**Standards Subcommittee**

March 26, 2025, Denver, CO.

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| **Standards Subcommittee** |
| **Chair: Daniel Sauer** | **Vice-Chair: Marcos Ferreira** | **Secretary: Ajith Varghese** |
| **Standards Coordinator: Steve Shull** |
| Room: Centennial Foyer (3), Hyatt Regency | Date: March 26,2025 | Time: 4:30 PM to 05:15 pm |
| Total Members: 95 | Present at time of quorum check: 55 | Attended per Record: 63 |
| Guests present: 71 | Membership requested: 13 | Membership accepted: 6 |

# L.1 Meeting Attendance

The Standards Subcommittee met on Wednesday; Mar 26th, 2025, at 4:31 PM (CST).

**55** members were in attendance at the beginning of the meeting, which met the quorum requirement.

Based on attendance roster and after correction to membership, it was confirmed that **63 of 95** members were present. 71 guests were also present, of which **13** guests requested membership of which **06** met attendance requirement and will be granted membership.

# L.2 Chair’s Remarks

The Chair welcomed members and guests to the S25 meeting. Chair briefly highlighted the requirement that while introducing one need to state their affiliation.

The agenda was moved by Eric Davis and seconded by Sanjib Som. The motion was carried with unanimous consent. The Minutes for Fall 2024 was moved by Steve Antosz and seconded by Jerry Murphy. The motion was carried with unanimous consent.

The chair presented the IEEE requirement for patent and copyrights. The Chair reminded WGs that call of the patent is required a during every WG meetings including on-line/Teleconference meeting. If there are any patent claim, it shall be noted but not discussed at the working group meetings. The chair reminded members of their membership duties to respond to surveys and ballots to maintain.

The Chair reminded the WG and TF leaders to submit their minutes from the meetings within **15 days** to the SC secretary. The SC Secretary then must submit the SC minutes within 45 days of the SC meeting.

WG on C57.12.00, C57.12.90, C57.152 and C57.133 and TF on IEEE/IEC and Reverse Power flow provided an update on status of their standards/TF.

**WG Status reports:**

* **WG C57.12.00:**
	+ Two additional changes to C57.12.00 were approved during the S25 meeting. DiTest SC approved an error correction in formula under external clearance section and Performance characteristic SC approved clarification in table 17 regarding Load loss measurement.
	+ WG approved motion to move the document with all approved changes to ballot.
	+ During Standard SC meeting, Eric Davis, WG chair moved a motion to move forward with SA ballot to revise the document. Steve Antosz seconded, and SC approved moving C57.12.00 to ballot unanimously.
* **WG C57.12.90 Test Code:**
	+ Three additional changes to Test code were approved during the meeting. Dielectric SC approved a change to move text related to Induced voltage test for transformer with series or multiple connection from section 10.5 Low frequency test to  10.7 Class I induce test and 10.8 Class II Induce test. Two changes to section 11 Temperature rise test was also approved by Insulation Life SC. The first one is  modification of altitude correction formula so that correction can be applied in both directions . The second change involves the addition of a thermal model and formula for calculation of hottest spot rise.
	+ WG approved a motion to move the document with all approved changes to ballot.
	+ Steve Antosz, the WG chair, moved a motion to move forward with SA ballot to revise the document. Ajith Varghese seconded, and motion was approved unanimously by SC.
* **WG C57.152 Field guide:**
* The guide is in Ballot resolution and the Chair provides an update of 145 comments received. WG unanimously approved motions approving the response to ballot comment and to recirculate the ballot.
* **IEEE/IEC Cross Reference TF:**
* TF discussed the scope and format and agree to create two separate cross-linking document – one to link IEEE standard to IEC and second to cross link based on topic. TF plans to survey to get feedback to prioritize the topics to start working on.
* **WG C57.133:**
* WG held a third meeting and  5 short presentations on reverse power flow was made. WG is planning one virtual WG meeting before Florida, kickoff small task forces to begin developing draft text on reverse power flow effects.

**TF Definitions of reverse power flow:**

* Held two virtual meetings between St. Louis and Denver meetings and made good progress on a definition of transformer reverse power flow, developing a 4-quadrant PQ diagram that could be used in PC57.133
* TF is Planning at least one more virtual TF meeting before Florida meetings.
* **WG C57.12.80 Terminology Guide**: WG did not meet. 2024 revision of guide is waiting to be published.

* **WG C57.12.70 Terminal Markings:** Currently not active and did not meet.
* **WG C57.163 Guide for Establishing Power Transformer Capability while under Geomagnetic Disturbances:** WG is not active and did not meet.

Detailed WG/TF reports are included as part of this report (pages 5 to 43).

**Other Discussions during SC:**

* There was a question on who all will part of C57.12.00 and C57.12.90 ballot resolution. The chair clarified that these WG members consisting of WG or TF chair of continuous revision, who are also the CRB. David Wallach clarified that as discussed during previous meetings as well and for future , this will be further reviewed as part of next P&P manual revision.
* It was also clarified that ballot is always for entire document, not just changed approved by SC.
* There was also a question about where members of WG or TF will be recognized for their work on C57.12.00 and C57.12.90.90. Steve Antosz clarified that members list of WG and TF who provided inputs to document will not included on document but all those ballot will be present. As for recognizing with award, it’s prerogative of WG chair.

L.4 Old Business

There was no old business to discuss.

# L.5 New Business

No new item was discussed.

# L.6 Attendance

Included as last pages of these minutes.

#  L.7 Adjournment

The meeting was adjourned at 4:55 PM CST.

Subcommittee New business and SC attendees list are included at end of this minutes after WG/TF reports ( pages 36-37).

Respectfully submitted,

Ajith M. Varghese

Standards SC Secretary

04/27/2025

# L.3 Working Group and Task Force Reports

## L.3.1 Standards Working Group on the Continuous Revision of C57.12.00

Standards Working Group on the Continuous Revision of C57.12.00

Standards Subcommittee

IEEE/PES Transformers Committee

WG Chair: Eric Davis

Spring 2025 Denver, CO; March 26, 2025

***INTRODUCTION***

This is a working group by committee of task forces, for continuous revision of C57.12.00. The purpose of this WG is to compile all the work being done in various TF/WG/SC’s for inclusion in the continuous revision of C57.12.00 in a consistent manner. The WG exists administratively in the Standards Subcommittee and has no live meetings. The technical work is done in other subcommittees based on expertise and scope. The WG Membership consists of the people actively working on the revisions. These people are the TF Chairs, SC Chairs and other significant contributors to the current version. The WG Members are:

Dan Sauer

Poorvi Patel

Sanjib Som

Ajith Varghese

Tauhid Ansari

This WG coordinates efforts with the companion standard C57.12.90 so that they publish together.

***SUMMARY***

C57.12.00-2021 was approved by IEEE SA Standards Board on November 9, 2021. and published January 2022. A Project Authorization Request (PAR) for Revision of PC57.12.00 was approved May 13, 2022. It expires December 31, 2026.

Changes approved by the appropriate subcommittees by the end of the Spring 2025 meeting will be included in the next revision of C57.12.00. This will allow sufficient time to ballot and resolve any comments prior to the expiration of the existing PAR.

***WG Meeting***

The WG met at the beginning of the SC meeting. Five of six members were present. A quorum was present. Dan Sauer made the following motion, “I move that C57.12.00 go to Sponsor Ballot with the changes approved by the respective SCs.” Ajith Varghese seconded the motion. The motion was unanimously approved.

Dan Sauer made the following motion, “I move that the WG create a Ballot Resolution Group to resolve comments received during the ballot.” Ajith Varghese seconded the motion. This motion was unanimously approved.

At the SC Meeting, the SC unanimously approved the WG to begin the IEEE-SA Ballot process for the C.57.12.00 document. Please refer to the SC minutes.

***Future Revisions and Pending Work***

Any new material provided by the various Task Forces to this WG for inclusion in the next revision, will first be approved by the responsible technical subcommittee (Dielectric Test, PCS, Distribution, IL, etc.) and then presented to the Standards Subcommittee for the “official” vote of approval to go to ballot.

The following groups are reviewing proposed changes that may impact this standard.

* Dielectric Test SC
	+ Section 6.8, Equation 3: Correct the formula replacing BIL with BSL. This change matches the original change surveyed and approved by DiTest for the previous revision. This change was approved by the SC.

$$BIL BSL=CFO×\left(1-1.28×\frac{σ\_{f}}{CFO}\right)$$

* TF PCS Continuous Revisions to C57.12.00 (PCS)
	+ The TF discussed the following items. Please refer to the TF and SC meeting minutes for additional details.
	+ Item 115: DC Current Injection Limits
	+ Item 116: Add an informational note in the text regarding kVA values in Table 11. The TF and SC approved this change.

**7.1.2 Transformer categories**

Four categories for the rating of transformers are recognized, as shown in Table 11.

NOTE: The kVA values for single-phase and three-phase in the table intentionally do not adhere to a 1-to-3 ratio for all values. Notably, for values near 500 kVA, the table presents 500 or 501 kVA for both single-phase and three-phase. This is historically due to an old distribution transformer kVA limit.

**Table 11 —Category of transformer ratings**



aAutotransformers with equivalent two-winding kVA of 500 or less, which are manufactured as distribution transformers in accordance with IEEE Std C57.12.20 [B32], IEEE Std C57.12.23™ [B33], IEEE Std C57.12.24™ [B34], IEEE Std C57.12.34 [B35], IEEE Std C57.12.36 [B36], IEEE Std C57.12.38 [B37], or IEEE Std C57.12.40™ [B38] shall be included in Category I, even though their nameplate kVA may exceed 500.

* + Item 119: Table 17 Clarify impedance voltage and load loss for Class II power transformers. The TF and SC approved this change.



* TF Revision of Impulse Tests C57.12.00 & C57.12.90 (DiTest)
	+ Please refer to the TF and SC meeting minutes for details.
* TF Continuous Revisions of Low Frequency Tests (DiTest)
	+ Please refer to the TF and SC meeting minutes for details.

Four changes have *already been approved* by the respective SC’s for the next revision. These approved changes are:

1. Changes to Low Frequency Tests from Ajith Varghese’s RLFT TF in the Dielectric Test SC. The final survey approved by TF and SC in the Spring 2023 meeting is shown below. Text in black is existing, red is revised, blue is added.

**5.10.5.5 Induced-voltage test for Class II power transformers**

With the transformer connected and excited as it will be in service, an induced-voltage test shall be performed as indicated in Figure 2, at voltage levels indicated in Columns 6 and 7 and 1.05 times the line to ground voltage per column 2 of Table 4. Minimum line-to-ground induced test levels for Class II power transformers shall be a multiple of corresponding line-to-ground nominal system voltage as follows: 1.58 times for one-hour tests and 1.8 times for 7200 cycles enhancement level tests.



**Figure 2 —Induced-voltage test for Class II power transformers**

1. Changes to Measurements of Auxiliary Losses from T. Ansari’s Continuous Revisions to C57.12.00 in the Performance Characteristics SC. The final survey approved by TF and SC in the Spring 2024 meeting is shown below. Text in black is existing, red is revised, blue is added.
	1. Total losses

The total losses of a transformer shall be the sum of the no-load losses and the load losses.

The losses of cooling fans, insulating liquid pumps, space heaters, and other ancillary equipment are not included in the total losses. When specified, power loss data on such ancillary equipment shall be furnished.

The standard reference temperature for the load losses of power and distribution transformers shall be defined as 20 °C plus the rated average winding rise. The standard reference temperature for the no-load losses of power and distribution transformers shall be 20 °C.

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

Note: The auxiliary losses do not include control cabinet components including but are not limited to cabinet heaters, online DGA or ancillary devices such as dehydrate breathers, nitrogen cabinet heaters, etc.

The manufacturer to provide total power consumption of all devices on the control schematic drawing to evaluate the power supply requirements.

1. Changes to Phasor Diagrams from T. Ansari’s Continuous Revisions to C57.12.00 in the Performance Characteristics SC. The motion approved by the TF and SC in the Spring 2024 meeting are shown below. The actual text from C57.12.00 is shown after the motion. Text in black is existing, red is revised, blue is added.



*Motion #1*

* + 1. Angular displacement (nominal) between voltages of windings for three-phase transformers

The angular displacement of a polyphase transformer is the time angle expressed in degrees between the line-to-neutral voltage of the reference identified high-voltage terminal H1 and the line-to-neutral voltage of the corresponding identified low-voltage terminal X1.

Unless specified otherwise and identified on the nameplate, the angular displacement between high-voltage and low-voltage phase voltages of three-phase transformers with Δ-Δ or Y-Y connections shall be zero degrees. The phasor group designation (vector group) shall be shown on the transformer’s nameplate, near the phasor diagram.

The angular displacement between high-voltage and low-voltage phase voltages of three-phase transformers with Y-Δ or Δ-Y connections shall be 30°, with the low voltage lagging the high voltage as shown in Figure 1.

Additional phasor diagrams are described in IEEE Std C57.12.70.

*Motion #2*

**H2**

**Δ – Δ CONNECTION (Dd0)**

**Y – Δ CONNECTION (Yd1)**

**Y – Y CONNECTION (Yy0)**

**Δ – Y CONNECTION (Dy1)**

**H1**

**H3**

**X2**

**X1**

**X3**

**X2**

**X3**

**X1**

**H2**

**H1**

**H3**

**X1**

**X3**

**X1**

**X3**

**X2**

**X2**

**H1**

**H3**

**H1**

**H3**

**H2**

**H2**

Figure 1 ―Phase relation of terminal designation for three-phase transformers

*Motion #3*

1. —Nameplate information

|  |  |  |  |
| --- | --- | --- | --- |
| Row | Nameplate A | Nameplate B | Nameplate C |
| 1 | Serial numbera | Serial numbera | Serial numbera |
| 2 | Month/year of manufacture | Month/year of manufacture | Month/year of manufacture |
| 3 | Class (ONAN, ONAF, etc.)b | Class (ONAN, ONAF, etc.)b | Class (ONAN, ONAF, etc.)b |
| 4 | Number of phases | Number of phases | Number of phases |
| 5 | Frequency | Frequency | Frequency |
| 6 | kVA ratinga, b | kVA ratinga, b | kVA (or MVA) ratinga, b |
| 7 | Voltage ratingsa, c | Voltage ratingsa, c | Voltage ratingsa, c |
| 8 | Tap voltagesd | Tap voltagesd | Tap voltagesd |
| 9 | Temperature rise, °C | Temperature rise, °C | Temperature rise, °C |
| 10 | Polarity (single-phase transformers) | Polarity (single-phase transformers) | Polarity (single-phase transformers) |
| 11 | Phasor diagram and phasor group designation(polyphase transformers) | Phasor diagram and phasor group designation(polyphase transformers) | Phasor diagram and phasor group designation(polyphase transformers) |
| 12 | Percent impedancee | Percent impedancee | Percent impedancee |
| 13 | — | Basic lightning impulse insulation levels (BIL)f | Basic lightning impulse insulation levels (BIL)f |
| 14 | Approximate total mass in kg or weight in lbg | Approximate total mass in kg or weight in lbh | Approximate total mass in kg or weight in lbh |
| 15 | Connection diagrami | Connection diagrami | Connection diagrami |
| 16 | Name and location (country) of manufacturer | Name and location (country) of manufacture | Name and location (country) of manufacture |
| 17 | Installation and operating instructions reference | Installation and operating instructions reference | Installation and operating instructions reference |
| 18 | The word *transformer* or *autotransformer* | The word *transformer* or *autotransformer* | The word *transformer* or *autotransformer* |
| 19 | Type of insulating liquid (generic name preferred)j | Type of insulating liquid (generic name preferred)j | Type of insulating liquid (generic name preferred)j |
| 20 | Conductor material (of each winding) | Conductor material (of each winding) | Conductor material (of each winding) |
| 21 | Liquid volume | — | Step-up operation suitabilityk |
| 22 | — | — | Maximum value of primary voltagel |
| 23 | — | — | Tank, pressure, and liquid datam |
| 24 | Department of Energy (DOE) compliantn | DOE compliantn | DOE compliantn |
| 25 | --- | --- | Core Design – Core or Shell form |
| 26 | --- | --- | Core Type - Number of limbs (wound), Shell Type - D type , 7 limbs, or others |

1. Changes to Low Frequency Tests from Ajith Varghese’s RLFT TF in the Dielectric Test SC. The final survey approved by TF and SC in the Fall 2024 meeting is shown below. Text in black is existing, red is revised, blue is added.
	1. Partial Discharge for Class I Transformers:



aFor nominal system voltage greater than maximum system voltage, use the next higher voltage class for applied-voltage test levels.

bThe induced-voltage test~~s shall be conducted at~~ voltages in the table above are based on an overvoltage factor of approximately 1.58 × nominal system voltage for the one hour test and 1.80 × nominal system voltage for the enhanced 7200 cycle test.

**5.10.5.5 Induced-voltage test for Class II power transformers**

With the transformer connected and excited as it will be in service, an induced-voltage test shall be performed as indicated in Figure 2, at voltage levels indicated in Columns 6 and 7 of Table 4. ~~Minimum line-to-ground induced test levels for Class II power transformers shall be a multiple of corresponding line-to-ground nominal system voltage as follows: 1.58 times for one-hour tests and 1.8 times for 7200 cycles enhancement level tests.~~



* 1. Induced Overvoltage – Nominal versus Maximum operating voltage:



Respectfully submitted,

Eric Davis, WG Chair

March 26, 2025

**L.3.4 WG Standards Transformer on Continuous Revision for C57.12.90**

Standards Working Group on the Continuous Revision of C57.12.90

Standards Subcommittee

IEEE/PES Transformers Committee

WG Chair: Stephen Antosz

Vice-Chair/Secretary: Jason Varnell

Spring 2025 Denver; March 26, 2025 (new text is highlighted)

***Introduction***

This is a working group by committee of task forces, for continuous revision of C57.12.90. The purpose of the WG is to keep track of the work being done in various TF/WG/SC’s for inclusion in the continuous revision of C57.12.90 in a consistent manner. The WG exists administratively in the Standards Subcommittee and has no live meetings. The technical work is done in other subcommittees based on expertise and scope. WG membership consists of the people actively working on revisions. These people are the TF Chairs, SC Chairs, and other significant contributors to the current version. WG Members are:

Donald Ayers

Ramsis Girgis

Poorvi Patel

Sylvain Plante

Bertrand Poulin

Diego Robalino

Hakan Sahin

Dinesh Sankarakurup

Daniel Sauer

Sam Sharpless

Sanjib Som

Ajith Varghese

Currently there are six Task Forces in three different Subcommittees, as follows:

1. PCS – Cont Rev to Test Code C57.12.90 Clauses 5-9, & 12, TF Chair: Hakan Sahin
2. PCS – Audible Sound Revision Clause 13, TF Chair: Ramsis Girgis
3. Dielectric Test – Cont Rev to Impulse Tests in Clause 10, TF Chair: Sylvain Plante
4. Dielectric Test – Cont Rev to LowFrequency Tests Clause 10, TF Chair: Ajith Varghese
5. Dielectric Test –Core Ground and Winding Insulation Resistance, 10.11, TF Chair: Diego Robalino
6. Insulation Life – Cont Rev to Temperature Test Clause 11 and Resistance Clause 5, TF Chair: Dinesh Sankarakurup

***Summary***

C57.12.90-2021 was approved as a revised standard by the IEEE-SA Standards Board on Nov 9, 2021. It was published on Feb 4, 2022. The WG Chair took out a new PAR on Feb 28, 2022, which was approved by the IEEE-SA Standards Board on May 13, 2022. The PAR expires on December 31, 2026.

The WG met at the beginning of the Standards SC meeting in Denver on March 26, 2025. A quorum was present. Ajith Varghese made the following motion, “I move that C57.12.90 go to Sponsor Ballot with the changes approved by the respective SCs.” Dan Sauer seconded the motion. The motion was unanimously approved.

Dan Sauer made the following motion, “I move that the WG create a Ballot Resolution Group (BRG) to resolve comments received during the ballot.” Ajith Varghese seconded the motion. We did; and the BRG will be the same WG members.

At the SC meeting, the SC unanimously approved the WG to begin the IEEE-SA ballot process for the C57.12.90 document. See the SC Minutes.

***Future Revisions and Pending Work***

Any new material provided by the various Task Forces to this WG for inclusion in the next revision, will first be approved by the responsible technical subcommittee (Diel Test, PCS, Dist, IL, etc.) and then presented to the Standards Subcommittee for the “official” vote of approval to go to ballot.

Changes *ALREADY APPROVED* for the next revision:

1. Hakan Sahin’s PCS TF for Revision of C57.12.90.
2. Changes to subclause 7.3, Ratio test methods to “modernize” it. Final survey approved in the Spring 2021 virtual meeting.

Insert a new subclause 7.3.1 as follows:

7.3.1 Electronic ratio and phase measurement meters

An electronic meter that determines the transformer turns ratio, polarity and phase angle may be used for the measurement of these parameters.

The existing 7.3.1 Voltmeter method should be renumbered to be 7.3.2, are no changes to the text.

The existing 7.3.2 Comparison method should be renumbered to be 7.3.3, no changes to the text or figures 10 & 11.

The existing 7.3.3 Ratio meter clause and figure 12 is to be deleted.

1. Ratio test voltage and frequency under subclause 7.1.2. Request to change frequency bandwith. TF and SC approved in Spring 2022.

**7.0 Ratio test**

**Current Version:**

**7.1.2 Voltage and frequency**

The ratio test shall be made at rated or lower voltage and rated or higher frequency.

**Revised Version**

**7.1.2 Voltage and frequency**

The ratio test shall be made at rated or lower voltage and be such that the ratio of test voltage to test frequency is less than or equal to the ratio of rated voltage to rated frequency.

1. Number of short-circuit tests under subclause 12.3.4. TF and SC approved in Spring 2022.

**Current Version:**

**12.3.4 Number of tests**

Each phase of the transformer shall be subjected to a total of six tests satisfying the symmetrical current requirement specified in 12.3.1 or 12.3.2, as applicable. Two of these tests on each phase shall also satisfy the asymmetrical current requirements specified in 12.3.3.

**Revised Version**

**12.3.4 Number of tests**

* When a three-phase transformer is tested in a three-phase test circuit or in a single-phase test circuit as given in Annex C, each phase of the transformer shall be subjected to three tests satisfying the asymmetrical current requirements specified in 12.3.3. The tests shall be performed on one of the outer phases with the tap-changer in the maximum position, on the other outer phase with the tap-changer in the minimum position and on the middle phase with the tap-changer in the principal position
* When a single-phase transformer is tested in a single-phase test circuit the transformer shall be subjected to three tests satisfying the asymmetrical current requirements specified in 12.3.3. The three tests shall be performed one each, with the tap-changer in the maximum, minimum and principal position.
1. Load Tap Changer performance test with rated voltage. New subclause 8.7. TF and SC approved in Spring 2022. It was re-discussed in Fall 2022 but no changes were made so still considered to be approved.

**8.7 Load Tap Changer Voltage Test**

**8.7.1 General**

In order to verify the performance of a transformer that has a load tap changer (LTC), the LTC shall be operated through one end-to-end-to-end sequence (from one tap extreme to the other tap extreme and back again) with the transformer energized at rated voltage.

**8.7.2 Control voltage**

Control voltage for the LTC motor during the test shall be as near to rated voltage as possible, with a minimum of 85%.

**8.7.3 Preparation for the test**

The LTC shall be fitted with all included equipment. It shall be connected as it will be in service, including protective devices.

**8.7.4 Procedure**

Either the high or low voltage winding of the transformer under test shall be energized at rated voltage and frequency, unless otherwise specified. The LTC shall be operated using the motor drive but not manual rotation. The LTC shall be operated through all tap positions twice, starting at one tap extreme and progressing to the other tap extreme, and then return back again to the original tap position. The test may be performed at intervals, if necessary, such as to adjust the test circuit for the applied voltage to be adjusted to the rated voltage of the tap position, but it is a requirement that the transformer be energized at no less than rated voltage corresponding to each tap to be changed.

**8.7.5 Observations and Analysis**

**8.7.5.1 Audible Sound**

The transformer shall be observed during this test and the operator shall identify that the sound during the tap changing operations was either normal or abnormal. With some types of tap changers, there will be abnormally loud sounds if components are not assembled properly. Note that during operation of the change-over selector (reversing switch or coarse-tap selector) the sound can be slightly different.

**8.7.5.2 Supply Test Circuit**

The test control system shall be monitored for any trip of the test circuit that automatically stops the circuit from keeping the transformer energized.

**8.7.5.3 Dissolved Gas-in-Oil Analysis**

Oil samples shall be taken from the LTC compartment of vacuum type tap-changers before and after the test and analyzed for dissolved gasses. Results of the analysis may show some increase of dissolved gases due to current commutation, resistor heating and / or stray-gassing of the oil.

**8.7.6 Failure Detection and Acceptance Criteria**

The transformer will have passed this LTC Voltage test if:

* The tap changer operates normally with no abnormal sound
* The transformer stays energized without a trip in the supply test circuit
* For mineral oil filled vacuum LTCs, the increase of the sum of H2, CH4, C2H6, C2H4 and C2H2 should not exceed 12 ppm for in-tank type LTCs and 6 ppm for compartment type LTCs.
* For non-vacuum type LTCs, or LTCs filled with a liquid other than mineral oil, the determination of acceptance criteria is through sound only and there is not a limit for increase in gases.
1. Load Tap Changer performance test with rated current. New subclause 9.6. TF and SC approved in Spring 2022. It was re-discussed in Fall 2022 but no changes were made so still considered to be approved.

**9.6 Load Tap Changer Current Test**

**9.6.1 General**

In order to verify the performance of a transformer that has a load tap changer (LTC), the LTC shall be operated through one end-to-end-to-end sequence (from one tap extreme to the other tap extreme and back again) with the transformer current flowing through the windings, corresponding to the top nameplate MVA rating.

**9.6.2 Control voltage**

Control voltage for the LTC motor during the test shall be as near to rated voltage as possible, with a minimum of 85%.

**9.6.3 Preparation for the test**

The LTC shall be fitted with all included equipment. It shall be connected as it will be in service, including protective devices.

**9.6.4 Procedure**

The test shall be performed by applying a short circuit either the high-voltage winding or the low-voltage winding and applying sufficient voltage across the other winding to cause a specific current to flow in the windings. The LTC shall be operated using the motor drive but not manual rotation. The LTC shall be operated through all tap positions twice, starting at one tap extreme and progressing to the other tap extreme, and then return back again to the original tap position. The test may be performed at intervals, if necessary, such as to adjust the test circuit for the applied voltage to be adjusted to the required current of the tap position, but it is a requirement that the transformer be energized at no less than 80% of the top MVA nameplate current value for each tap change.

**9.6.5 Observations and Analysis**

**9.6.5.1 Audible Sound**

The transformer shall be observed during this test and the operator shall identify that the sound during the tap changing operations was either normal or abnormal. With some types of tap changers, there will be abnormally loud sounds if components are not assembled properly. Note that during operation of the change-over selector (reversing switch or coarse-tap selector) the sound can be slightly different.

**9.6.5.2 Supply Test Circuit**

The test control system shall be monitored for any trip of the test circuit that automatically stops the circuit from keeping the transformer energized.

**9.6.5.3 Dissolved Gas-in-Oil Analysis**

Oil samples shall be taken from the LTC compartment of vacuum type tap-changers before and after the test and analyzed for dissolved gasses. Results of the analysis may show some increase of dissolved gases due to current commutation, resistor heating and / or stray-gassing of the oil.

**9.6.6 Failure Detection and Acceptance Criteria**

The transformer will have passed this LTC Voltage test if:

* The tap changer operates normally with no abnormal sound
* The transformer stays energized without a trip in the supply test circuit
* For mineral oil filled vacuum LTCs, the increase of the sum of H2, CH4, C2H6, C2H4 and C2H2 should not exceed 12 ppm for in-tank type LTCs and 6 ppm for compartment type LTCs.
* For non-vacuum type LTCs, or LTCs filled with a liquid other than mineral oil, the determination of acceptance criteria is through sound only and there is not a limit for increase in gases.
1. Changes to Insulation Power Factor test, from Diego Robalino’s Diel Test SC TF for Winding Insulation Power Factor. Final survey approved in the Fall 2021 virtual meeting and by DielTest SC Jan 2022. Specifically with regards to Subclause 10.10.2 revising the accuracy requirements of instrumentation.

The existing text is:



The revised text to replace it will be:

10.10.2 Instrumentation

The insulation line-frequency power factor or dissipation factor may be measured by special bridge circuits or by the voltampere-watt method. The accuracy of the measurement instrumentation at or near rated frequency should be:

* for Insulation Power Factor Below 1%: +/-2% of reading +/-0.05% absolute
* for Insulation Power Factor Above 1%: +/-5% of reading +/-0.05% absolute
1. Changes to Clause 11 Temperature Test, from Dinesh Sankarakurup’s TF in the Insulation Life SC.
2. Changes to subclause 11.3.2, Liquid Temp Rise Determination. Final survey approved by TF and SC in the Spring 2023 meeting. In the first paragraph change the word “ultimate” to “stabilized”, and add a sentence that the top oil rise shall not be averaged over time. Text in black is existing, red is revised, blue is deleted.

Liquid temperature rise is the difference between liquid temperature and ambient temperature. The ~~ultimate~~ stabilized temperature rise above ambient shall be considered to be reached when the top liquid temperature rise does not vary more than 2.5% or 1 °C, whichever is greater, during a consecutive 3 h period. The stabilized liquid temperature rise determined at the end of the total loss run shall not be averaged over time.

1. 11.4.3 Add text that reverse correction for altitude is also allowed; i.e., when factory is located above 1000 m and transformer rating is based on <1000m. The final survey was done and approved by TF and SC in the Spring 2025 meeting
2. Proposal by Bertrand Poulin to move OFAF Cooling and Top Duct Oil temperature diagram from C57.119 to C57.12.90. The final survey was done and approved by TF and SC in the Spring 2025 meeting
3. Changes to Audible Sound from Ramsis Girgis’ TF in the Perf Char SC. The changes were approved by the TF at Spring 2023. The Perf Char SC approved in-person at the Kansas City meeting. Text in black is existing, red is revised, blue is deleted.
4. Changes to 13.3.3.1 No-load audible sound level.

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 ~~may, upon purchaser request, and as agreed upon,~~ 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. Thesame is true for SVC transformers when connected to a capacitive load; Again, for these transformers, the measurements shall ~~may, upon purchaser request, and as agreed upon,~~ be made with the transformer operating at the highest sound producing condition.

1. Changes to 13.5.5.1 Measuring ambient sound pressure level.

~~The ambient sound pressure level shall be established by averaging the ambient sound pressure levels measured immediately preceding and immediately following the sound measurements with the transformer energized. The ambient sound shall be measured at a minimum of four locations, and the instruments shall be in conformance with 13.2.~~ The ambient sound pressure level 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 13.2. However, additional measurements may be made if agreed to by the manufacturer and purchaser or if the ambient measurements vary by more than 3 dB around the transformer. …

1. Changes to 13.3.3.2 Load audible sound level.

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.

1. Changes to Low Frequency Tests from Ajith Varghese’s RLFT TF in the Diel Test SC. Final survey approved by TF and SC in the Spring 2023 meeting. Text in black is existing, red is revised, blue is deleted.
2. Changes to Induced Test for Class II, Clause 10.8.2 PD Test Procedure

**10.8.2 Test procedure**

The voltage shall first be raised from zero to the 1.05 X line to ground value of the nominal system voltage (column 2, C57.12.00 Table 4) and held long enough to attain a stable partial discharge level and then record the level of partial discharge. The voltage shall then be raised to the one-hour level and held for a minimum of 5 min or until a stable partial discharge level is obtained to verify that there are no partial discharge problems. The partial discharge level shall be measured at the end of the 5 min period. If the 5 min. period at the 1 h voltage level is extended to obtain a stable partial discharge level the partial discharge shall be measured at the end of this period so that the level of partial discharges are recorded just before raising the voltage to the enhancement level. The voltage shall then be raised to the enhancement level and held for 7200 cycles. The voltage shall then be reduced directly to the one-hour level and held for 1 h.

During this 1 h period, partial discharge measurements shall be made at 5 min intervals. Partial discharge acceptance criteria shall be based on each line terminal rated 69 kV and above. These measurements shall be made in accordance with 10.9.

Immediately following the 1 h period, the voltage shall then be reduced to 1.05 X line to ground value of the nominal system voltage (column 2, C57.12.00 Table 4) and held until a stable partial discharge level is obtained and the partial discharge level measured.

1. Changes to Induced Test for Class II, Clause 10.8.5 PD Failure Detection.

**10.8.5 Failure detection**

Failure may be indicated by the presence of smoke and bubbles rising in the insulating liquid, an audible

sound such as a thump, or a sudden increase in the test current. Any such indication shall be carefully

investigated by observation, by repeating the test, and by other diagnostic tests to determine whether a

failure has occurred. In terms of interpretation of partial discharge measurements, the results shall be

considered acceptable and no further partial discharge tests required under the following conditions:

1. The magnitude of the partial discharge level does not exceed 250 pC during the 1 h test period.
2. The increase in partial discharge levels during the 1 h period does not exceed 50 pC.
3. The partial discharge levels during the 1 h period do not exhibit any steadily rising trend, and no sudden sustained increase in the levels occurs during the last 20 min of the test.
4. The magnitude of partial discharge level at 1.05 X Nominal System Voltage following the 1 h test period does not exceed 100 pC.
5. Addition of text regarding venting of bushings during PD test. In Vancouver S24, the Dielectric Tests SC approved the following text to be added to the end of Subclause 10.8.5.

If the partial discharge is measured during the Induced-voltage testing of the transformer and is suspected to be generated within an OIP (oil-impregnated-paper) bushing(s), it is permissible to “vent” the bushing(s) exhibiting partial discharge to the atmosphere using the bushing manufacturer’s instructions.

Unless agreed between manufacturer & purchaser, bushings shall not be vented proactively prior to dielectric testing. The Induced-voltage test shall be entirely repeated after venting the bushing and a note shall be added to the certified test report indicating bushing(s) were vented during the induced-voltage test.

Notes:

1. Partial discharge intended to be addressed by venting the bushing, is a low energy discharge arising from partial vacuum (pressure below atmosphere) created in the expansion chamber and/or gas bubbles generated during the Temperature Rise test and the cooling down afterwards. Partial vacuum is created in the expansion chamber due to absorption of nitrogen or air into oil, and gas bubbles are formed due to saturation of nitrogen or air. Partial discharges from these cases may be resolved by venting the bushing. If continuous gas bubble generation or elevated partial discharge remains after the venting, additional investigations are required.
2. If there are concerns of gas generation from the temperature rise test causing bushing failure during impulse or applied voltage test, an induced-voltage test can be performed before impulse testing for diagnostic purposes. A complete induced-voltage test shall be performed as the last dielectric test, as specified in subclause 10.1.5.1 for dielectric test sequence.
3. Not all OIP bushings exhibit these conditions, so bushing design can be a factor.
4. The same condition of gas bubble formation or partial vacuum may occur in service during normal operation of load and overload cycles.
5. Re-establishment of the bushing gas space blanket and resealing of the bushing must also be performed in accordance with the bushing manufacturer’s instructions. The internal integrity of the bushing may be compromised by venting, by allowing in oxygen and moisture or by not reestablishing proper conditions.
6. A revision to add clarification to the overvoltage factor for Induced Test in 10.8.1. In St Louis F24, the Dielectric Tests SC approved the following revisions to Subclause 10.8 Induced-voltage test for Class II power transformers. Text in black is existing, red is revised, blue is deleted.
	* 1. General

Each Class II power transformer shall receive an induced-voltage test with the required test voltage levels from IEEE Std C57.12.00-2021 Table 4 columns 6 and 7 based on the HV voltage class corresponding to the maximum system voltage. The required test voltage levels shall be induced in the high-voltage winding. The tap connections shall be chosen, when possible, so that test levels developed in the other windings during the one-hour test are *x* times their nominal system ~~maximum operating~~ voltages, as specified in Table 4 of IEEE Std C57.12.00-2021, where *x* (also referred to as the “overvoltage factor” in the text that follows) is the ratio of the line-to-line test voltage on the high-voltage winding to the nominal system ~~maximum operating~~ voltage.

1. Class I PD test. Revision to the test procedure by Don Ayer’s sub Task Force. In St Louis F24, the Dielectric Tests SC approved revisions to Subclause 10.7 to insert a new category of test for Class I power transformers when PD measurements are specifically requested by the purchaser. What follows in red text is all new.

**Induced-voltage tests for Class I power transformers with partial discharge measurements specifically requested by the purchaser**

**General**

Each Class I power transformer shall receive an induced-voltage test with the required test levels induced in the high-voltage winding. The tap connections shall be chosen, when possible, so that test levels developed in the other windings during the one-hour test are *x* times their maximum operating voltages, as specified in Table 3, Part C of IEEE Std C57.12.00-2021, where *x* (also referred to as the “overvoltage factor” in the text that follows) is the ratio of the test voltage on the high-voltage winding to the maximum operating voltage.

For a transformer built with a single magnetic core holding all windings, all windings are excited at a unique induction level, often referred to as “volts-per-turn.” During an induced-voltage test, with the transformer connected and excited as in service, all windings are excited at the same overvoltage factor, regardless of what tap is selected. Each winding turn receives the same voltage. The tap connections shall be chosen, when possible, such that voltages developed across other windings meet or exceed the required overvoltage factor.

The situation is quite different when transformers are equipped with auxiliary devices with separate magnetic cores, such as preventive autotransformer (reactor), series (booster) transformer, or series regulator. Different magnetic cores can be excited at different levels during operation or testing. In certain tap positions, these auxiliary devices do not have their core excited at all and no voltage appears across their windings. For such cases, the selection of the tap-changer position shall be guided by the principles described below. One exception is when such auxiliary devices are not excited on a permanent basis but used only as transitional devices. If equalizing windings are used, the highest voltage impressed across the preventive autotransformer will occur in either the bridging or non-bridging positions. This is because the preventive autotransformer is energized in all tap positions (bridging and non-bridging).

NOTE 1¾Equalizing windings are described in IEEE Std C57.131 and IEC 60214-1.

For transformers equipped with a series (booster) transformer, preventive autotransformer (reactor), or any other device, the selected tap position of the load tap-changer (LTC) shall be the one that produces the highest voltage across the windings of the series transformer, preventive autotransformer, and other auxiliary devices as applicable. There can be a conflict of choosing such a tap position when more than one such device is present. In such a case, the selected tap position of the LTC should be the best compromise so that all devices are tested with overvoltage. One common example is the case where a series transformer and preventive autotransformer are both present. In this case, the tap selected shall be the one that is closest to the position that produces the highest voltage across the windings of the series transformer and simultaneously excites the preventive autotransformer, which is typically a bridging position (not applicable when the preventive autotransformer is energized only during transition).

In order to test the series (booster) transformer, preventive autotransformer, and other devices, at the required minimum overvoltage factor, the voltage developed on the terminals of other windings may exceed the one-hour level mentioned in Table 3, Part C of IEEE Std C57.12.00-2021. In such cases, an alternative tap position may be selected by agreement between the manufacturer and the purchaser to avoid overstressing components such as bushings. [Annex D](file:///C%3A%5CUsers%5Csanto%5CAppData%5CLocal%5CMicrosoft%5CWindows%5CINetCache%5CContent.Outlook%5C4ZBFSMN8%5CClass%20I%20PD%20Testing_S24%20Approved_10312024.docx#_bookmark252) shows examples that can serve as a guide to select the LTC tap position for transformers having series (booster) transformer and/or preventive autotransformers.

For certain types of devices such as series reactors used as current limiting devices, there is no voltage developed across their windings during the induced voltage test as these devices are only excited when current flows in their windings. There is no option available to apply any overvoltage for these devices during the induced test.

NOTE 2¾The selection of the tap-changer position for induced test should be agreed upon between manufacturer and purchaser prior to design to avoid conflicts during final acceptance tests.

**Test procedure**

The voltage shall first be raised to the one-hour level and held for a minimum of 1 min or until a stable partial discharge level is obtained to verify that there are no partial discharge problems. The level of partial discharges shall be recorded just before raising the voltage to the enhancement level. The voltage shall then be raised to the enhancement level and held for 7200 cycles. The voltage shall then be reduced directly to the one-hour level and held for 1 h.

During this 1 h period, partial discharge measurements shall be made at 5 min intervals. Partial discharge acceptance criteria shall be per subclause 10.7.2.5 and these measurements shall be made in accordance with [10.9.](file:///C%3A%5CUsers%5Csanto%5CAppData%5CLocal%5CMicrosoft%5CWindows%5CINetCache%5CContent.Outlook%5C4ZBFSMN8%5CClass%20I%20PD%20Testing_S24%20Approved_10312024.docx#_bookmark154)

The pressure inside the transformer tank during the induced test shall not be increased by artificial means for the purpose of reducing the PD level. The liquid level and pressure inside of the transformer tank and/or conservator tank shall be configured such that the oil head pressure during the induced test does not exceed the pressure under usual service conditions. Any exceptions that increase tank pressure by more than 3.5 kPa (0.5 psi) over normal operating pressure, such as the use of an elevated test facility conservator tank, requires customer approval prior to test. A note shall be added to the certified test report confirming this approval.

NOTE¾Increasing the pressure for diagnostic purposes, such as to identify and possibly reduce suspected bubbles in the liquid, may be done as a remedial step to diagnose a source of high PD. To be considered valid, the test needs to be repeated with no added pressure as stated previously.

**Connections**

The transformer shall be excited exactly as it will be in service. The voltage may be induced from any winding or from special windings or taps provided for test purposes. Single-phase transformers shall be excited from single-phase sources. Three-phase transformers shall be excited from three-phase sources. The neutral terminals and other terminals that are normally grounded in service shall be solidly grounded. This will stress all of the insulation at the same per unit of overstress.

**Frequency**

The test frequency shall be increased, relative to operating frequency, as required to avoid core saturation. The requirements in [10.7.2](file:///C%3A%5CUsers%5Csanto%5CAppData%5CLocal%5CMicrosoft%5CWindows%5CINetCache%5CContent.Outlook%5C4ZBFSMN8%5CClass%20I%20PD%20Testing_S24%20Approved_10312024.docx#_bookmark144) are also applicable in the case of this induced test

**Failure detection**

Failure may be indicated by the presence of smoke and bubbles rising in the insulating liquid, an audible sound such as a thump, or a sudden increase in the test current. Any such indication shall be carefully investigated by observation, by repeating the test, and by other diagnostic tests to determine whether a failure has occurred. In terms of interpretation of partial discharge measurements, the results shall be considered acceptable and no further partial discharge tests required under the following conditions.

1. For transformers with nominal system voltage (NSV) of 34.5KV and above, the magnitude of the partial discharge level does not exceed 250 pC during the 1 h test period. For transformers below 34.5 kV NSV, the magnitude of the partial discharge level shall be set by agreement between the purchaser and the manufacturer.
2. For transformers with nominal system voltage (NSV) of 34.5 kV and above the increase in partial discharge levels during the 1 h period does not exceed 50 pC. For transformers rated below 34.5 kV NSV, the increase of the partial discharge level shall be set by agreement between the purchaser and the manufacturer.
3. The partial discharge levels during the 1 h period do not exhibit any steadily rising trend, and no sudden sustained increase in the levels occurs during the last 20 min of the test.

Judgment should be used on the 5 min readings so that momentary excursions of the partial discharge readings caused by cranes or other ambient sources are not recorded. Also, the test may be extended or repeated until acceptable results are obtained.

A failure to meet the partial discharge acceptance criterion shall not warrant immediate rejection, but it shall lead to consultation between purchaser and manufacturer about further investigations.

1. Induced test. Editorial issue raised in Denver Spring 2025 that existing subclause 10.5.1 on Induced Tests on transformers with Series or Multiple connections should be moved back to 10.8.4 for Class II power transformers, where it was in 2006 edition. Since this issue also could apply to Class I power transformers, it will be duplicated in 10.7.2.4. The TF approved after only one discussion, in Denver on March 25. The Dielectric Tests SC also approved on March 26 The text is:

**Induced-voltage test for transformers with series or multiple connections**

Transformers with windings that have multiple connections (series-parallel or delta-wye) and whose connections each have a nominal system voltage of 25 kV or above shall receive two induced tests, one in each connection. If more than one winding has such multiple connections, then the connections in each of the windings shall change between the tests, and the manufacturer shall determine the relative connections for each test. The test voltage and duration ~~(Class I—7200 cycle or Class II—one-hour test)~~ shall be contingent on the system voltage level of the high-voltage winding for the connection being tested. In all cases, the last induced test shall be for the connection with the highest test voltage.

1. Changes to Impulse Tests from Sylvain Plante’s TF in the Diel Test SC. Final survey approved by TF and SC in the Spring 2023 meeting.
2. Changes to 10.3.2.2, 10.3.2.3, 10.4.4, 10.4.5 impulse tests on transformers with series-multiple and delta-wye connections. The following final wording was approved by the Dielectric Test SC during the S23 Milwaukee SC meeting

10.3.2.2 Windings for series, parallel or multiple connections. The windings shall be tested for all series, parallel and multiple connections. The test voltage for these conditions shall correspond to the BIL of the winding for that connection.

10.3.2.3 Windings for delta or wye connections. The three-phase transformer shall be tested on both delta and wye connections. The test voltage for each connection shall correspond to the BIL of the winding for that connection.

10.4.4 Windings for series, parallel or multiple connections. For high-voltage windings with series, parallel or multiple connections above 15 kV, the routine impulse test shall be conducted on each connection at its assigned BIL. For nominal system voltages of 15 kV and below, only the series connections shall be tested, unless tests on all connections are specified.

10.4.5 Windings for delta or wye connections. For high-voltage windings of three-phase transformers with delta or wye connection above 15 kV, the routine impulse test shall be conducted on each connection at its assigned BIL. For nominal system voltages of 15 kV and below, only the wye connection shall be tested, unless tests on all connections are specified.

1. Establishing guidelines about use of +/-3% tolerance on voltage peak for SI and LI. The following final wording was approved by the Dielectric Test SC during the F23 Kansas City SC meeting

Add as second paragraph to Subclause 10.2.2.2 The basic rule for application of the tolerance on voltage crest value is that testing laboratories shall aim for the test value specified.  For any of the impulses of a test series, if the actual measured voltage is lower than the required voltage crest value but within the allowable tolerance of ±3%, the impulse crest shall be accepted as valid. For any required subsequent impulse on the same terminal, adjustments shall be made to aim for the specified test value

Add as second paragraph to Subclause 10.3.1.1 The basic rule for application of the tolerance on voltage crest value is that testing laboratories shall aim for the test value specified.  For any of the impulses of a test series, if the actual measured voltage is lower than the required voltage crest value but within the allowable tolerance of ±3%, the impulse crest shall be accepted as valid. For any required subsequent impulse on the same terminal, adjustments shall be made to aim for the specified test value.

1. Tap position for switching impulse. The S24 Vancouver Dielectric Tests SC approved a motion to add the following at the end of Subclause 10.2.4:

While selecting the tap connection complying to above requirements, the phase-to-phase voltage withstand capability of the transformer active part including LTC, bushings and all accessories shall be reviewed.

Testing on a non-compliant tap connection shall be discussed and agreed between manufacturer and purchaser.”

***Pending Work***

Since this is a continuous revision document, there is ongoing work in Task Forces.

1. Possible revisions from Hakan Sahin’s PCS TF for Revision of C57.12.90. In Denver Spring 2025 there was discussion related to Clause 5 and determining the temperature used for measuring cold resistance. This item is ongoing, but at this time there are no decisions made and nothing to change in 12.90. A small sub-TF will draft the wording.
2. Possible changes to Clause 13 sound test from Ramsis’ TF. Measuring sound level of Preventive Autotransformers (PA) in air as a Quality Control check was again presented and discussed. Possibly a Task Force Paper will be written. In Denver Spring 2025 there was continued discussion. This item is ongoing, but at this time there are no decisions made and nothing to change in 12.90.
3. Possible changes to Subclause 10.2 or 10.3 from Sylvain Plante’s TF regarding switching and lightning impulse tests. Ongoing discussion on the topic of requirement for sensitivity of current measurement of chopped waves. And possible future change to 10.3.4.2 to add requirements for voltage overlays, proposed by Jason Varnell.
4. Other possible revisions to subclauses 10.5 to 10.10 from Ajith Varghese’s TF for revision of low frequency tests. New discussion on the topic of PD calibration requirement moving from C57.113 Clause 5.1 to C57.12.90.
5. Possible changes to subclause 10.11 from Diego Robalino’s TF regarding insulation resistance. Possible future changes to insulation resistance measurement procedures are being considered, as compared to conflicting procedures in other documents such as C57.152. Also, possible future addition of core megger and clamp megger procedures since none currently exist in 12.90. The Task Force has gathered data on core ground measurements but has nothing to change in C57.12.90.
6. Changes to Clause 11 Temperature Test from Dinesh Sankarakurup’s TF
	* Clarification to Hottest spot Rise calculation using Fiber Optics. Egon and Ewald Schweiger of Siemens advanced their proposal to add as an alternate method an option to measure hot spot temperature using direct measurement with fiber optic probes. A small sub task force developed wording. This was further discussed at TF meeting in Vancouver S24, and more work will be done. It was not discussed in St. Louis F24. Discussion in Denver Spring 2025 resulted in the request to circulate the proposed new text, and gather data.
	* Request for clarification for temp test of 3-winding transformers, injecting maximum losses, and correcting for maximum common winding current in autos. Prior to Kansas City a small sub group developed some wording, it was briefly discussed in Kansas City. It was not discussed in St. Louis F24, nor in Denver Spring 2025..
	* Standardize Method for Hot resistance extrapolation not covered in Kansas City, but Bertrand Poulin submitted some info that should be circulated to the TF. It was not discussed in St. Louis F24, nor in Denver Spring 2025..

Respectfully submitted,

Stephen Antosz, WG Chair

Jason Varnell, WG Vice-Chair

March 27, 2025

## L.3.5 WG Standards Transformer on Revision for C57.152, Guide of Field Tests

*Standards Subcommittee,
WG – PC57.152 Revision
IEEE / PES Transformers Committee*

*March 25, 2025, 4:45PM – 6:00PM****UNAPPROVED MINUTES***

**Welcome**

The chair of the working group, Marcos Ferreira, and the secretary, Goran Milojevic, opened the meeting at 04:45PM.

1. **Attendance and Attendance for Quorum**

At the time of the meeting there were 30 Members, including Chair and Secretary. A total of 18 members were counted as present at the meeting. 72 members and guests signed into the circulating paper roster.

18 members present of 30 mean requirements for quorum were fulfilled. The list of attendees who signed into the paper roster is shown below:

|  |  |  |
| --- | --- | --- |
| Name | Affiliation | Status |
| Ferreira, Marcos | FEMA | Chair |
| Milojevic, Goran | DV Power | Secretary |
| Bradshaw, Jeremiah | US Bureau of Reclamation | Member |
| Dutta Roy, Samragni | Siemens Energy | Member |
| Ermakov, Evgenii | Hitachi Energy | Member |
| Foata, Marc | Maschinenfabrik Reinhausen | Member |
| Gara, Lorne | Shermco | Member |
| Gustavsson, Niklas | Hitachi Energy | Member |
| Hayes, Roger | GE Vernova | Member |
| Hernandez, Ronald | Doble Engineering Company | Member |
| Locarno, Mario | Doble Engineering Company | Member |
| Mabrey, Stephanie | Weidmann Group | Member |
| Murray, David | TVA | Member |
| Poorvi, Patel | EPRI | Member |
| Robalino, Diego | Megger | Member |
| Saad, Mickel | Hitachi ABB Power Grids | Member |
| Sweetser, Charles | OMICRON Electronics Corp USA | Member |
| Tanaka, Troy | Burns & McDonnell | Member |
| Woods, Deanna | PTT | Member |
| Alonso, Mario | Georgia Transformer | Guest |
| Arnold, Elise | SGB | Guest |
| Balakrishnan, Mani | Delta Star | Guest |
| Chanda, Sudip | Delta Star | Guest |
| Chanmin, Jeong | HD Hyundai Service | Guest |
| Cordova, Olivia | US Bureau of Reclamation | Guest |
| Crockett, Dan | Ameren | Guest |
| Da Silva, Roberto | Maschinenfabrik Reinhausen | Guest |
| Debass, Sami | EPRI | Guest |
| Delgado, Gabriel | Invenergy | Guest |
| Duffy, Jesse | Nashville Electric Service | Guest |
| Elliott, Will | AEP SWEPCO | Guest |
| Espindola, Marco | Hitachi Energy | Guest |
| Faur, Florin | Prolec GE | Guest |
| Garner, Joshua | RESA Power | Guest |
| Gyore, Attila | MIDEL & MIVOLT Fluids | Guest |
| Jarosz, Patrycja | IEEE SA | Guest |
| Jones, Brexton | SD Myers | Guest |
| Kumar, Arvind | Delta Star | Guest |
| Labh, Ashwini | Hitachi Energy | Guest |
| LaBean | Consumers Energy | Guest |
| Lachance, Mathieu | Omicron Energy | Guest |
| Lakhani, Komel | Siemens Energy | Guest |
| Leal, Fernando | Prolec GE | Guest |
| Mani, Kumar | Duke Energy | Guest |
| Mellin, Tony | Vaisala | Guest |
| Merrill, Logan | Omicron Energy | Guest |
| Naderian, Ali | Consultant | Guest |
| Neild, Kris | Megger | Guest |
| Newbill, Mark | Hitachi Energy | Guest |
| Ortiz, Cuahtemoc | Niagara Power Transformer Company | Guest |
| Qiao, Crystal | Trench Group | Guest |
| Rapelly, Layman | Georgia Transformer | Guest |
| Robles, Antonio | US Bureau of Reclamation | Guest |
| Rodriguez, Jesus Sanchez | Vetriv | Guest |
| Santos, Armindo | Prolec GE | Guest |
| Sar Kinen, Garret | Xcel Energy | Guest |
| Scardazzi, Akior | Siemens Energy | Guest |
| Shaikh, Salahuddin | NRG Energy | Guest |
| Sinclair, John | Black & Veatch | Guest |
| Singh, Amitkumar | Con Edison | Guest |
| Steele, H. Allen | TVA | Guest |
| Szczechowski, Janusz | Maschinenfabrik Reinhausen | Guest |
| Sze, Matthew | Omicron Energy | Guest |
| Tan, Jonathan | Northern Transformer | Guest |
| Thiede, Andreas | HIGHVOLT Prueftechnik Dresden | Guest |
| Tolcachir, Eduardo | TTE | Guest |
| Varghese, Ajith | Prolec GE | Guest |
| Whitten, Christopher | Hitachi Energy | Guest |
| Wright, Jeffrey | Duquesne Light | Guest |

1. **Approval of the Agenda**

The motion to approve the agenda was made by Evgenii Ermakov, and seconded by Diego Robalino. The motion was approved unanimously.

1. **Approval of Minutes of Fall 2024 Meeting**

The motion to approve the Minutes of Spring 2024 Meeting was made by Stephanie Mabrey, and seconded by Poorvi Patel. The motion was approved unanimously.

1. **Call for Patents**

The chair presented slide 1-4, dated January 2, 2018 informing of the IEEE patent policy and participants duty to inform. There were no issues related to patent assurance brought up by attendees in the meeting.

1. **IEEE Copyright Policy**

The chair presented IEEE-SA Copyright Policy slides 1-2 informing the audience of the policy.

1. **Chair’s Remarks**

The chair, Marcos Ferreira, gave the following remarks.

“Updates since the last meeting, fall 2024, the CRG gathered several times through Teams meetings to address all comments provided by MEC successfully. Goran and I would like to express our sincere appreciation for the dedication and contribution from CRG team. Furthermore, Goran and I will present all technical and general comments to all of you, members of this WG, at this time so we can a vote to accept the responses proposed by CRG team.”

1. **Report by the WG Secretary on the Comment Resolution Group’s (CRG) activities**

The secretary, Goran Milojevic, informed the working group about the activities since the Fall 2024 meeting:

* Initial balloting closed on November 5th, 2024, after an extension, once 76% response rate was reached.
* 91% approval rate on the draft
* 145 comments received in regular balloting process
* 32 comments on revised Section 7.2
* 2 comments on revised Section 7.3
* 16 comments on revised Section 7.4
* 34 comments on new annexes J and K
* 61 comments on the rest of the document
* 49 comments were editorial
* 51 comments were technical
* 45 comments were general
* Additional comments received after the close of balloting
* Comment Resolution Group (CRG) was formed at the Fall 2024 meeting with the following membership: Evgenii Ermakov, Niklas Gustavsson, Attila Gyore, Marcos Ferreira, Marc Foata, Ronald Hernandez, Mario Locarno, Goran Milojevic, Diego Robalino, Charles Sweetser.
* Five online meetings of the CRG were held.
* All 145 comments received during the official balloting process were addressed. The CRG members reached out to some commenters for clarification and consulted with other working groups within the Transformer Committee.
* During the meetings, CRG decided to accept 45 editorial comments and to revise 4.
* Out of remaining 96 technical and general comments CRG proposes accepting 63, revising 15, and rejecting 18.
* The full list of comments, with resolutions proposed by the CRG, was sent for review by email on March 14th

After the report, Stephanie Mabrey asked for clarification when the additional comments were received. The secretary, Goran Milojevic responded that they were received after the close of balloting.

1. **Discussion of responses to technical and general comments proposed by the CRG**

The secretary, Goran Milojevic, asked for present members and guests to bring up for discussion any specific comment responses proposed by the comment resolution group. Poorvi Patel asked to provide examples of major technical changes that were made to the document during the comment response process. The secretary, Goran Milojevic, explained the changes made in Table 1, and also additional references to document C57.166 which caused removal of certain parts of the PC57.152 document.

1. **Vote on accepting the response proposed by the CRG**

After reviewing the proposed comment responses, Mario Locarno made a motion to vote on the full list of 145 comment responses that was submitted to the members for review prior to the meeting. The motion was seconded by Mickel Saad. The motion was accepted unanimously.

Another motion, to authorize the Comment Resolution Group to respond to any general and technical comments received during ballot recirculation, was made by Charles Sweetser and seconded by Mario Locarno. The motion was accepted unanimously.

1. **Meeting Adjournment**

The motion to adjourn the meeting was made by Evgenii Ermakov, and seconded by Mario Locarno. The meeting was adjourned at 05:30PM.

Respectfully submitted,

Marcos Ferreira – Chair Goran Milojevic – Secretary

## L.3.6 WG C57.133 Reverse Power Flow

Minutes – Third Meeting: WG PC57.133

“Guide for Evaluating Transformer Performance under Reverse Power Flow”

3:15 PM to 4:30 PM MDT | March 25, 2025
Centennial DE, Floor 3 | Hyatt Regency Denver at Colorado Convention Center
Denver, CO

Chair: Ryan Hogg Bureau of Reclamation rhogg@ieee.org

Vice Chair: Bruce Webb Knoxville Utilities Board bruce.webb@kub.org

Secretary: Drew Welton Intellirent dwelton@intellirentco.com

**Minutes** – items in green = discussion during meeting

1. [Behavior](https://standards.ieee.org/wp-content/uploads/import/documents/other/Participant-Behavior-Individual-Method.pdf), [Copyright](https://standards.ieee.org/wp-content/uploads/2022/02/ieee-sa-copyright-policy.pdf), and [Patent](https://mentor.ieee.org/myproject/Public/mytools/mob/slideset.ppt) – reviewed all slides
2. Quick review – PAR (expires 12/31/2028) – reviewed
3. Attendance form and quorum check (91 members; 46 required for quorum)
	1. Attendance form displayed for attendees to sign in
	2. 61 members were present of 91 total members, quorum was achieved
	3. 24 guests requested membership, only 5 met the requirements for membership
	4. Plans to record the meeting were announced, no objections
4. Agenda approval
	1. Previously sent out, unanimous approval of the agenda, no objections
5. Minutes approval
	1. October 29, 2024 meeting (St Louis)
	2. February 24, 2025 meeting (virtual)
	3. Previously sent out, unanimous approval of both sets of minutes, no objections
6. iMeet Central site:
	1. <https://ieee-sa.imeetcentral.com/ieeedashboard/>
	2. Quick demo, how to access IEEE Transaction Paper
	3. Announcement of permission granted to the working group to use the Sept 1983 IEEE transaction paper, “Power Flow Direction Definitions for Metering of Bidirectional Power”. Document has a quadrants metering diagram.
	4. Plan to both upload it to Transformer Committee website and iMeet Central for working group to have as a reference.
7. Status update – TF Definition of Transformer Reverse Power
	1. Chair of TF = Ryan Hogg
	2. Have held 2 virtual meetings, more planned
	3. Report on status of definition work
	4. Developing a quadrants figure that standard could use
	5. Task force chair provided an update of the work on a definition of reverse power.
	6. TF has 29 member and conducted two virtual meetings since St. Louis (Fall 2024). Hopefully one more meeting to close the task force and present the working group with a finalized definition. TF also developed a quadrants image that guide could use.
	7. Ramsis Girgis remarked about the feasibility of reverse power flow in step down vs. step up transformers, and the relationship of lagging power factor. A review of the different quadrants was presented for discussion.
8. Presentations: The following five presentations were delivered
	1. Ramsis Girgis (Hitachi Energy) – Feasibility of Reverse Power Flow Scenarios in Step-Down Power Transformers
		1. Question: For this modeling, was the high voltage system assumed to not move up/down in voltage, low side voltage moves as a result of reverse power flow?
			1. Answer: Yes, you can have up to 6% of the change in that case.
	2. Ryan Hogg (Bureau of Reclamation) – Dry Type GSU and Station Service Power
	3. Vinay Patel (Con Edison of New York) – Distributed generation
		1. Amitabh Sarkar – We need to talk about how this affects the transformers, what were they designed for. What is the reverse power flow?
		2. Chair – Agreed, this is what these presentations/discussions are designed to bring up.
	4. Dan Blaydon (Baltimore Gas & Electric) – Solar DER
	5. Drew Welton (Intellirent) – Auto-determination OLTC controls
9. Review document outline – Chair presented “Draft PC57.133 Outline” (included further on in these minutes)
	1. Thomas Dauzat – proposed sections (*per email on February 27, 2025*)
		1. Reverse Power Flow – Power
		2. Reverse Power Flow – Transmission/Substation
		3. Reverse Power Flow – Distribution/Feeders
		4. Thomas Dauzat made a motion to split up the document into three sections: (1) Power, (2) Transmission/Substation, and (3) Distribution/Feeders
		5. Motion was seconded by Ramsis Girgis
		6. A discussion of the motion was held during which many people asked for clarification of the motion’s intent, the chair repeated the motion
		7. The motion was moved to be tabled; the motion to table the previous motion was seconded and received unanimous approval
10. Request task force chairs and volunteers to draft various proposed guide sections – did not have time to discuss, plan to discuss during a virtual working group meeting
11. Call for volunteers to present at future in-person meetings: – reviewed, no new volunteers spoke up during meeting
	1. E.g., how have you/your organization been approaching reverse power and transformers, what impacts are you/your organization seeing…
	2. In the works
		1. Fall 2025 – Joe White
12. Old Business – none – reviewed
13. New Business – any? – no time to begin any new business
14. Next meetings
	1. Possible virtual – if did not establish initial TFs to begin drafting text, host a virtual meeting to finalize outline and assign TFs – per discussion/status in meeting, planning to have a virtual working group meeting to establish task forces to begin drafting text for the guide
	2. In person: Fall 2025 in Bonita Spring, FL
15. Adjourn – meeting adjourned as completed the agenda items

Draft PC57.133 Outline – as presented with item 9.

**Introduction –** “how we got here” as an industry

1. **Overview**
	1. Scope
	2. Purpose
	3. Word Usage
2. **Normative References**
3. **Definitions, acronyms, and abbreviations**
	1. Definitions
	2. Acronyms and abbreviations
4. **Historical context** *(this might become an informative annex)*
	1. Watts and VARs chart
	2. Typical causes of reverse power flow *(note similarity to proposed Annex B)*
5. **C57 Standards and Power Flow Direction**
	1. Step-down, step-up, bi-directional, same voltage both sides
	2. C57.12.00, C57.12.01… other standards and how they discuss power flow direction
6. **Potential effects**
	1. Voltage regulation (including OLTC and controls)
	2. Core saturation (LV taps, variable flux)
	3. Winding heating (common windings of autos)
	4. Voltage imbalance (battery back feeding, delta connections and grounding)
	5. Volts per turn increase (low voltage winding on step-down transformer, but providing VARs back to system)
	6. Asymmetrical pennant cycle tap changer (does not work in reverse)
	7. Inverters – Step down not designed to be inverter transformers, now operating as step-up (e.g., two grounds = harmonics; core design (shielding/grounding)
	8. …
7. **Transformer designs and potential effects**
	1. Simple two winding
	2. Two winding w/ LV taps
	3. Two winding w/ LV taps, variable flux
	4. Auto transformers
	5. Multi winding transformers
	6. Amorphous vs grain-oriented cores
8. **Recommended actions for operation of existing transformers**
9. **Recommended guidance for new transformers (e.g., specification type language)**

Annexes

Annex A: (informative) How to determine numerical values for Watt/VAR values for a specification

Annex B: (informative) How to assess which transformers are/may be subject to reverse power flow (system condition, therefore informative annex)

**Working Group Force Membership/Guests**:

|  | **First Name** | **Last Name** | **Affiliation** | **Membership** | **Attended Feb 24, 2025 Meeting?** |
| --- | --- | --- | --- | --- | --- |
| 1 | Kayland  | Adams  | Prolec-GE Waukesha  | Member | No |
| 2 | Gilles | Bargone | FISO | Member | Yes |
| 3 | Mats | Bernesjo | Hitachi Energy | Member | Yes |
| 4 | Daniel | Blaydon | Baltimore Gas and Electric | Member | Yes |
| 5 | William  | Boettger | Boettger Transformer Consulting LLC | Member | Yes |
| 6 | Garrett | Bradshaw | Howard Industries  | Member | Yes |
| 7 | Jeffrey | Brooks | Asplundh Engineering Services | Member | Yes |
| 8 | Alfredo  | Carrizales  | Prolec GE  | Member | Yes |
| 9 | Thomas | Dauzat | AEP-SWEPCO | Member | Yes |
| 10 | Nikolaus | Dillon | Dominion Energy | Member | Yes |
| 11 | Fernando | Duarte | Hitachi Energy | Member | Yes |
| 12 | Roger | Dugan | (Retired) Self | Member | No |
| 13 | Eric | Elson | San Diego Gas & Electric  | Member | Yes |
| 14 | Miguel | Garcia | Hitachi Energy | Member | No |
| 15 | Eduardo  | Garcia  | Siemens Energy | Member | Yes |
| 16 | David | Garcia-Paredes | Virginia Transformers Corp | Member | No |
| 17 | James | Gardner | Prolec-GE Waukesha | Member | Yes |
| 18 | Ramsis | Girgis | Hitachi Energy | Member | Yes |
| 19 | Jose Antonio | Gonzalez Ceballos | Virginia/Georgia Transformers | Member | No |
| 20 | William  | Griesacker  | WGA | Member | Yes |
| 21 | Jesse | Hall | Virginia Transformer Corp. | Member | No |
| 22 | Corey | Hanson | Flex-Core | Member | Yes |
| 23 | Giovanni | Hernandez Decanini | Virginia Transformers Corp | Member | Yes |
| 24 | Saramma | Hoffman | PPL | Member | No |
| 25 | Ryan | Hogg | Bureau of Reclamation | Member | Yes |
| 26 | Derek | Hollrah | Burns & McDonnell | Member | Yes |
| 27 | Saif | Hossain | Trench Group  | Member | Yes |
| 28 | Miljenko | Hrkac | Hitachi Energy | Member | No |
| 29 | Jose | Izquierdo | Siemens energy | Member | Yes |
| 30 | Nick | Jensen | Delta Star | Member | Yes |
| 31 | John | John | Virginia Transformer Corp  | Member | Yes |
| 32 | Christopher | Johnson | Oncor | Member | No |
| 33 | Akash | Joshi | Kimley-Horn | Member | No |
| 34 | Thrinadha  | Katapalli  | Virginia Transformer Corp | Member | No |
| 35 | Anton | Koshel | Delta Star Inc | Member | Yes |
| 36 | Mark | Lachman | Doble | Member | Yes |
| 37 | Jihun | Lee | HD HYUNDAI ELECTRIC  | Member | No |
| 38 | Junho | Lee | HD Hyundai Electric | Member | No |
| 39 | Kushal | Mahajan | Sungrow | Member | Yes |
| 40 | Swapnil | Marathe | Megger | Member | Yes |
| 41 | Daniel | Martinez | Jfe guest | Member | No |
| 42 | Katherine  | Marulanda | Magnetron  | Member | No |
| 43 | Brian | McCarrick | Virginia Transformer Corp | Member | Yes |
| 44 | Omar | Mendez | Prolec | Member | Yes |
| 45 | Emilio | Morales-Cruz | Qualitrol  | Member | Yes |
| 46 | Tyler | Morgan | Duke Energy | Member | Yes |
| 47 | Dan | Mulkey | Mulkey Engineering Inc | Member | No |
| 48 | Ali | Naderian | EnerPars | Member | Yes |
| 49 | Shankar | Nambi | Bechtel Energy, Inc. | Member | Yes |
| 50 | Eduardo | Orozco | GE Grid Solutions | Member | No |
| 51 | Sanjay | Patel | Royal Smit Transformers  | Member | Yes |
| 52 | Vinay  | Patel | Con Edison | Member | Yes |
| 53 | Gustavo | Prado | Siemens Energy | Member | No |
| 54 | Tim | Raymond | Inductive Reasoning | Member | Yes |
| 55 | Yuri | Rossini | Siemens Energy | Member | Yes |
| 56 | Marnie  | Roussell | Entergy  | Member | Yes |
| 57 | Paul | Salvato | Intellirent | Member | No |
| 58 | Amitabh  | Sarkar  | Virginia Transformer Corporation  | Member | Yes |
| 59 | Markus | Schiessl | SGB | Member | Yes |
| 60 | Eric | Schleismann | Southern Company  | Member | Yes |
| 61 | Hemchandra  | Shertukde | University of Hartford | Member | Yes |
| 62 | Leena | Shimpi | Mgm transformer  | Member | No |
| 63 | Stephen | Shull | BBC Electrical Services Inv | Member | Yes |
| 64 | Igor | Simonov | Toronto Hydro | Member | No |
| 65 | James | Spaulding | City of Fort Collins Utilities  | Member | No |
| 66 | Andy | Speegle | Entergy  | Member | No |
| 67 | Brad | Staley | Leeward Renewable Energy  | Member | No |
| 68 | Sunny | Swarna | Virginia Transformer Corp | Member | Yes |
| 69 | Marc | Taylor | JFE Shoji Canada | Member | Yes |
| 70 | Joseph | Tedesco | Hitachi Energy | Member | Yes |
| 71 | Ed | teNyenhuis | Hitachi Energy | Member | Yes |
| 72 | Mark | Tostrud | Dynamic Ratings | Member | Yes |
| 73 | Kannan | Veeran  | Virginia/Georgia Transformer Corp | Member | No |
| 74 | Juan | Velasquez | Magnetrón SAS | Member | No |
| 75 | Karsten | Viereck | Reinhausen Germany | Member | Yes |
| 76 | Krishnamurthy | Vijayan  | Pennsylvania transformers  | Member | No |
| 77 | Dharam | Vir | Prolec GE  | Member | Yes |
| 78 | Pragnesh | Vyas | Cleveland cliffs | Member | Yes |
| 79 | David | Walker | MGM Transformers | Member | Yes |
| 80 | Joe | Watson | JD Watson and Associates  | Member | Yes |
| 81 | Bruce  | Webb | Knoxville Utilities Board  | Member | Yes |
| 82 | Drew | Welton | Intellirent | Member | Yes |
| 83 | Joe | White | POWER Engineers | Member | Yes |
| 84 | Jeffrey | Wright | Duquesne Light | Member | Yes |
| 85 | Fei | Yang | Hitachi Energy | Member | Yes |
| 86 | Tim | Young | Hitachi Energy  | Member | No |
| 87 | Guang | Yuan | Hitachi Energy  | Member | Yes |
| 88 | Michael | Zarnowski | Carte International | Member | No |
| 89 | Hongzhi (Alan) | Zhang | Hitachi Energy | Member | No |
| 90 | Shibao | Zhang | PCORE Electric | Member | Yes |
| 91 | Waldemar | Ziomek | PTI Transformers LP | Member | Yes |
| 92 | Stefan | Abelen | Maschinenfabrik Reinhausen Germany | Guest | No |
| 93 | Mihirkumar | Amin | Eaton Corporation | Guest | Yes, Requested Membership - not granted |
| 94 | Kyungchan | An | HYOSUNG | Guest | Yes |
| 95 | Alex | Ayala | ERMCO power partners | Guest | Yes |
| 96 | Duvier | Bedoya | Hitachi  | Guest | Yes |
| 97 | Edwin | Betancourt | Siemens Energy | Guest | No |
| 98 | Enrique | Betancourt | Prolec GE  | Guest | Yes |
| 99 | Naveen | Bhardwaj | Trench Group | Guest | No |
| 100 | Kevin | Biggie | Weidmann  | Guest | Yes |
| 101 | Jeremiah | Bradshaw | Bureau of Reclamation | Guest | No |
| 102 | Josipa | Brekalo | Koncar D&ST | Guest | Yes |
| 103 | Christopher  | Brown | San Diego Gas and Electric  | Guest | Yes |
| 104 | David | Calitz | Siemens Energy | Guest | Yes |
| 105 | Fidel | Castro | Sdge | Guest | Yes |
| 106 | Bhaumik | Choksi | Hitachi Energy | Guest | No |
| 107 | Rhett | Chrysler | ERMCO | Guest | No |
| 108 | Adriana | Cisco Sullberg | Salt River Project | Guest | Yes |
| 109 | Brian | Conneighton | Cleveland Cliffs | Guest | Yes |
| 110 | Janet | Crockett | Fayettville PWC | Guest | Yes, Requested Membership - not granted |
| 111 | Rich | Cryer | Digitaldrid inc | Guest | Yes |
| 112 | Marcos | Czernorucki | Hitachi Energy | Guest | Yes |
| 113 | Luiz | de Oliveira | Hitachi Energy | Guest | Yes, Requested Membership - granted after Denver meeting |
| 114 | Sami | Debass | EPRI | Guest | Yes, Requested Membership - not granted |
| 115 | Scott | Digby | Duke Energy | Guest | Yes |
| 116 | Paul | Dolloff | EKPC and University of Kentucky | Guest | No |
| 117 | Samragni | Dutta Roy  | Siemens Energy Inc  | Guest | Yes, Requested Membership - not granted |
| 118 | Janko | Dzodan | Koncar D&ST | Guest | No |
| 119 | Egui | Espitia | Reinhausen Manufacturing Inc | Guest | Yes |
| 120 | Sanford | Fong | Georgia Power | Guest | Yes |
| 121 | Patrick | Foster | NextEra Energy | Guest | Yes, Requested Membership - not granted |
| 122 | Raymond | Frazier | Ameren | Guest | No |
| 123 | Alan | Fujimori | Romagnole | Guest | Yes |
| 124 | Jose | Gamboa | The H-J Family of Companies  | Guest | Yes |
| 125 | Dragana | Gasic | Koncar D&ST | Guest | No |
| 126 | Orlando | Giraldo | The H-J Family of Companies | Guest | Yes, Requested Membership - not granted |
| 127 | Alireza  | Gorzin  | Black & Veatch | Guest | No |
| 128 | Shawn | Gossett | Ameren | Guest | Yes |
| 129 | Christine  | Grunbaum  | Ameren | Guest | No |
| 130 | Didier | Hamoir | Transformer Protector Corporation  | Guest | Yes |
| 131 | Kevin | Hampton  | Siemens Energy | Guest | No |
| 132 | Kyle | Heiden | Eaton | Guest | Yes, Requested Membership - not granted |
| 133 | Peter | Heinzig | Weidmann  | Guest | Yes |
| 134 | Jean Carlos (JC)  | Hernandez-Mejia | Georgia Tech NEETRAC | Guest | Yes |
| 135 | Balaji | Janakiraman | Virginia Transformer  | Guest | Yes |
| 136 | Kurt | Kaineder | TRENCH  | Guest | Yes, Requested Membership - not granted |
| 137 | Gary | King | Consultant/self | Guest | Yes |
| 138 | Kenneth  | Klein  | Johnson  | Guest | Yes |
| 139 | Dmitriy  | Klempner  | Southern California Edison  | Guest | Yes |
| 140 | Nicholas | Koinis | CenterPoint energy  | Guest | Yes |
| 141 | Matija | Koprivnjak | Končar D&ST | Guest | Yes |
| 142 | Nihat | Kosedagi | Hitachi Energy | Guest | No |
| 143 | Krzysztof | Kulasek | Delta Star Inc. | Guest | Yes |
| 144 | Angela | Leigl | Eaton | Guest | No |
| 145 | Xose | Lopez-Fernandez | Universidade de Vigo | Guest | Yes, Requested Membership - granted after Denver meeting |
| 146 | Tim-Felix  | Mai | Siemens Energy  | Guest | Yes, Requested Membership - not granted |
| 147 | Kumar | Mani | Duke Energy | Guest | Yes |
| 148 | Filip | Mikulecky | Koncar Power Transformers Ltd. | Guest | Yes |
| 149 | Curtis | Moore | DIGITALGRID, INC. | Guest | Yes |
| 150 | Charles | Morgan | Eversource Energy | Guest | No |
| 151 | Fredy | Murcia | Siemens Energy | Guest | Yes, Requested Membership - granted after Denver meeting |
| 152 | Hugo | Murillo  | HJ | Guest | Yes, Requested Membership - granted after Denver meeting |
| 153 | Aniruddha | Narawane | Eaton | Guest | Yes, Requested Membership - not granted |
| 154 | Ashwin | Padmanaban Iyer | STP | Guest | Yes |
| 155 | Dipeshkumar | Patel | Hyper solutions | Guest | Yes, Requested Membership - not granted |
| 156 | Nitesh | Patel | Hyundai Power Transformers  | Guest | Yes, Requested Membership - not granted |
| 157 | Monil | Patel | PG&E  | Guest | Yes |
| 158 | Marcelino | Perez | Prolec | Guest | Yes, Requested Membership - not granted |
| 159 | Jouni  | Peppanen | EPRI | Guest | No |
| 160 | Luka | Peuc | Končar D&ST | Guest | Yes |
| 161 | Thien | Pham | Siemens Energy | Guest | Yes, Requested Membership - not granted |
| 162 | Chris | Powell | Intermountain Electronics  | Guest | Yes, Requested Membership - not granted |
| 163 | João | Pranke | Federal University of Santa Maria | Guest | No |
| 164 | Adnan  | Rashid  | Measurement Canada | Guest | No |
| 165 | Robert | Reepe | Georgia Power Co | Guest | Yes |
| 166 | Wei | Ren | EPRI | Guest | No |
| 167 | Juan | Rodriguez | Magnetron | Guest | Yes |
| 168 | Rodrigo  | Ronchi  | WEG Transformers México  | Guest | Yes |
| 169 | Daniel | Sauer | Eaton | Guest | No |
| 170 | Kabir | Sethi | Hitachi Energy Germany Ag | Guest | Yes, Requested Membership - not granted |
| 171 | Salahuddin  | Shaikh | NRG Energy Inc | Guest | Yes, Requested Membership - not granted |
| 172 | Masoud | Sharifi | Siemens Gamesa Renewable Energy | Guest | No |
| 173 | Jason | Snyder | First Energy Corp | Guest | Yes |
| 174 | Markus | Stank | MR | Guest | Yes, Requested Membership - not granted |
| 175 | Andy | Steineman | Delta Star, Inc. | Guest | Yes |
| 176 | Janusz | Szczechowski | Reinhausen | Guest | Yes, Requested Membership - not granted |
| 177 | Michael | Thompson | SEL Engineering Services  | Guest | No |
| 178 | Timothy | Tillery | Howard Industries | Guest | Yes |
| 179 | Eduardo  | Tolcachir  | TTE Transformers  | Guest | No |
| 180 | Leonard  | Torchia  | PSE&G  | Guest | Yes |
| 181 | Reinaldo | Valentin | Duke Energy | Guest | No |
| 182 | Valentina | Valori | Hitachi Energy  | Guest | Yes |
| 183 | Matt | Weisensee  | PacifiCorp  | Guest | Yes |
| 184 | Stephen | Wolbach | Alabama Power | Guest | Yes |
| 185 | Terry | Wong | Trench Limited | Guest | Yes, Requested Membership - granted after Denver meeting |
| 186 | Jiahao | Xie | S&C electric | Guest | Yes |
| 187 | Koray | Yavuz | Noark Electric US | Guest | No |
| 188 | Patrycja | Jarosz | IEEE SA | IEEE SA | No |

Note: Membership was only granted to those requesting who had attended two of the last three meetings.

## L.3.7 TF - IEEE / IEC Continuous Cross Reference

**S25 Unapproved Meeting Minutes**

Standards Subcommittee Task Force

IEEE / IEC Cross Reference

Monday, March 24, 2024, 1:45pm to 3:00pm

Chair: Alan Washburn

1. Welcome
	1. Meeting came to order at 1:50pm
2. Introduction of participants
	1. 31 attendees:
	2. Jaroslaw Chorzepa, Juan Carlos Cruz Valdes, Ronny Doerr, Samragni Dutta Roy , Egui Espitia, James Gardner, Kyle Heiden, Saramm Hoffman, Traci Hopkins, Anton Koshel, Komelabbas Lakhani, José Luis Machain, Emilio Morales-Cruz, Augusto Morando, Hossein Nabi-Bidhendi, Shankar Nambi, Nirav Patel, Miguel Plascencia, Thomas Prevost, Robert Reepe, Marnie Roussell, Cody Schott, Ahmad Skeik, H. Allen Steele, David Stockton, Fernando Tirado, Aparna Vedantham, Pragnesh Vyas, Alan Washburn, Stephen Wolbach, James Thompson
3. IEEE SA patent policy and call for patents
4. IEEE SA copyright policy
5. Membership review
	1. 5 of 10 members, quorum achieved
6. Review/approval of agenda
7. Review/approval of S24, F24 meeting minutes
8. Old business
	1. Scope of TF
		1. Continued discussion on index scope, format
	2. Report on virtual meetings held
9. New business
	1. Moving from Collabratec to OneDrive
	2. Sample results
		1. Split into two indexes, documents and topics
	3. Discuss method to collect data
		1. Will be sending a survey to gather ideas for prioritized topic list
10. Adjourn

# Standards SC S24 Attendance List

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