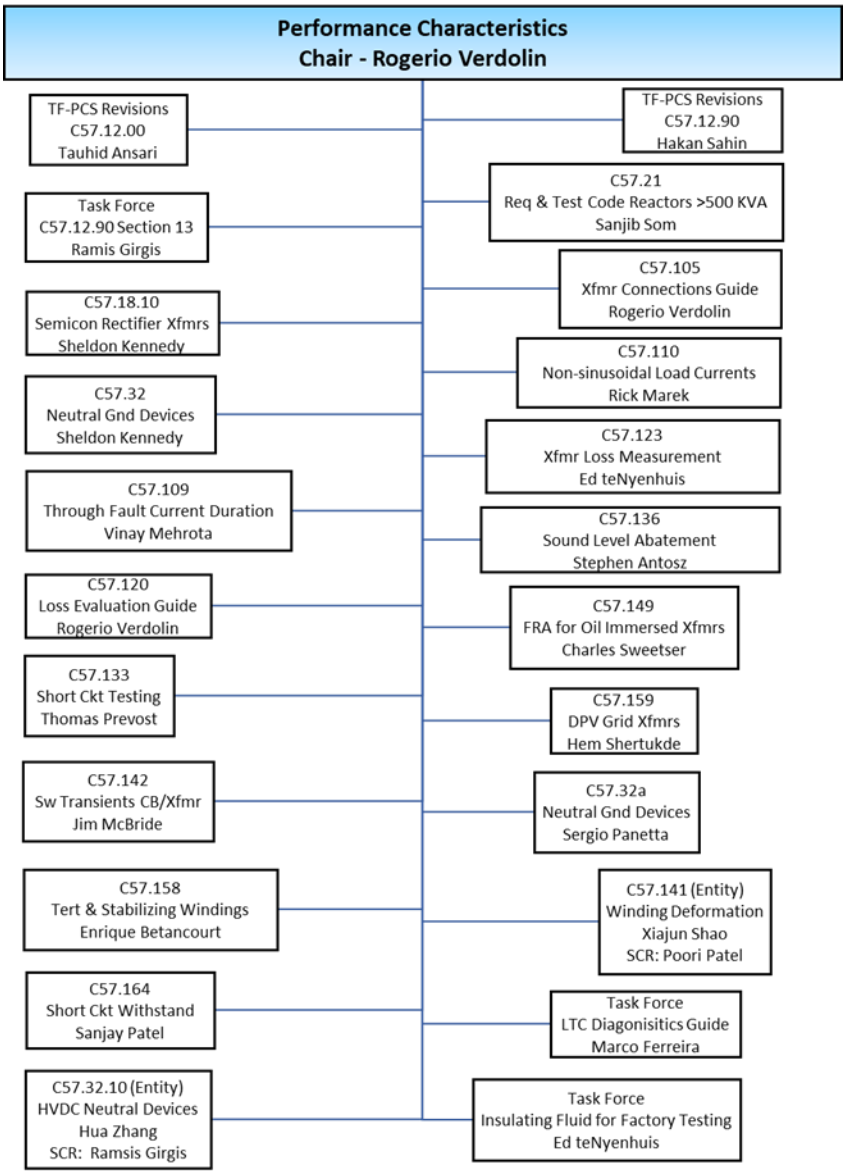
The Chair asked anyone with new business to submit in writing prior to the meeting.

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
- 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 – 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) – P. Hopkinson
- C57.164 – Short Circuit Withstand (in development) – S. Patel
- 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)
- 2025 PAR's
  - C57.136 Audible Sound Guide (New WG)
  - C57.141 Entity WG Guide for Detection, Monitoring and Evaluation of Winding Deformation

Status of Standards without active PARs

- 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)
- 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 8 Members missed the past 2 meetings and have been moved to "Guest" status:

- Irving Antweiler
- Neil Kranch II
- Rodrigo Ronchi
- Kushal Singh
- Israel Barrientos-Torres
- Arnaud Martig
- Mark Shem-Tov
- Matthew Weisensee

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

No Guests requested membership at the Spring 2022 meeting and have attended the past 2 of the last 3 meetings.

Attendance / Membership – Quorum determination

- Current breakdown of the Subcommittee:
  - 108 Members
  - 55 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 was made by P. Patel and seconded by D. Sauer. The motion passed by unanimous consent.

J.4 Approval of Last Meeting Minutes

The Chair presented the minutes of meeting held in March 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 H. Shertukde and seconded by P. Hopkinson. 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 Guide for App of Transf. Connections Corrig. - C57.105** **Rogerio Verdolin**
- **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

Highlights:

Meeting held Monday at 9:30 AM

- 62 in attendance, 32 members on the roster, 19 members attended, a quorum was achieved.
- The PAR expires this year. An extension was submitted.
- Revision is completed; grounding, connections, and analysis. A few items were discussed and edited regarding the connection table. PAR expires this year.
- A Motion was brought to the floor requesting the modified document as discussed in this meeting be sent to the PCS Subcommittee to prepare for ballot. The motion was carried unanimously.
- The C57.149 WG unanimously approved to move document to SA Ballot.
- Motion by C. Sweetser for PCS approval to move the document to SA Ballot. Seconded by D. Sauer. Motion was approved unanimously.

2) C57.105/Cor R. Verdolin

- This is the first meeting of this Corrigendum: Members:7, Guests:14, Total:21
- The Chairman informed the WG that this meeting was called to address errors found in the C57.105-2019 publication. No other section will be in scope during this corrigendum discussions.
- Chairman displayed a PowerPoint presentation detailing the differences between the 1978 version and 2019 versions. The errors found in the 2019 version related to the notes corresponding to Table 1.

- At the end of the presentation, the Chairman presented the final proposed table and notes with the appropriate corrections.
- Phil Hopkinson made a motion to approve the changes to Table and the amended notes, Ben Garcia seconded the motion. The WG approved the changes unanimously.
- Ben Garcia will add this approved wording into the IEEE Corrigendum Template for the Chairman to out for ballot. The next meeting, Milwaukee WI, the WG will spend the meeting time resolve ballot comments.
- Phil Hopkinson made a motion to send the Corrigendum to ballot, Ben Garcia seconded the motion and the WG approved the motion unanimously.
- Chairman Verdolin will request permission from the Performance Characteristics SC for approval to route the draft Corrigendum to ballot
- Motion by R. Verdolin for PCS approval to move the document to ballot. Seconded by D. Sauer. Motion was approved unanimously.

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

Meeting Date / Time : October 17th, 2022, @ 3:15PM to 4:30PM

- After scope and purpose for the Group, the Chair presented IEEE Copyright and Patent statements, with no issues raised by Members present.
- 87 total attendees, consisting of 46 Members and 41 Guests, so a quorum was achieved; 9 Guests requested membership. Agenda and Minutes from previous meeting were unanimously approved.

Highlights:

- Old Business
  - WG Item 112, Clarification on ±0.5% tolerance of ratio of three phase transformer, originally submitted by Ryan Hogg.
    - Motion to "*Create a TF to review Section 9.1 of C57.12.00 and provide recommendation on phase-to-phase ratio tolerance to this TF Group*" was proposed (D.Sauer, P.Hopkinson). The motion passed with R.vonGehmingen, D.Sauer and R.Hogg as first volunteers.
  - WG Item 113, Measurement of auxiliary loss, 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.
    - Motion to "*Assemble a group to propose new wording to Section 5.9 C57.12.00*" was proposed (A.Varghese, D.Sauer) and passed. Following individuals volunteered to participate: A.Varghese, H.Shertukde, D.Vir, J. Kazmierczak, S.Thomas, and K.Singh..
  - WG Item 114, Modification of Section 5.7.2 of C57.12.00, by Steve Antosz. "To add a requirement that the phasor group designation be the required IEEE nomenclature for identifying the angular displacement between windings for three-phase power and distribution transformers. C57.12.70 Standard Terminal Markings and Connections was revised and includes this slightly new requirement. This proposal harmonizes with IEC.
    - After group's discussion, Motion was proposed (S.Antosz, S.Som) to send survey within the PCS to investigate interest on modifying existing text. Motion passed unanimously.
  - With no New Business, the meeting was adjourned at 4:20.

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

- The WG met as scheduled. The meeting was attended by 31 members (out of 52), and 39 guests, for a total of 70 persons. There were 2 requests for membership. A quorum was established with 31 / 52 = 60% attendance. The agenda was unanimously approved as was the unapproved minutes from the previous meeting.
- Chairman Stephen Antosz presided over the meeting with Dr. Ramsis Girgis being the Vice-Chair, and Mats Bernesjo as Secretary.
- The Chair welcomed the audience, reviewed the agenda and reviewed the changes in the July 2022 circulated revision of the Guide, Draft 5.
- There were some minor comments to Draft 5 so the WG officers made appropriate revisions and we now have Draft 6.
- The WG Chair said that Draft 6 is now considered to be the Final technical version. Receiving no opposition to this nor no other items of Old or New Business, a motion was approved by 100% unanimous consent of the members to send the document to the Perf Char Subcommittee for procedural survey and approval to launch the IEEE-SA ballot.
- If that approval is received from the subcommittee, then the WG Chair will form the ballot pool, send Draft 6 to IEEE-SA for Mandatory Editorial Coordination (MEC)
- Hopefully, we will be able to launch the ballot before year-end.
- A few volunteers were solicited to form a Ballot Resolution Group (BRG), and be prepared to address any comments that will come back from the ballot.
- Motion by S. Antosz for PCS approval to move the document to ballot. Seconded by D. Sauer. Motion was approved unanimously.

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

- The TF met as scheduled. The meeting was attended by 29 members (out of 40), and 44 guests, for a total of 73 persons. There were 2 requests for membership. A quorum was established with 72 % of the membership attendance. The agenda was unanimously approved as was the unapproved minutes from the previous meeting
- The Chairman presided over the technical portion of the meeting while the Secretary presided over the Administrative portion
- The technical agenda included discussion of items previously brought up during, and after, balloting of Standard C57.12.90 – 2021.

These are: (1) Conditions of Core excitation for measuring core noise, (2) Method of adding ambient Sound Pressure level measurements, (3) Correction for Ambient Noise, (4) Measuring Load noise after the Heat-Run Test, (5) Measuring Load noise for ONAN-rated only transformers, and (6) Near-field correction for Pole Mount Transformers

- **Results from Discussions of items previously brought up during, and after, balloting of C57.12.90-2021:**
    - Text of Paragraph on the Standard Conditions of Core excitation for measuring core noise will be modified based on feedback from the meeting and will be proposed to the TF before the Spring 2023 meeting
    - The statement on determination of Ambient noise to say: "The ambient sound pressure level shall be established by logarithmically averaging….."
    - The suggestion that Ambient noise correction be made at each measuring point. was not accepted. Existing text need not be changed

- The suggestion of measuring Load noise after the Heat-Run Test was not accepted based on previous discussions and test data. Impact of Temperature on Load noise is explained in the new Noise Guide. No further action is needed
- Comment received that: Existing text in Clause 13 states that "load audible sound level shall be measured at the ONAF measuring Contour", which does not apply to ONAN-rated only transformers. The following statement will be added ***"For transformers with only an ONAN rating, load noise is to be measured at the ONAN Sound Measuring Contour"***
- Question received whether the 1 dB Near-Field correction applies to Sound measurement of Pole-mount transformers. The Chairman proposed that this correction be applied only to Power Transformers of ≥10 MVA rating.

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

Highlights:

- First Task Force meeting held on Monday 10/17/22, 4:45 PM
- 36 attendees
- Presentation given by Phil Hopkinson discussing the Line-to-Ground harmonics observed in transformers connected to IGBT inverters.
- Harmonics are filtered L-L, but not L-G.
- Capacitance between the LV winding and the core are inducing high voltages across the core laminations causing PD and gassing.
- Core shielding, by way of a sheet conductor that is grounded, has been used to eliminate the voltages across the core.
- TF recommends embedding in C57.159
- P. Hopkinson made a motion to have C57.159 take up adding information on core ground shields for DPV applications. Seconded by D. Sauer. Passed by unanimous consent.

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

- Meeting started on time at 9:30 am.
- Total attendance = 115
- Members = 34/72 No quorum, Guests = 72, Guests requesting membership = 9
- Introduced the new TF leadership
- Reviewed the old businesses which had already passed thru PCS survey, but had legitimate comments during the Spring-22 meeting. Had more discussions. The topics were:
  - Revision for the "Ratio tests voltage and frequency" under section 7.1.2
  - New test section "LTC tests" under load
  - Since both sections have already been approved by PCS, and no new critical comments were made, decision is to move on
- No additional new business
- Meeting adjourned at 10:20 am

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

- 73 total attendees. The WG achieved a quorum.
- Agenda was approved. The minutes of Spring 2022 meeting were also approved.
- Draft 10 Ballot is completed. Ballot Closed April 27, 2022. Ballot Group – 179. Response Rate - 75%. Approval Rate – 91%. Comments - 305
- PAR Extension ends December 31, 2023.

- Total Comments – 305. Editorial Required – 107. Editorial Not Required – 109. Technical Required – 67. Technical Not Required – 22. Draft 11 is Started. Editorial - 145 Addressed. Technical - 35 Addressed
- Meeting concentrated on fourth item (internal surge protection). Presentation by J. Montanha, presented by E. Kirchenmayer. Presentation will be on the website.
- Comment Resolution Group of 8 people has been formed and empowered to resolved comments provided all CRG members are in agreement:
    - Jim McBride
    - Xose Lopez
    - Tom Melle
    - Dave Caverly
    - Phil Hopkinson
    - Curtis Frazier
    - Akash Joshi
    - Klaus Pointner (figures)
- Report on IEE Switchgear Liaison Task Force to WG for Revision of C57.142 was made.

7) WG PC57.32.10 – Entity Oversight

Guide for the Selection of Neutral-Grounding Devices for HVDC Converter Transformers
Chairman: Hua Zhang; Contact: Bo Zhou

Email from Zhang Hua received on October 7th, 2022:
"At present, about 80% of the contents have been completed, and the technical points have been discussed clearly. The remaining work includes the normative review of standard text and syntax, patent and intellectual property rights review, etc. The fifth working group meeting is planned to be held at the end of 2022 and submitted after the final review.
The draft standard and the minutes of the fourth working group meeting will be sent to you as soon as they are sorted into English today."
Meeting Minutes sent on October 13th, 2022.
Working summary of IEEE PC57.32.10
4-4th Meeting Minutes draft of WG PC57.32.10

J.6 Unfinished (Old) Business

- There was no old business.

J.7 New Business

- E. Betancourt submitted a request for PCS to consider performance of transformers during continuous unbalanced loading conditions. E. Betancourt made a mtion to form a study group to investigate this condition and, if necessary, to set a limit for acceptable unbalanced operation conditions on C57.12.00 complaint transformers. Seconded by D. Vir. Motion passed by unanimous consent.

J.8 Adjournment

- The meeting adjourned at 3:15PM**.**

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: October 17, 2022 0930 H
Meeting Location: Charlotte, North Carolina
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 66 total attendees, consisting of 19 members and 47 guests. A quorum (19/31) was achieved.

AGENDA
1. Introductions and Attendance Sheets
2. IEEE-SA Standards Board Bylaws on Patents in Standards
3. Approval of Minutes from November 15, 2021, and March 28, 2022
4. Approval of Agenda
5. Discussions
    a. PAR Status
    b. Present final document to WG for comments regarding submission to PCS SC and the ballot process.
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.
19 members were present at this meeting, so a quorum was achieved.
The agenda and minutes were not approved; the WG will proceed with an email motion to approve the agenda and minutes.
CS noted that the PAR expires this year and so we need to prepare for balloting. Draft 3 is ready for ballot.

Noted Discussions:
Reviewed Agenda. Motion to accept Agenda. Approved.

Reviewed Patent information and Copyright Policy

Motion (Diego Robalino) to accept the last two sets of minutes (Spring/22 and Fall/21 meetings). Seconded. Carried.

Scrolled through the document to review.

Mario Locarno asked about the timeline for completing the document through publication.

Will Knapek moved that the document be approved for the next steps. Seconded by Wes Schrom. Discussion about Table 1 Connection Diagrams. Added wording to include reference to IEEE C57.12.70 for explanation of vector diagrams.

Will Knapek's motion was defeated (he wanted to withdraw it, but it needed to be dispositioned by a vote).

Motion to strike some extraneous wording on the explanation of Table 1. Seconded. Approved.

Mani Kumar moved to add wording to the grounding section regarding testing of tertiary windings. Seconded by Mario Locarno. "It is recommended that all tertiary delta windings should be closed and not grounded (if bushings are available externally)." Need to add a note to the connection Table 1 (add to note 1). Mani's motion carried unanimously.

Jason Varnell moved to send the modified document as discussed in this meeting to the SubCommittee to prepare for ballot. Wes Schrom seconded. Carried unanimously.

Revision tasks are wrapping up with the main focus on consolidated failure modes, connection tables, and analysis. The sections are solid and in good shape.

An edit was required in the new connection table. It was associated with Delta primaries. D1 was referenced when it should have been a D11. This was noted and the correction performed.

Some new wording was submitted by and reviewed by Wes Schrom regarding grounding. It is now in Draft 3.

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	Black & Veatch	Member
Jason Varnell	Doble	Member
Shibao Zhang	PCORE Electric	Member
Will Knapek	Omicron	Member
Jonathan Sinclair	PPL	Member
Scott Reed	MVA	Member
Kumar Mani	Duke Energy	Member
Wes Schrom	Carolina Dielectric	Member
Diego Robalino	Megger	Member
Mickel Saad	Hitachi Energy	Member
Egon Kirshenmayer	Siemens Energy	Member
Parminder Panesar	Virginia Transformer	Member
James McBride	JMX High Voltage	Member
Ismail Guner	Hydro Quebec	Member
Jesse Duffy	Nashville Electric Service	Guest
Don Doris	Nashville Electric Service	Guest
Marco Espindola	Hitachi Energy	Guest

Amitabh Sarkar	Virginia Transformer	Guest
Peter Heinzig	Weidmann	Guest
Gary King	Howard Industries	Guest
Kiran Vedante	Ritz Instrument Transformers	Guest
Kayland Adams	Waukesha	Guest
Herman Parrales	Waukesha	Guest
Steve Jordan	TVA	Guest
Chris Slattery	First Energy	Guest
Raymond Frazier	Ameren	Guest
Shawn Gossett	Ameren	Guest
David Murray	TVA	Guest
Bo Blackman	Southern Company	Guest
Duvier Bedoya	Hitachi Energy	Guest
Mama Mbouombouo	Hitachi Energy	Guest
Ajith Varghese	Prolec GE Waukesha	Guest
Cihangir Sen	Duke Energy	Guest
Richard Frye	Eaton	Guest
Gabriel Lopes Mamede	Siemens Energy	Guest
Alaor Scardazzi	Siemens Energy	Guest
Andy Speegle	Entergy	Guest
Samson Debass	EPRI	Guest
Fernando Salinas	Power Partners	Guest
Bruce Forsyth	Bruce Forsyth and Associates, LLC	Guest
Jean Carlos Hernandez	Georgia Tech	Guest
Rakesh Patel	Hitachi Energy	Guest
Eric Davis	Burns & McDonnell	Guest
Zan Kiparizoski	Howard Industries	Guest
Eduardo Garcia	Siemens Energy	Guest
Drew Welton	Intellirent	Guest
Oscar Pinon	OTC Services	Guest
Vivek Bhatt	Prolec Energy	Guest
Abdulmajid Shaikh	Delta Star	Guest
Lorna Gara	Shermco	Guest
Roger Hayes	GE Grid Solutions	Guest
Mike Miller	Siemens Energy	Guest
Jorge Cruz	Niagara Transformers	Guest
Leopoldo Rodriguez	Transformer Testing Services, LLC	Guest
Polo Orozco	GE Grid Solutions	Guest
Balakrishnan Mani	Virginia Transformer	Guest
Rogelio Martinez	Georgia Transformer	Guest
Mike Craven	Qualus Corp.	Guest
Evanne Wang	DuPont	Guest
Malia Zaman	IEEE-SA	Guest
Katrina Swanson	Southern Company	Guest

Respectfully submitted,

Charles Sweetser
Chair
C57.149 WG

J.9.2 C57.105/Cor.

Working Group "IEEE Guide for Application of Transformer Connections in Three-Phase Electrical Systems (Corrigendum)" PC57.105
(Performance Characteristics Sub-Committee)

Meeting Date/Time: October 17, 2022 11:00 AM – 12:15 PM
Meeting Location: Charlotte, North Carolina
Chairman: Rogerio Verdolin
Vice-Chair: Benjamin Garcia

1. **Attendance:**
   This is the first meeting of this Corrigendum
   - Members (out of 7): 7
   - Guests: 14
   - Total: 21
   - Quorum (4 required): YES

2. Meeting was called to order at 11:00am on Monday, October 17th, 2022.

3. The Chairman informed the WG that this meeting was called to address errors found in the C57.105-2019 publication. No other section will be in scope during this corrigendum discussions.

4. The Chairman was looking for a volunteer to fill the vice-chair role, Ben Garcia volunteered to fill that position during this corrigendum.

5. The Chairman informed the WG that they should only sign up as a member of the group if they plan to take an active role in the standards process.

6. The agenda was unanimously approved by the WG; no call for minutes approval as this is the first meeting back since the 2019 publication.

7. The Chairman discussed the Patent Slide in accordance with IEEE procedure.

8. The Chairman displayed the 2014 C57.12.31 Corrigendum as an example to the WG of what a Corrigendum is and what our task is to address the errors in C57.105.

9. The Chairman then displayed a PowerPoint presentation detailing the differences between the 1978 (the last approved version) and 2019 versions. The errors found in the 2019 version related to the notes corresponding to Table 1. The sub-notes for Table 1 (the text below the table) does not correspond with the numerical notes called out for in the table. At the end of the presentation, the Chairman presented the final proposed table and notes with the appropriate corrections.

10. Phil Hopkinson made a motion to approve the changes to Table and the amended notes, Ben Garcia seconded the motion. The WG approved the changes.

11. Ben Garcia will add this approved wording into the IEEE Corrigendum Template for the Chairman to out for ballot. The next meeting, Milwaukee WI, the WG will spend the meeting time resolve ballot comments.

12. Phil Hopkinson made a motion to send the Corrigendum to ballot, Ben Garcia seconded the motion and the WG approved the motion.

13. Chairman Verdolin will request permission from the Performance Characteristics SC for approval to route the draft Corrigendum to ballot

No Old Business:

- None

Next Steps:

- None

14. Meeting Adjourned at 11:35am
    - Motion: Sam Sharpless

Respectively submitted,

Rogerio Verdolin, Chair

Benjamin Garcia, Vice-Chair

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

Anton Koshel	Delta Star	Guest
Areeb Wazir	Eaton	Guest
Ben Garcia	Southern California Edison	Vice-Chair
Edwin Betancourt	Siemens Energy	Guest
Flip Mikulecky	Siemens Energy, KPT	Guest
Goran Plisic	Siemens Energy, KPT	Guest
John K. John	Virginia Transformer Corp.	Member
Juan Alfredo Carrizales	Prolec GE	Guest
Juliano Montanha	Siemens Energy	Request Membership
Jvijay Tendulkar	Eaton	Request Membership
Kushal Mahajan	Eaton	Request Membership
Marnie Roussell	Entergy	
Oliverio Sanchez	Pacific Gas & Electric	Guest
Paul Dolloff	EKPC	Guest
Phil Hopkinson	HVOLT Inc.	Member
Ramon Hayes	Dominion Energy, SC	
Rhea Montpool	Schneider Electric	
Roger Verdolin	Verdolin Solutions Inc.	Chair
Tim Tillery	Howard Industries	Guest
Val Tatu	Power Smiths	
Vivek Bhatt	Prolec Energy	Prolec

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: October 18, 2022 0930 H
Meeting Location: Charlotte, North Carolina
Chairman: Hakan Sahin
Vice-Chair: Pugal Selvaraj
Secretary: Adam Sewell

Meeting was called to order at 9:30 AM, October 18, 2022.

1. Administrative

a. IEEE Patent Policy and Call for Patents and IEEE SA Copyright Policy
   i. No comments from group

b. Introduction of the Task Force's new leadership
   i. Chair: Hakan Sahin
   ii. Vice-Chair: Pugal. Selvaraj-*new this meeting*
   iii. Secretary: Adam Sewell-*new this meeting*

c. Review of Fall 2022 agenda
   i. No comments from group

d. Introductions of the attendees
   i. Attendance sheets were passed out. Due to time constraints, chair did not have each attendee announce their name/affiliation
   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

e. Updated membership review and count for quorum
   i. 72 members were listed and 27 were counted as present by hand count. A second hand count was done a little later in the meeting and 34 members were counted. Based on the 2 hand counts, the chair announced there was NO QUORUM for this meeting.
   ii. Member list was presented ordered by first name. Going forward, member lists will be presented ordered by last name.
   iii. Attendance sheets after meeting completed showing 44 members attended.
   iv. **Members are expected to attend and stay in the meeting so business can be conducted.**

f. Approvals needed but not made due to lack of quorum:
   i. Spring 2022 minutes
   ii. Fall 2022 agenda

2. Old Business

a. Continuous discussions on the motion made for the approved revision for the "Ratio tests voltage and frequency" under section 7.1.2
    i. Discussions were brought up about wording of rated frequency wording
b. Continuous discussions on the new approved test sections 8.7 & 9.6 "LTC tests" under load
    i. Discussions were brought up related to the amount test setup changes may be needed to complete this test, and the time it would take as presented

3. New Business – request for new business discussions
a. No new business discussions brought up

4. Membership changes
a. Officers will look at attendance of members and change membership based on attendance before Spring 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: March 21, 2023 at Spring 2023 Transformer Committee Meeting scheduled for March 19-23, 2023, Milwaukee, WI, 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: 11/16/22

Annexure – A Meeting Attendance:

Kayland Adams	Prolec GE Waukesha	Guest
Harry Andrews	Bicron Electronics	Guest
Stephen Antosz		Member
Edmundo Arevalo	Bonneville Power Adm	Guest
Elise Arnold	SGB	Member
Onome Avanoma	MJC	Guest-RM1
Alex Ayala	Power Partners	Guest
Donald Ayers		Member
Gilles Bargone	FISO Technologies Inc.	Guest-RM1
Chris Baumgartner		Member
Duvier Bedoya	Hitachi Energy	Guest
Mats Bernesjo		Guest-RM1
Enrique Betancourt	Prolec GE	Guest
Daniel Blaydon		Member
William Boettger	Boettger Transformer Consulting LLC	Member
Sanket Bolar	Megger	Guest
Jeffrey Britton		Member
Darren Brown	Howard Industries	Guest
Steven Brzoznowski		Member
Jorge Cruz		Member
Domenico Cursi	Doble Engineering Co.	Guest

Thomas Dauzat		Guest-RM1
Everton De Oliveira	Siemens Energy	Member
Samson Debass	EPRI	Guest
Scott Dennis		Member
Scott Digby		Guest
Jeffrey Door	The H-J Family of Companies	Guest
Don Dorris	Nashville Electric Service	Guest
Jesse Duffy	Nashville Electric Service	Guest
Samragni Dutta Ray	Siemens Energy	Guest
William Elliott		Member
Hugo Flores	Hitachi Energy	Member
Marc Foata	Maschinenfabrik Reinhausen	Guest
Joseph Foldi		Member
Anthony Franchitti		Member
Raymond Frazier		Member
Richard Frye	EATON Corporation	Guest
Eduardo Garcia Wild	Siemens Energy	Guest
Ramsis Girgis		Member
Shawn Gossett		Guest-RM1
Bill Griesacker	Duquesne Light Co.	Member
Kyle Heiden		Guest
Sergio Hernandez Cano	Hammond Power Solutions	Guest
Giovanni Hernandez	Virginia Transformer Corp.	Guest
John Herron	Raytech USA	Member
Saramma Hoffman	PPL	Guest
Ramadan Issack	AEP	Guest-RM1
John John	Virginia Transformer Corp.	Member
Christopher Johnson	Oncor Electric Delivery	Guest
Stephen Jordan		Guest
Akash Joshi	Black & Vcatch	Member
Sheldon Kennedy	Niagara Transformer	Guest
Gary King		Member
Axel Krämer		Guest
Mark Lachman		Member
Fernando Leal	Prolec GE	Member
Weijun Li	Braintree Electric Light Dept.	Guest
Kumar Mani	Duke Energy	Guest
Lee Matthews	Howard Industries	Guest
Tim Menter	Lincoln Electric System	Guest
Aaron Meyers	EATON Corporation	Guest
Rhea Montpool		Guest
David Murray	TVA	Member
Volney Naranyo	Megger	Guest
Kristopher Neild	Megger	Guest
Dwight Parkinson	EATON Corporation	Guest
Herman Parrales	Prolec GE Waukesha	Guest
Sanjay Patel	Smit Transformer	Member
Verena Pellon	FPL	Guest
Harry Pepe		Member
Jarrod Prince		Guest
Ion Radu	Hitachi Energy	Member

Sebastian Rehkopf	Maschinenfabrik Reinhausen	Guest
Michael Richardson	Ameren	Guest
Leopoldo Rodriguez	Transformer Testing Services LLC	Guest
Hakan Sahin	Virginia/Georgia Transformer	Chair
Fernando Salinas	Power Partners	Guest
Amitabh Sarkar	Virginia Transformer Corp.	Member
Daniel Sauer		Member
Markus Schiessel		Member
Eric Schleismann	Southern Company	Guest
Dan Schwartz	Quality Switch, Inc.	Guest
Pugal Selvaraj	Virginia Transformer Corp.	Vice-Chair
Adam Sewell	Quality Switch, Inc.	Secretary
Hemchandra Shertukde		Member
Avijit Shingari	Pepco Holdings	Guest
Abdul Majid Shoukh	Delta Star Inc.	Guest
Jin Sim	Jin Sim & Associates	Guest
Kushal Singh		Guest
Chris Slattery		Guest-RM1
Sanjib Som		Guest-RM1
Mike Spurlock	Spurlock Engineering Svcs	Member
Kyle Stechschulte	AEP	Guest
Andrew Steineman		Guest
Kerwin Stretch	Siemens Energy	Guest
Shankar Subramany	KEMA Netherlands	Member
Charles Sweetser	Omicron	Guest
Matthew Sze	Omicron	Guest
Marc Taylor	JFE Shoji Power Canada Inc.	Guest
Ed teNyenhuis	Hitachi Energy	Member
Scott Thomas	Hitachi Energy	Guest
Cole Van Dreel	American Transmission Company	Guest
Ajith Varghese	Prolec GE Waukesha	Member
Jason Varnell	Doble Engineering Co.	Member
Krishnamurthy Vijayan		Member
Pragnesh Vyas	Sunbelt Solomon	Guest-RM1
Matthew Weisensee		Guest
Zachery Weiss	WEG	Guest
Drew Welton		Guest
Baitun Yang	R.E. Uptegraff	Member
Kwasi Yeboah	GE Grid Solutions	Guest
Waldemar Ziomek	PTI Transformers	Guest

J.9.4 WG PC57.136 Noise Guide

Unapproved Minutes of Fall 2022 WG IEEE PC57.136, "Guide for Audible Sound of Liquid-Immersed Power Transformers"

The work group met at 1:45 PM, on Monday, October 17, 2022, as part of the WG PCS Guide for Audible Sound of Liquid-immersed Power Transformers. Chairman Steve Antosz presided over the meeting with Dr. Ramsis Girgis being the Vice-Chair, and Mats Bernesjo, Secretary.

The meeting was attended by 31 members (out of 52) and 39 guests, for a total meeting attendance of 70 persons. Two attendees requested membership at this meeting.* A quorum was established with 31 / 52 = 59 % attendance. The agenda was unanimously approved as was the unapproved minutes from the previous meeting (Spring meeting, Denver 2022).

First, the Chairman welcomed the audience to this meeting, reviewed the agenda, and commented on the latest circulated revision of the Guide.

Dr. Girgis then presented new additions to the Guide since last meeting. Some of these were partly in response to previous requests from Power Transformer users and some were new information added to the Guide.

The following items were added to the text of the Guide:

- A section on magnitude of Variability of measured sound level of Core and Load noise of transformers of the same design (Section 3.2.6)
- A statement, or two, related to the following items:
    a) When to perform core noise measurements, before or after dielectrics tests (Section 3.3.1)
    b) Noise impact of current limiting reactors (Section 4.2)
    c) Magnetostriction (Section 5.1.2)
    d) Impact of Sound Panels and Sound Enclosures on transformer Cooling (Section 5.4.3 and 5.4.4) and Figure 9 was updated.
    e) Active Noise Cancellation using loudspeakers (Section 6.2)

Additionally, editorial improvements were made throughout the Guide

Also, the Bibliography was updated as follows:

a) Added some new References
b) Subdivided the whole list of references into sections corresponding to content of the Guide
c) Arranged the references in each section in an alphabetical order

Finally, References in the text of the Guide were limited to where information in the Guide:

a) Is taken directly from the reference
b) Where more information on the subject is available in these references.

Finally, a motion to move the Guide to the PCS was held and was unanimously approved. It is now the task of the WG Chair to begin the process of having a formal IEEE-SA Ballot. The WG Chair will form a ballot pool, initial volunteers to this pool are Dr. Ramsis Girgis, Eduardo Garcia, David Wallach, and Mats Bernesjo, and to send the final draft of the Guide to IEEE-SA for Mandatory Editorial Coordination (MEC).

' They are from Mark Lachman (Doble) and Tim Rocque (Prolec-GE Waukesha).*

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

Respectfully submitted,

Mats Bernesjo, WG Secretary

Fall 2022 WG Meeting Attendance and Affiliation is as follows:

Mohammed Al Yousuf	PSE&G LI	Guest
Stephen Antosz	Stephen Antosz & Associates, Inc.	Chair
Elise Arnold	SGB	Member

Javier Arteaga	Hitachi Energy	Member
Onome Avanoma	MJ Consulting	Member
Barry Beaster	H-J Family of Companies	Guest
Mats Bernesjo	Hitachi Energy	Secretary
Enrique Betancourt	Prolec GE	Member
Edwin Betancourt	Siemens Energy	Guest
William Boettger	Boettger Transformer Consulting LLC	Member
Darren Brown	Howard Industries	Guest
Steven Brzoznowski	Bonneville Power Administration	Member
Juan Alfredo Carrizales	Prolec GE	Guest
Camilo Casallas	Trench Limited	Guest
David Caverly	Trench Limited	Guest
Jorge Cruz	Niagara Transformer	Guest
Juan Carlos Cruz Valdes	Prolec GE	Member
Everton De Oliveira	Siemens Energy	Member
Scott Dennis	Hitachi Energy	Member
Scott Digby	Duke Energy	Member
Nik Dillon	Dominion Energy	Guest
Marco Espindola	Hitachi Energy	Guest
Thomas Falkenburger	Coil Innovation USA	Guest
Hugo Flores	Hitachi Energy	Member
Joe Foldi	F&A	Guest
Eduardo Garcia Wild	Siemens Energy	Member
Alexander Gaun	Coil Innovation GmbH	Guest
Jeff Gragert	Xcel Energy	Guest
Ismail Guner	Hydro-Quebec	Member
Ramon Hayes	Dominion Energy	Guest
Anirudhdhsinh Jhala	Transformers & Rectifiers	Guest
Jerzy Kazmierczak	Hitachi Energy	Member
Gael Kennedy	GR Kennedy & Associates LLC	Guest
Egon Kirchenmayer	Siemens Energy	Guest
Mark Lachman	Doble	Guest*
Don Lowman	Dominion Energy	Guest
Mama Mbouombouo	Hitachi Energy	Guest
Aaron Meyers	EATON Corporation	Guest
Joe Nims	Allen & Hoshall	Guest
Tomas Olsson	Hitachi Energy	Guest
Marcin Pietraszczyk	Hitachi Energy	Guest
Oscar Pinon	OTC Services	Guest
Sylvain Plante	HQ	Guest
Klaus Pointner	Trench Austria GmbH	Member
Ulf Radbrandt	Hitachi Energy	Guest
Ion Radu	Hitachi Energy	Member
Rakesh Rathi	Virginia Transformer Corp.	Guest
Pierre Riffon	Pierre Riffon Consultant Inc.	Guest
Tim Rocque	Prolec GE Waukesha	Guest*
Daniel Sauer	EATON Corporation	Member
Markus Schiessl	SGB	Member
John Sen	Duke Energy	Member
Devki Sharma	Entergy	Guest
Michael Sharp	Trench Ltd Canada	Guest

Andre Simons	JFE Shoji	Member
Kushal Singh	ComEd	Guest
Christopher Slattery	FirstEnergy Corp.	Member
Sanjib Som	Pennsylvania Transformer	Member
Andy Steineman	Delta Star Inc.	Guest
Troy Tanaka	Burns & McDonnell	Guest
Marc Taylor	JFE Shoji Power Canada Inc.	Member
Ryan Thompson	Burns & McDonnell	Guest
Ajith Varghese	SPX Transformer Solutions, Inc.	Member
Kiran Vedante	Ritz Instrument Transformers	Member
Rogerio Verdolin	Verdolin Solutions Inc.	Member
Dharam Vir	SPX Transformer Solutions, Inc.	Member
David Wallach	Duke Energy	Member
Jeffrey Wright	Duquesne Light	Guest
Fang Zhu	R.E. Uptegraff	Guest
Kris Zibert	Allgeier Martin	Guest

**Requested membership*

J.9.5 TF PCS Audible Sound Revision to Test Code C57.12.90-2021

The Task Force met at 1:45 PM, on Monday, October 17, 2022. 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 2021 meeting, the membership was adjusted to 40 members. There was 29 of 40 members with a total of 73 persons in attendance. A quorum was established with 72.5 % of the membership. A call was made for any objections for a unanimous approval of the Fall 2021 TF minutes; no objections were raised so minutes are approved as written. A shared agenda with the Sound Guide, C57.136, was presented without objections for approval. Six requests for membership have been reviewed.
The technical agenda items included a discussion of items previously brought up during, and after, balloting of Standard C57.12.90 – 2021. These are:

1. Core excitation for measuring core noise
2. Method of adding ambient Sound Pressure level measurements
3. Correction of Ambient Noise
4. Measuring Load noise after the Heat-Run Test
5. Measuring Load noise for ONAN rated only transformers
6. Near-field correction for Pole Mount Transformers

The discussion included presentation of the existing text, the comments received, and the proposed resolution for each of the comments received.

Item 1 – Core Excitation for Measuring Core Noise
The comment received on this section was that 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. The issue here is that this relates to three different situations, namely:

- Operating at greater than rated core flux density because of a tap position
- Power Transformers with Preventive Autotransformers operating at a bridging tap position
- Variable Flux and SVC Transformers

An active discussion, by several attendees regarding the tap position used for core noise measurements, included the following:

- Testing at a bridging Tap position should include the case with a Series Transformer. The Chairman agreed and commented that typically the contribution of noise from PAs and Series Transformers is very small, except in cases of noisy PAs caused by manufacturing or design issues.
- It was proposed that the supplier can determine the tap position to provide the highest no-load sound pressure level.
- Concerns, for a requirement for testing at operating conditions corresponding to worst case, were raised concerning the cost of meeting guarantees at such operating conditions. It was suggested that such a request needs to be defined by the user in the Specification if needed.
- For Variable Flux Transformers and SVC Transformers, Customer Specifications typically request noise testing, and sometimes guaranteeing, at highest core flux density

Based on the above discussion, a modified text for this paragraph of the Standard will be proposed to the TF before the Spring 2023 meeting.

Item 2 – Method of adding ambient Sound level measurements
The comment received on this section indicated that the text does not specify whether to add ambient sound pressure measurements arithmetically or logarithmically. The Chairman requested the attendees to consider the following:

- The difference between adding the Ambient noise measurements Logarithmically or Arithmetically is typically a fraction of 1 dB
- When there are significant differences between individual ambient noise measurements, the Arithmetical Sum gives a lower average ambient and lower ambient correction, but the logarithmic sum is more correct

The TF agreed to modify the statement to say: "*The ambient sound pressure level shall be established by logarithmically averaging….."*

Item 3 – Ambient Sound Pressure level correction
The comment received on this item is whether the Ambient noise correction be made at each measuring point. The Chairman commented that this would not be correct, and that the existing text is correct. The group agreed, so no further action is needed.

Item 4 – Measuring Load noise after the Heat-Run test
The comment received was whether Load noise should be measured after the Heat-Run test. The Chairman responded that this item was discussed in great detail at previous meetings of this TF. Test data showed that the impact of temperature on Load noise is small, and it is + / - depending on the design of the transformer. Also, text on this impact has already been incorporated in the Noise Guide, PC57.136. The group consensus agreed no further action is needed.

Item 5 – Measuring Load noise for ONAN rated only transformers
The comment received on this item was that existing text in Clause 13.3.3.2: Load audible sound level states that "*load audible sound level shall be measured at the ONAF measuring contour*". A comment was received that there are some transformers are only ONAN rated. It was agreed by the group to add the following statement at the end of the existing statement.
"*For transformers with only an ONAN rating, load noise is to be measured at the ONAN Sound Measuring Contour"*

Item 6 – Near-field correction for pole mount transformers
The question received on this is: Should the 1 dB Near-Field correction be applied to Sound measurement of Pole-mount transformers? The Chairman responded that tThe 1 dB subtraction is meant to account for the reactive sound power that typically exists in the close vicinity of Power Transformer Tank and does not propagate. Therefore, it does not impact sound levels at a distance from the transformer. So, the question is: What size or type of transformers this correction should not apply to? He proposed that this correction be applied only to Power Transformers of $\geq$10 MVA rating.

Several alternative MVA values were proposed, such as 5 MVA or 1 MVA. It was also suggested to use kVA versus MVA as this is the general unit in the standard. It was commented at the meeting that the location and placement in the substation can affect whether this correction is necessary. In most cases, this correction is generally not needed for small transformers.

The chairman agreed to consider the feedback obtained at the meeting and would make appropriate updates to be reviewed by the group before the Spring meeting of the TF.

Since time had expired, the meeting was adjourned.

Respectfully submitted,
Barry Beaster, TF Secretary

Fall 2022 Meeting Attendance

Mohammed Alyousuf	PSEG LI
Stephen Antosz	Stephen Antosz & Associates, Inc.
Elise Arnold	SGB
Javier Arteaga	Hitachi Energy
Onome Avanoma	MJ Consulting
Barry Beaster	H-J Family of Companies
Mats Bernesjo	Hitachi Energy
Enrique Betancourt	Prolec GE
Edwin Betancourt	Siemens Energy
William Boettger	Boettger Transformer Consulting LLC
Darren Brown	Howard Industries
Juan Alfredo Carrizales	Prolec GE
Camilo Casallas	Trench Limited
David Caverly	Trench Limited
Everton De Oliveira	Siemens Energy
Scott Dennis	Hitachi Energy
Scott Digby	Duke Energy
Nickolaus Dillon	Dominion Energy
Marco Espindola	Hitachi Energy
Thomas Falkenburger	Coil Innovation USA, Inc.
Hugo Flores	Hitachi Energy
Joseph Foldi	Foldi & Associates, Inc.
Eduardo Garcia Wild	Siemens Energy
Ramsis Girgis	Hitachi Energy
Ramon Hayes	Dominion Energy S.C.
John John	Virginia Transformer Corp.
Jerzy Kazmierczak	Hitachi Energy

Egon Kirchenmayer	Siemens Energy
Mark Lachman	Doble Engineering Co.
Don Lowman	Dominion Energy S.C.
Mama Mbouombouo	Hitachi Energy
Aaron Meyers	Eaton
Tomas Olsson	Hitachi Energy
Sylvain Plante	Hydro-Quebec
Klaus Pointner	Trench Austria GmbH
Ion Radu	Hitachi Energy
Rakesh Rathi	Virginia Transformer Corp.
Tim Rocque	SPX Transformer Solutions, Inc.
Amitabh Sarkar	Virginia Transformer Corp.
Markus Schiessl	SGB
Cihangir Sen	Duke Energy
Devki Sharma	Entergy
Michael Sharp	Trench Limited
Andre Simons	Cogent Power Inc.
Christopher Slattery	FirstEnergy Corp.
Sanjib Som	Pennsylvania Transformer
Troy Tanaka	Burns & McDonnell
Marc Taylor	JFE Shoji Power Canada Inc.
Ajith Varghese	SPX Transformer Solutions, Inc.
Jason Varnell	Doble Engineering Co.
Kiran Vedante	Ritz Instrument Transformers
Rogerio Verdolin	Verdolin Solutions
Krishnamurthy Vijayan	PTI Transformers
David Wallach	Duke Energy
Jeffrey Wright	Duquesne Light Co.

J.9.6 TF PCS Continuous Revisions to C57.12.00

PCS Task Force on General Requirements C57.12.00

Performance Characteristics Subcommittee
IEEE / PES Transformers Committee

October 17, 2022
Charlotte, North Carolina (USA)

UNAPPROVED MINUTES

The PCS Task Force on General Requirements for C57.12.00 met at 3:15 PM on Monday, October 17, 2022. 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 46 members (out of 57), 41 guests, for a total meeting attendance of 87 persons, including 9 requests for membership at this meeting. A quorum was established with 46 / 57 = 81 % attendance.
The agenda was unanimously approved (1st Dan Sauer, 2nd Ryan Musgrove) as was the unapproved minutes (1st Hugo Flores, 2nd Dan Sauer) from the previous meeting (Spring meeting, Denver 2022).

The following **9** guests requested membership:

Nik Dillon	Dominion Energy
Richard vonGemmingen	Dominion Energy
Kayland Adams	Prolec-GE Waukesha
Baitun Yang	R.E. Wortegraft
Jerzy Kazmierczak	Hitachi Energy
Shankar Subramany	KEMA Netherlands
Elise Arnold	Starkstrom Geretebau GmbH
Michael Craven	Qualus Power Services
Hemchandra Shertukde	University of Hartford

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"

In this meeting, Dan Sauer asked the motion to be restated and a lengthy discussion followed this particular topic with input from Ryan Musgrove, Dan Sauer, Javier Arteaga, Ajith Varghese, Tauhid Ansari, and Krishnamurthy Vijayan.
Discussed:

- Whether this is a test issue
- Can 1 % between two phases be accepted although each of the measured values per phase is within the tolerance
- New people in the Industry pushing transformers through test without considering the end result
- Discrepancies between turns & voltage ratios, a 1 turn error may cause this tolerance to be exceeded
- Not indicative of a manufacturing issue but rather a testing issue
- Consider the difference between two phases in the design
- Maybe the proposed 0.5 % ratio is too strict?
- Come up with a definition of the acceptable deviation between phases that can also explain the difference and not automatically pass a transformer during test

- Needs to be investigated but we do need to have a limit. This is important when the transformer is commissioned on-site by field technicians.

It was agreed upon to modify the motion and to vote on this topic.

Vote: 27 agree, 5 oppose, and 10 abstain
Motion passed to create a TF with Richard vonGemmingen as the chair, Dan Sauer and Ryan Hogg as participants.

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

"I see there is some disconnect between what different manufactures 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 need 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.

Motion proposed by Ajith Varghese, seconded by Dan Sauer: "To reword Section 5.9, taking as reference text below (Okay for TF to define the wording)":

"For Class II transformers (See 5.10), control/Auxiliary (~~Cooling~~) losses shall be measured and reported on test report for each cooling stages individually.

Measured value of losses shall be reflective of maximum power (Wattage) that is needed to power the Cooling and Control/Auxiliary devices supplied with the transformer.

Control/Auxiliary devices shall include Heaters, Regenerative breathers, Tap changer operation, Electronic monitors/Analyzers, Oil filters, Nitrogen Generators devices etc.

Some of the devices may need higher wattage at starting. Measured/reported value shall be reflect wattage during normal operation.

If there are devices that are operated only at set condition(like heater based on cold ambient) and test can't be performed under factory test conditions, wattage under those condition shall be added to measured losses"

Ajith Varghese stated that his motion would not change the text suggested above conceptually. A short discussion followed whether to assemble a group to "reword C57.12.00 Section 5.9". It was decided to vote on the motion to assemble a group to work on the updated text.

Vote: 31 agree, 0 oppose, and 8 abstain

Motion to assemble a group to reword this section passed

This group will be assembled as follows: Ajith Varghese, Shertukde Hemchandra, Dharam Vir, Jerzy Kazmierczak, Scott Thomas, Tauhid Ansari and Kushal Singh.

WG Item 114, Modification of Sec 5.7.2
Submitted by Steve Antosz

I propose that we add a requirement that the phasor group designation (also known as: vector group or clock number notation) be the required IEEE nomenclature for identifying the angular displacement between windings for three-phase power and distribution transformers. The reason I am suggesting this is because C57.12.70 Standard Terminal Markings and Connections was revised and includes this slightly new requirement in Clause 7. See attached C57.12.70-2020 Clause 7 and Annex A. 12.00 already refers to 12.70 in subclauses 5.7.2 and 5.7.3; and most Product Standards refer to 12.70 also. So, I am proposing that we enhance 12.00 to highlight the requirement that the phasor group designation be shown on the transformer's nameplate. The nomenclature is detailed in 12.70. This proposal also harmonizes with IEC, for whatever that's worth.

Motion # 1:

Add the following sentence at the end of the second paragraph in Subclause 5.7.2:

"The phasor group designation (vector group) shall be shown on the transformer's nameplate, near the phasor diagram."

Motion # 2:

Revise existing Figure 1 to describe the phasor group designation for the four example connections given, as: Dd0, Yd1, Yy0, Dy1

Motion # 3:

Revise Table 6, Row 11 for Nameplates A, B, and C. Change; "Phasor Diagram" to "Phasor Diagram and Phasor Group Designation"

A short discussion followed the above topic (Steve Antosz, Dan Sauer, Jason Varnell, and Hakan Sahin) including: Is there enough interest in the TF to change this? Field Technicians often ask for this information, having it on the nameplate would help. Should this be included in C57.12.00? C57.12.70 is the right place for this motion. Should we wait until the spring meeting to check with manufacturers to see if there is space on the nameplate?

It was decided to vote on the motion (Steve Antosz, Sanjib Som) to send this topic to the subcommittee (PCS) to get more input.

Vote: 37 agree, 0 oppose, and 0 abstain

Motion to send it to PCS passed

Chairman Tauhid Ansari asked whether there was any new business. With a quiet floor, the Chairman asked for the meeting to be adjourned.

Meeting was adjourned at 4:20 PM (Motion Dan Sauer, Second Hugo Flores)

Respectfully submitted,

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

Attendance Fall 2022 Meeting – PCS TF to Revision C57.12.00

Kayland Adams	Prolec-GE Waukesha	Guest (RM)
Tauhid Haque Ansari	Hitachi Energy	Chair
Stephen Antosz	Stephen Antosz & Associates, Inc.	Member
Elise Arnold	Starkstrom Geratebau GmbH	Guest (RM)
Javier Arteaga	Hitachi Energy	Member
Alex Ayala	Power Partners	Guest
Donald Ayers	Ayers Transformer Consultants	Guest
Christopher Baumgartner	WE Energies	Member
Duvin Bedoya	Hitachi Energy	Guest
Mats Bernesjo	Hitachi Energy	Secretary
Enrique Betancourt	Prolec GE	Vice Chair
Edwin Betancourt	Siemens Energy	Guest
Daniel Blaydon	Baltimore Gas & Electric	Member
William Boettger	Boettger Transformer Consulting LLC	Member
Sanket Bolar	Oncor Electric Delivery	Member
Darren Brown	Howard Industries	Member
Steven Brzoznowski	BPA	Guest
Michael Craven	Qualus Power Services	Guest (RM)
Jorge Cruz	Niagara Transformer	Guest
Eric Davis	Burns & McDonnell	Guest
Everton De Oliveira	Siemens Ltda	Member
Nikolaus Dillon	Dominion Energy	Guest (RM)
Don Dorris	Nashville Electric Service	Member
Fernando Duarte	ABB	Guest
Samradin Dutton	Siemens Energy	Guest
Hugo Flores	Hitachi Energy	Member
Joseph Foldi	Foldi & Associates, Inc.	Guest
Anthony Franchitti	PECO	Member
Raymond Frazier	Ameren	Guest
Eduardo Garcia Wild	Siemens Energy	Member
Ramsis Girgis	Hitachi Energy	Member
Shawn Gossett	Ameren	Member
Bill Griesacker	Duquesne Light	Guest
Shertukde Hemchandra	University of Hartford	Guest (RM)
John Herron	Raytech USA	Member
Ryan Hogg	USBR	Member
Phil Hopkinson	HVOLT Inc.	Member
John John	Virginia Transformer Corp.	Member

Christopher Johnson	Oncor	Guest
Steven Jordan	TVA	Member
Akash Joshi	Black & Veatch Inc.	Member
Jerzy Kazmierczak	Hitachi Energy	Guest (RM)
Sheldon Kennedy	Niagara Transformer	Guest
Zan Kiparizoski	Howard Industries	Member
Anton Koshel	Delta Star Inc.	Guest
Mark Lachman	Doble	Member
Joseph Machain	Prolec GE	Guest
Rogelio Martinez	Georgia Transformer	Guest
Alberto Martinez	WEG	Guest
Aaron Meyers	Eaton	Guest
Paul Mushill	Ameren	Guest
Shankar Nambi	Bechtel Energy, Inc.	Member
Volney Naranyo	Megger	Guest
Kristopher Neild	Megger	Member
Joe Nims	Allen & Hoshall	Member
Jonas Oliveira	Hitachi Energy	Guest
Sanjay Patel	SMIT Transformers	Member
Jarrod Prince	ERMCO	Member
Ulf Radbrandt	Hitachi Energy	Guest
Ion Radu	Hitachi Energy	Guest
Hossein Rezas	Transformer Consultant, Inc.	Guest
Marnie Roussell	Entergy	Member
Hakan Sahin	Virginia / Georgia Transformers	Member
Dinesh Sankarakurup	Duke Energy	Guest
Amitabh Sarkar	Virginia Transformers	Member
Daniel Sauer	Eaton Corporation	Member
Markus Schiessl	SGB	Member
John Sen	Duke Energy	Member
Jin Sim	Jin Sim & Associates	Guest
Kushal Singh	ComEd	Guest
Kenneth Skinger	Scituate Consulting Inc.	Guest
Christopher Slattery	FirstEnergy Corp	Member
Steven Snyder	Hitachi Energy	Member
Sanjib Som	Pennsylvania Transformers	Member
Andrew Steineman	Delta Star Inc.	Guest
Shankar Subramany	KEMA Netherlands	Guest (RM)
Ed teNyenhuis	Hitachi Energy	Member
Scott Thomas	Hitachi Energy	Guest
Alan Traut	Howard Industries	Guest
Ajith Varghese	Prolec-GE	Member
Jason Varnell	Doble Engineering Co.	Member
Krishnamurthy Vijayan	PTI Transformers	Member
Dharam Vir	Prolec-GE Waukesha	Member
Richard von Gemmingen	Dominion Energy	Guest (RM)
David Wallach	Duke Energy	Member
Baitun Yang	R.E. Uptegraff	Guest (RM)
Kris Zibert	Allgeier Martin	Member

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

TF Inverter Transformer Precautions on Ground Shields C57.159
Unapproved Meeting Minutes
Fall 2022 Meeting
Charlotte, NC
4:45 pm, Monday, October 17

The Task Force met at the Sheraton, Charlotte, NC– Symphony 2,3 Conference Room. The meeting was called to order at 4:45PM by Chair - Phil Hopkinson.

First task force meeting – 36 in attendance

Informative Presentation: Phil Hopkinson

- **SUMMARY**
- Step-Up transformers connected to IGBT (inverter) devices are typically connected phase-to-phase as a delta connection or as a wye with an ungrounded (floating) neutral.
- Unusual gassing and overheating have been recorded with transformers used in this application
- Phase-to-ground high frequency harmonics are observed.
- DGA analysis showed elevated levels of Hydrogen and Methane
- Transformer tear-down showed evidence of carbon traces between LV winding and coil and discolored fiberglass tape on the outer laminations, suggesting partial discharge.
- Post tear-down analysis shows that capacitances between the LV winding and the core are causing excessive lamination-to-lamination voltages.
- Due to the dielectric property differences between mineral oil and FR3, the voltages across the core are higher in MO than FR3
- Core shielding with a sheet conductor that is subsequently grounded has been successfully used to prevent the voltages across the core.

Discussion following the presentation:

- The Task Force recommends placing this information into C57.159 where inverter transformers are used.
- Other solutions may be applied but this writeup is quite descriptive of the issue.

Task Force Adjourned at 5:45 PM.

J.9.8 WG HV & EHV Breaker & Transformer Sw. Transients C57.142

MEETING NOTES
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
Charlotte, NC
Tuesday, October 18, 2022
1:45 PM – 3:00 PM Eastern Time Zone – USA
Symphony 6,7
Chairman – Jim McBride
Vice Chair – Xose Lopez-Fernandez
Secretary – Tom Melle

1) Meeting called to order at 1:45 PM Eastern Daylight Time.
2) Welcome and Chair's Remarks
3) 73 Attendees were present (28 of 46 Members were present and 45 Guests)
Quorum was achieved.
4) Approval of Agenda (motion to approve by Tom Melle / 2nd by Steve Snyder)
Minutes from Spring 2022 (motion to approve by Dave Caverly / 2nd by Jeff Briton)
5) C57.142 SA Ballot and Comment Resolution – Jim McBride
305 comments received. 107 editorial changes (required) and 109 editorial (not required).
67 Technical required. 22 Technical (not required).

The Chair asked the group for a motion to form a Comment Resolution Group (CRG) and for the CRG to act on behalf of the Working Group without further consultation, provided all CRG members are in agreement with any actions/resolutions. Motion passed with no objection (motion by Marnie Roussell / 2nd by Phil Hopkinson)

The ballot resolution group volunteers are:
- WG Officers (Jim McBride, Xose Lopez, Tom Melle, Dave Caverly)
- Klaus Pointner (volunteered to assist with figures)
- Phil Hopkinson
- Curtis Frazier
- Akash Joshi
- Weijun Li
- Amitabh Sarkar
- Dharam Vir

6) Switchgear Liaison Update (Dave Caverly)
No new business from the Switchgear group. The Spring Switchgear Committee meeting is being held in parallel in Burlington, VT. . Dave Caverly will check with Switchgear Taskforce for any interested parties to join the CRG.
7) Mitigation Methods Task Force Update – Jim McBride / Phil Hopkinson
8) There was no New Business
9) Next Meeting (Spring 2023 – Milwaukee, WI)
10) Adjournment (motion by Phil Hopkinson / 2nd by Dave Caverly)

- **Following the meeting, there was a Special Presentation on the effects of High Frequency Transients on CTs – Dr. Zoltan Roman (GE Grid Solutions)**

Fall 2022 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
David Caverly	Trench Limited	Member
J. Arturo Del Rio	Siemens Energy	Member
Kyle Heiden	EATON Corporation	Member
Philip Hopkinson	HVOLT Inc.	Member
Mohammad Iman	MGM Transformer Company	Member
John John	Virginia Transformer Corp.	Member
Akash Joshi	Black & Veatch	Member

Egon Kirchenmayer	Siemens Energy	Member
Moonhee Lee	Hammond Power Solutions	Member
Weijun Li	Braintree Electric Light Dept.	Member
Colby Lovins	Federal Pacific	Member
Afshin Rezaei-Zare	York University	Member
Pierre Riffon	Pierre Riffon Consultant Inc.	Member
Marnie Roussell	Entergy	Member
Amitabh Sarkar	Virginia Transformer Corp.	Member
Thomas Sizemore	ABB Inc.	Member
Steven Snyder	Hitachi Energy	Member
Mike Spurlock	Spurlock Engineering Services, LLC	Member
Shankar Subramany	KEMA Labs	Member
Rogerio Verdolin	Verdolin Solutions Inc.	Member
Dharam Vir	Prolec-GE Waukesha	Member
Baitun Yang	R.E. Uptegraff	Member
Waldemar Ziomek	PTI Transformers	Member
Edmund Areuglo	BPA	Guest
Mateja Bubnjar Kucko	Siemens Energy, KPT	Guest
Michael Craven	Qualus Corporation	Guest
Jorge Cruz	Niagara Transformer	Guest
Samson Debass	EPRI	Guest
Nikolaus Dillon	Dominion Energy	Guest
Marco Espindola	Hitachi Energy	Guest
Raymond Frazier	Ameren	Guest
Jose Gamboa	H-J Family of Companies	Guest
Dora Gaziloda	KONCAR - Instrument Transformers	Guest
Ramon Hayes	Dominion Energy South Carolina	Guest
Saramma Hoffman	PPL Electric Utilities	Guest
Sheldon Kennedy	Niagara Transformer	Guest
Dmitriy Klempner	Southern California Edison	Guest
Nan Konfa	KONCAR - Instrument Transformers	Guest
Mario Locarno	Doble Engineering Co.	Guest
Don Lowman	Dominion Energy South Carolina	Guest
Tim-Felix Mai	Siemens Energy	Guest
Aaron Meyers	EATON Corporation	Guest
Juliano Montanha	Siemens Energy	Guest
Tim Morris	Walton EMC	Guest
Volney Naranyo	Megger	Guest
Jonas Oliveira	Hitachi Energy	Guest
Sylvain Plante	Hydro-Quebec	Guest
Goran Plisic	Siemens Energy	Guest
Christoph Ploetner	t.b.a.	Guest
Daniel Posadas	Prolec SA de CV	Guest
Leslie Recksiedler	Manitoba Hydro	Guest
Zoltan Roman	GE Grid Solutions	Guest
Andre Rottenbacher	Ritz Instrument Transformers	Guest
Manish Saraf	Hammond Power Solutions	Guest
Masoud Shariei	Siemens Gamesa Renewable Energy	Guest
Brian Sonnenberg	Instrument Transformers, LLC	Guest
Hampton Steele	Tennessee Valley Authority	Guest
Andrew Steineman	Delta Star Inc.	Guest

Joseph Tedesco	Hitachi Energy	Guest
Vijay Tendulkar	EATON Corporation	Guest
Risto Trifunoski	Trench Group	Guest
Deniss Villagran	GE Grid Solutions	Guest
Dieter Wagner	Hydro One	Guest
Nicholas Walder	EATON Corporation	Guest
Barrett Wimberly	GE Grid Solutions	Guest
Malia Zaman	IEEE	Guest
Shibao Zhang	PCORE Electric	Guest
Fang Zhu	R.E. Uptegraff	Guest

J.10 Performance Characteristics Subcommittee Attendance List

First Name	Last Name	Affiliation	Status
Kayland	Adams	Prolec-GE	Guest
Gregory	Anderson	GW Anderson & Associates, Inc.	Guest
Stephen	Antosz	Stephen Antosz & Associates, Inc	Member
Edmundo	Arevalo	Bonneville Power Administration	Guest
Elise	Arnold	SGB	Guest
Kush	Arora	Reinhausen	Guest
Javier	Arteaga	Hitachi Energy	Member
Onome	Avanoma	MJ Consulting	Guest
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
Olivier	Bedoya		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
Jeffrey	Britton	Phenix Technologies, Inc./Doble Eng.	Member
Steven	Brzoznowski	Bonneville Power Administration	Guest
Camilo	Casallas	TRENCH	Guest
David	Caverly	Trench Limited	Guest
Zunyoung	Cho	HZW America	Guest
Rhett	Chrysler	ERMCO	Guest
Craig	Colopy	EATON Corporation	Member
Juan Carlos	Cruz Valdes	Prolec GE	Guest
Michael	Dahike	Central Moloney Inc.	Guest

Everton	De Oliveira	Siemens Energy	Member
Samson	Debass		Guest
J. Arturo	Del Rio	Siemens Energy	Member
Scott	Dennis	Hitachi Energy	Member
Antonio	DiBiase	Tempel Steel	Guest
Scott	Digby	Duke Energy	Guest
Nikolaus	Dillon	Dominion Energy	Guest
Paul	Dolloff	East Kentucky Power	Guest
Samragni	Dutta Roy	Siemens Energy	Guest
Marco	Espindola	Hitachi Energy	Guest
Reto	Fausch	RF Solutions	Member
Hugo	Flores	Hitachi Energy	Member
Joseph	Foldi	Foldi & Associates, Inc.	Member
Anthony	Franchitti	PECO Energy Company	Guest
Raymond	Frazier	Ameren	Guest
Rich	Frye	EATON Corporation	Guest
Jose	Gamboa	H-J Family of Companies	Member
Rob	Ghosh	General Electric	Guest
Ramsis	Girgis	Hitachi Energy	Member
Shawn	Gossett	Ameren	Member
Bill	Griesacker	Duquesne Light Co.	Member
Ismail	Guner	Hydro-Quebec	Guest
Kevin	Hampton	Siemens Energy	Guest
Kyle	Heiden	EATON Corporation	Guest
Peter	Heinzig	Weidmann Electrical Technology	Guest
Sergio	Hernandez Cano	Hammond Power Solutions	Member
Gary	Hoffman	Advanced Power Technologies	Guest
Saramma	Hoffman	PPL Electric Utilities	Guest
Ryan	Hogg	Bureau of Reclamation	Guest
Philip	Hopkinson	HVOLT Inc.	Member
Ramadan	Issack	American Electric Power	Guest
Anirudhphsinh	Jhala	T&R (India)	Guest
John	John	Virginia Transformer Corp.	Member
Christopher	Johnson	Oncor Electric Delivery	Guest
Stephen	Jordan	Tennessee Valley Authority	Member
Akash	Joshi	Black & Veatch	Member
Sheldon	Kennedy	Niagara Transformer	Member
Gael	Kennedy	GR Kennedy & Associates LLC	Guest
Christoph	Kerschenbauer	Siemens Energy	Guest
Gary	King	Howard Industries	Guest
Egon	Kirchenmayer	Siemens Energy	Member

Dmitriy	Klempner	Southern California Edison	Guest
Anton	Koshel	Delta Star Inc.	Guest
Axel	Kraemer	Maschinenfabrik Reinhausen	Guest
Andrew	Larison		Guest
Moonhee	Lee	Hammond Power Solutions	Guest
Aleksandr	Levin	Weidmann Electrical Technology	Member
Weijun	Li	Braintree Electric Light Dept.	Member
Colby	Lovins	Federal Pacific	Guest
Tim-Felix	Mai	Siemens Energy	Member
Alberto	Martinez	WEG Transformers USA Inc.	Guest
Mama	Mbouombouo		Guest
James	McBride	JMX Services, Inc.	Member
Omar	Mendez	Prolec-GE	Guest
Tim	Menter	Lincoln Electric System	Guest
Aaron	Meyers	EATON Corporation	Guest
Francis	Mills	Power Engineers	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
Kristopher	Neild	Megger	Member
Yaw	Nyanteh	Hyosung Hico	Guest
Jonas	Oliveira	Hitachi	Guest
Herman	Parrales	Prolec-GE	Guest
Sanjay	Patel	Smit Transformer	Member
Poorvi	Patel	Electric Power Research Institute	Member
Verena	Pellon	FPL	Guest
Harry	Pepe	Phenix Technologies, Inc.	Guest
Sylvain	Plante	Hydro-Quebec	Member
Christoph	Ploetner	t.b.a.	Guest
Klaus	Pointner	Trench Austria GmbH	Member
Jarrod	Prince	ERMCO	Member
Ulf	Radbrandt	Hitachi Energy	Member
Ion	Radu	Hitachi Energy	Member
Adnan	Rashid	Measurement Canada / ISED	Guest
Pierre	Riffon	Pierre Riffon Consultant Inc.	Member
Diego	Robalino	Megger	Guest
Tim	Rocque	SPX Transformer Solutions, Inc.	Member
Marnie	Roussell	Entergy	Member
Hakan	Sahin	Virginia/Georgia Transformer	Guest
Oliverio	Sanchez	Pacific Gas & Electric	Guest

Amitabh	Sarkar	Virginia Transformer Corp.	Guest
Daniel	Sauer	EATON Corporation	Member
Markus	Schiessl	SGB	Guest
Alfons	Schrammel	Siemens Energy	Guest
Pugal	Selvaraj	Virginia Transformer Corp.	Guest
Cihangir	Sen	Duke Energy	Guest
Devki	Sharma	Entergy	Guest
Hemchandra	Shertukde	University of Hartford	Member
Jin	Sim	JSA	Guest
Andre	Simons	JFE Shoji Power Canada Inc.	Guest
Kenneth	Skinger	Scituate Consulting, Inc.	Member
Christopher	Slattery	FirstEnergy Corp.	Member
Steven	Snyder	Hitachi Energy	Member
Jason	Snyker	First Energy	Guest
Sanjib	Som	Pennsylvania Transformer	Vice-Chair
Mike	Spurlock	Spurlock Engineering Services, LLC	Member
Brad	Staley	Leeward Renewable Energy	Guest
Kyle	Stechschulte	American Electric Power	Member
Andrew	Steineman	Delta Star Inc.	Guest
Shankar	Subramany	KEMA Labs	Guest
Charles	Sweetser	OMICRON electronics Corp USA	Member
Matthew	Sze	Omicron Electronics	Guest
Troy	Tanaka	Burns & McDonnell	Guest
Vijay	Tendulkar	EATON Corporation	Guest
Ed	teNyenhuis	Hitachi Energy	Member
Scott	Thomas		Guest
Alan	Traut	Howard Industries	Guest
Cove	Van Dreel	ATC	Guest
Ajith	Varghese		Member
Jason	Varnell	Doble Engineering Co.	Member
Kiran	Vedante	Ritz Instrument Transformers	Member
Joshua	Verdell	ERMCO	Guest
Rogerio	Verdolin	Verdolin Solutions Inc.	Chair
Krishnamurthy	Vijayan	PTI Transformers	Member
Dharam	Vir	Prolec-GE	Member
Richard	vonGemmingen	Dominion Energy	Guest
David	Wallach	Duke Energy	Guest
Alan	Washburn	Burns & McDonnell	Guest
Joe	Watson	JD Watson and Associates Inc.	Member
Areeb	Wazir	EATON Corporation	Guest
Bruce	Webb	Knoxville Utilities Board	Member

Matthew	Weisensee	PacifiCorp	Guest
Drew	Welton	Intellirent	Guest
Jeffrey	Wright	Duquesne Light Co.	Member
Baitun	Yang	R.E. Uptegraff	Member
Joshua	Yun	Virginia Transformer Corp.	Guest
Peter	Zhao	Hydro One	Member
Fang	Zhu		Guest
Kris	Zibert	Allgeier, Martin and Associates	Secretary
Waldemar	Ziomek	PTI Transformers	Guest