Standards Subcommittee

March 26, 2025, Denver, CO.

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.

$$\sout{BIL}\ BSL = CFO \times \left(1 - 1.28 \times \frac{\sigma_f}{CFO}\right)$$

- 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

Category	Single phase (kVA)	Three phase (kVA)
I[a]	5 to 500	15 to 500
II	501 to 1667	501 to 5000
III	1668 to 10 000	5001 to 30 000
IV	Above 10 000	Above 30 000
NOTE—All kVA ratings listed are minimum nameplate kVA for the principal windings.		

[a]Autotransformers 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.

Tests	Distribution transformers			Class I power transformers			Class II power transformers			Comments
	Routine	Design	Other	Routine	Design	Other	Routine	Design	Other	
Performance										
Impedance voltage and load loss at rated current and rated frequency on the rated voltage connection, and at the tap extremes of the first unit of a new design	*			*			*			These measurements shall be taken only at the rated voltage connection for a two winding unit, and at all rated voltage connections for units with three or more windings. For the Class II power transformers, at least one test shall be performed at the minimum kVA rating and one test at the maximum kVA rating. The tested load loss of duplicate transformers shall be corrected to reference temperature by assuming the same stray and eddy loss as the design test transformer. For LTC units, see 8.3.2.

- 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.

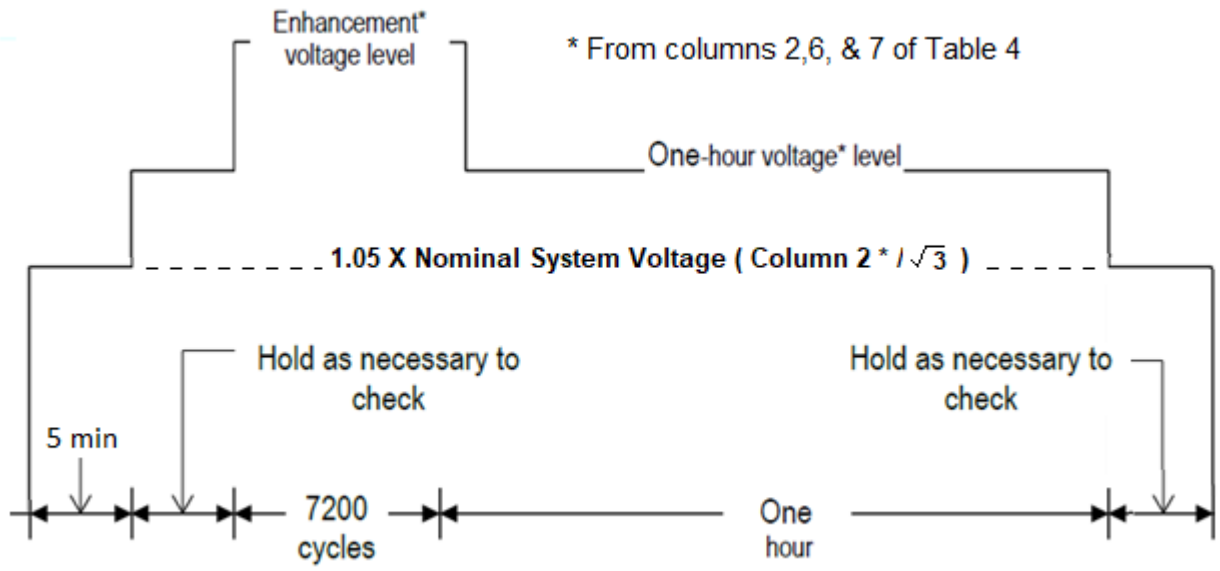

Figure 2 —Induced-voltage test for Class II power transformers

2. 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.

5.9 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 **Error! Reference source not found.**), ~~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.

3. 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.

2. WG Item 114, Modification of Sec 5.7.2/Steve Antosz (Prolec GE)
   - Proposal to add the phasor-group designation as required nomenclature for identifying the angular displacement between windings for three-phase power and distribution transformers. Std. C57.12.70 "Standard Terminal Markings and Connections" was recently revised and updated with that concept. As both standards are linked through mutual references, the proposal includes the phasor group designation be shown on the transformer's nameplate. The nomenclature is detailed in 12.70. This proposal also harmonized with IEC Stds.
   - Three motions passed:
     - 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"

Motion #1

5.7.2 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 H_1 and the line-to-neutral voltage of the corresponding identified low-voltage terminal X_1.
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 **Error! Reference source not found.**.
Additional phasor diagrams are described in IEEE Std C57.12.70.

Motion #2

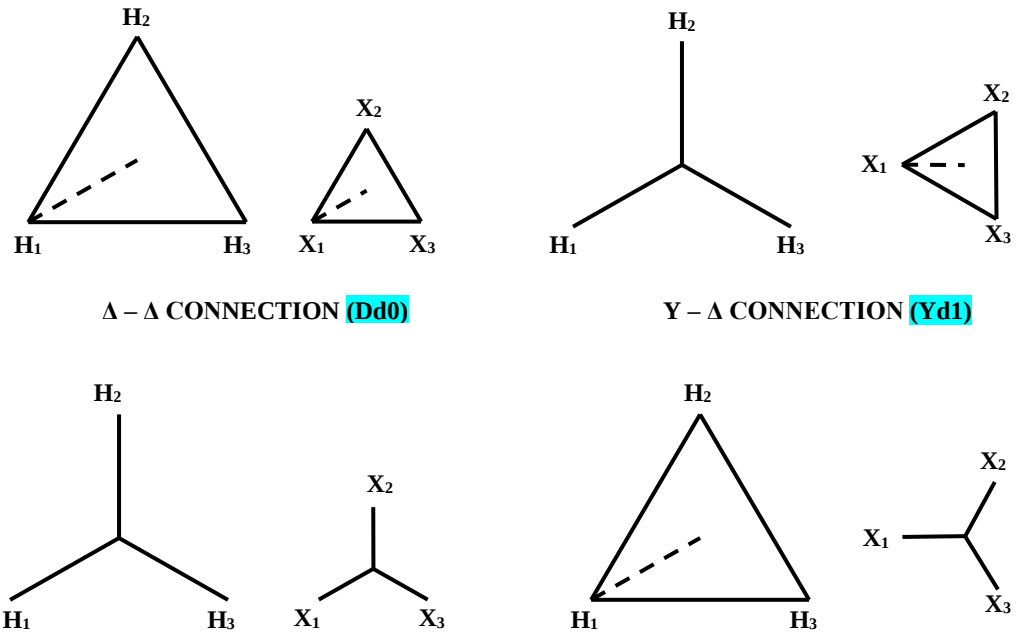

Figure 1 —Phase relation of terminal designation for three-phase transformers

Motion #3

Table 6—Nameplate information

Row	Nameplate A	Nameplate B	Nameplate C
1	Serial number[a]	Serial number[a]	Serial number[a]
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 rating[a, b]	kVA rating[a, b]	kVA (or MVA) rating[a, b]
7	Voltage ratings[a, c]	Voltage ratings[a, c]	Voltage ratings[a, c]
8	Tap voltages[d]	Tap voltages[d]	Tap voltages[d]
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 impedance[e]	Percent impedance[e]	Percent impedance[e]
13	—	Basic lightning impulse insulation levels (BIL)[f]	Basic lightning impulse insulation levels (BIL)[f]
14	Approximate total mass in kg or weight in lb[g]	Approximate total mass in kg or weight in lb[h]	Approximate total mass in kg or weight in lb[h]
15	Connection diagram[i]	Connection diagram[i]	Connection diagram[i]
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 suitability[k]
22	—	—	Maximum value of primary voltage[l]
23	—	—	Tank, pressure, and liquid data[m]
24	Department of Energy (DOE) compliant[n]	DOE compliant[n]	DOE compliant[n]
25	---	---	Core Design – Core or Shell form
26	---	---	Core Type - Number of limbs (wound), Shell Type - D type , 7 limbs, or others

4. 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.
    a. Partial Discharge for Class I Transformers:

Table 4—Dielectric insulation levels for all windings of Class II power transformers, voltages in kV

Maximum system voltage (kV rms)	Nominal system voltage[a] (kV rms)	Applied- voltage test[g] (kV rms)			Induced-voltage test[b, c] (phase to ground) (kV rms)		Winding line-end BIL[d] (kV crest)				Neutral BIL[e, g] (kV crest)	
		Delta and fully insulated wye	Grounded wye	Impedance grounded wye or grounded wye with higher BIL	Enhanced 7200 cycle	One hour	Mini-mum	Alternates			Grounded wye	Impedance grounded wye or grounded wye with higher BIL
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12	Col 13
≤ 17	≤ 15	34	34	34	16	14	**110**				110	110
26	25	50	34	40	26	23	**150**				110	125
36	34.5	70	34	50	36	32	**200**				110	150
48	46	95	34	70	48	42	200	**250**			110	200
73	69	140	34	95	72	63	250	**350**			110	250
121	115	173	34	95	120	105	350	**450**	550		110	250
145	138	207	34	95	145	125	450	**550**	650		110	250
169	161	242	34	140	170	145	550	**650**	750	825	110	350
242	230	345	34	140	240	210	650	**750**	**825**	**900**	110	350
362	345	518	34	140	360	315	900	1050	1175		110	350
550	500	N/A	34	140	550[f]	475[f]	1425	1550	1675		110	350
765	735	N/A	34	140	880[f]	750[f]	1950[f]	2050			110	350
800	765	N/A	34	140	885[f]	795[f]	1950[f]	2050			110	350

[a]For nominal system voltage greater than maximum system voltage, use the next higher voltage class for applied-voltage test levels.

[b]The 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.~~

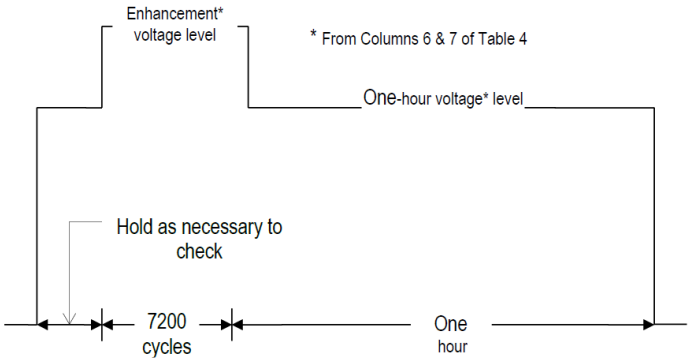

Figure 2—Induced-voltage test for Class II power transformers

b. Induced Overvoltage – Nominal versus Maximum operating voltage:

Table 3—Dielectric insulation levels for distribution and Class I power transformers, voltages in kV

Maximum system voltage (kV rms)	Nominal system voltage[a, g] (kV rms)	Applied- voltage test[f] (kV rms)			Induced-voltage test[b, f] (phase to ground) (kV rms)	Winding line-end BIL[e, f] (kV crest)			Neutral BIL[d, f, h] (kV crest)	
		Delta or fully insulated wye	Grounded wye	Impedance grounded wye or grounded wye with higher BIL		Minimum	Alternates		Grounded wye	Impedance grounded wye or grounded wye with higher BIL
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
Part A - Distribution transformers										
1.5	1.2[c]	10	-	10	1.4	**30**			30	30
3.5	2.5[c]	15	-	15	2.9	**45**			45	45
6.9	[c]	19	-	19	5.8	**60**			60	60
11	8.7[c]	26	-	26	10	**75**			75	75
17	15	34	-	34	17	**95**	110		75	75
26	25	40	-	40	29	**125**	**150**		75	95
36	34.5	50	-	50	40	125	**150**	**200**	75	125
48	46	95	-	70	53	200	**250**		95	150
73	69	140	-	95	80	250	**350**		95	200
Part B - Class I power transformers without partial discharge testing										
1.5	1.2	10	10	10	1.4	**30**	**45**		45	45
3.5	2.5	15	15	15	2.9	**45**	**60**		60	60
6.9	5	19	19	19	5.8	**60**	**75**		75	75
11	8.7	26	26	26	10	**75**	**95**		95	95
17	15	34	26	34	17	**95**	**110**		95	110
26	25	50	26	40	29	**150**			95	125
36	34.5	70	26	50	40	**200**			95	150
48	46	95	34	70	53	200	**250**		110	200
73	69	140	34	95	80	250	**350**		110	250

Maximum system voltage (kV rms)	Nominal system voltage[a, g] (kV rms)	Applied- voltage test[f] (kV rms)			Induced- voltage test[f, j] (phase to ground) (kV rms)		Winding line-end BIL[e, f] (kV crest)		Neutral BIL[d, f, h] (kV crest)	
		Delta or fully insulated wye	Grounded wye	Impedance grounded wye or grounded wye with higher BIL	Enhanced 7200 cycles	One hour	Minimum	Alternate	Grounded wye	Impedance grounded wye or grounded wye with higher BIL
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 11	Col 12
Part C - Class I power transformers with partial discharge testing specifically requested by purchaser										
1.5	1.2	10	10	10	1.2	1.1	**30**	**45**	45	45
3.5	2.5	15	15	15	2.6	2.3	**45**	**60**	60	60
6.9	5	19	19	19	5.2	4.6	**60**	**75**	75	75
11	8.7	26	26	26	9	7.9	**75**	**95**	95	95
17	15	34	34	34	16	14	**95**	**110**	95	110
26	25	50	34	40	26	23	**150**		95	125
36	34.5	70	34	50	36	32	**200**		95	150
48	46	95	34	70	48	42	200	**250**	110	200
73	69	140	34	95	72	63	250	**350**	110	250

[a] For nominal system voltage greater than maximum system voltage, use the next higher voltage class for applied-voltage test levels.

[b] Induced-voltage tests shall be conducted at 2.0 × nominal system voltage for 7200 cycles.

[c] Bold typeface BILs are the most commonly used standard levels.

[d] Y-Y-connected transformers using a common solidly grounded neutral may use neutral BIL selected in accordance with the low-voltage winding rating.

[e] Single-phase distribution and power transformers and regulating transformers for voltage ratings between terminals of 8.7 kV and below are designed for both Y and Δ connection, and are insulated for the test voltages corresponding to the Y connection so that a single line of transformers serves for the Y and Δ applications. The test voltages for such transformers, when connected and operated, are therefore higher than needed for their voltage rating.

[f] For series windings in transformers, such as regulating transformers, the test values to ground shall be determined by the BIL of the series windings rather than by the rated voltage between terminals.

[g] Values listed as nominal system voltage in some cases (particularly voltages 34.5 kV and below) are applicable to other lesser voltages of approximately the same value. For example, 15 kV encompasses nominal system voltages of 14 440 V, 13 800 V, 13 200 V, 13 090 V, 12 600 V, 12 470 V, 12 000 V, and 11 950 V.

[h] Neutral BIL shall never exceed winding BIL.

[j] Induced voltage tests shall be conducted at 1.58 x nominal system voltage for one hour and 1.8 x nominal system voltage for enhanced 7200 cycle test.

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.

    a. 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.

b. 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.

c. 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.

d. 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.

e. 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.

2. 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:

   10.10.2 Instrumentation

   The insulation power factor may be measured by special bridge circuits or by the voltampere-watt method. The accuracy of measurement should be within ± 0.25% insulation power factor, and the measurement should be made at or near a frequency of 60 Hz.

   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

3. Changes to Clause 11 Temperature Test, from Dinesh Sankarakurup's TF in the Insulation Life SC.

   a. 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.

   b. 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

c. 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

4. 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.

   a. 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. The same 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.

   b. 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. …

   c. 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.

5. 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.

   a. 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.

b. 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:

a) The magnitude of the partial discharge level does not exceed 250 pC during the 1 h test period.
b) The increase in partial discharge levels during the 1 h period does not exceed 50 pC.
c) 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.
d) The magnitude of partial discharge level at 1.05 X Nominal System Voltage following the 1 h test period does not exceed 100 pC.

c. 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.

d. 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.

10.8.1 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.

e. 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 1—Equalizing 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 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 2—The 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.

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.

NOTE—Increasing 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 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.

a) 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.

b) 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.

c) 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.

f. 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.

6. 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.

   a. 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.

b. 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.

c. 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

2. 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.

3. 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.

4. 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.

5. IEEE Copyright Policy

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

6. 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."

7. 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.

8. 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.

9. 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.

10. 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, Copyright, and Patent – reviewed all slides
2. Quick review – PAR (expires 12/31/2028) – reviewed
3. Attendance form and quorum check (91 members; 46 required for quorum)
    a. Attendance form displayed for attendees to sign in
    b. 61 members were present of 91 total members, quorum was achieved
    c. 24 guests requested membership, only 5 met the requirements for membership
    d. Plans to record the meeting were announced, no objections
4. Agenda approval
    a. Previously sent out, unanimous approval of the agenda, no objections
5. Minutes approval
    a. October 29, 2024 meeting (St Louis)
    b. February 24, 2025 meeting (virtual)
    c. Previously sent out, unanimous approval of both sets of minutes, no objections
6. iMeet Central site:
    a. https://ieee-sa.imeetcentral.com/ieeedashboard/
    b. Quick demo, how to access IEEE Transaction Paper
    c. 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.

    d. 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
    a. Chair of TF = Ryan Hogg
    b. Have held 2 virtual meetings, more planned
    c. Report on status of definition work
    d. Developing a quadrants figure that standard could use
    e. Task force chair provided an update of the work on a definition of reverse power.
    f. 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.
    g. 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
    a. Ramsis Girgis (Hitachi Energy) – Feasibility of Reverse Power Flow Scenarios in Step-Down Power Transformers
        i. 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.
    b. Ryan Hogg (Bureau of Reclamation) – Dry Type GSU and Station Service Power
    c. Vinay Patel (Con Edison of New York) – Distributed generation
        i. Amitabh Sarkar – We need to talk about how this affects the transformers, what were they designed for. What is the reverse power flow?
        ii. Chair – Agreed, this is what these presentations/discussions are designed to bring up.
    d. Dan Blaydon (Baltimore Gas & Electric) – Solar DER
    e. Drew Welton (Intellirent) – Auto-determination OLTC controls
9. Review document outline – Chair presented "Draft PC57.133 Outline" (included further on in these minutes)
    a. Thomas Dauzat – proposed sections (*per email on February 27, 2025*)

i. Reverse Power Flow – Power
ii. Reverse Power Flow – Transmission/Substation
iii. Reverse Power Flow – Distribution/Feeders
iv. Thomas Dauzat made a motion to split up the document into three sections: (1) Power, (2) Transmission/Substation, and (3) Distribution/Feeders
v. Motion was seconded by Ramsis Girgis
vi. A discussion of the motion was held during which many people asked for clarification of the motion's intent, the chair repeated the motion
vii. 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
    a. E.g., how have you/your organization been approaching reverse power and transformers, what impacts are you/your organization seeing…
    b. In the works
        i. Fall 2025 – Joe White
12. Old Business – none – reviewed
13. New Business – any? – no time to begin any new business
14. Next meetings
    a. 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
    b. 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**
   - 1.1. Scope
   - 1.2. Purpose
   - 1.3. Word Usage
2. **Normative References**
3. **Definitions, acronyms, and abbreviations**
   - 3.1. Definitions
   - 3.2. Acronyms and abbreviations
4. **Historical context** *(this might become an informative annex)*
   - 4.1. Watts and VARs chart
   - 4.2. Typical causes of reverse power flow *(note similarity to proposed Annex B)*
5. **C57 Standards and Power Flow Direction**
   - 5.1. Step-down, step-up, bi-directional, same voltage both sides
   - 5.2. C57.12.00, C57.12.01… other standards and how they discuss power flow direction
6. **Potential effects**
   - 6.1. Voltage regulation (including OLTC and controls)
   - 6.2. Core saturation (LV taps, variable flux)
   - 6.3. Winding heating (common windings of autos)
   - 6.4. Voltage imbalance (battery back feeding, delta connections and grounding)
   - 6.5. Volts per turn increase (low voltage winding on step-down transformer, but providing VARs back to system)
   - 6.6. Asymmetrical pennant cycle tap changer (does not work in reverse)
   - 6.7. Inverters – Step down not designed to be inverter transformers, now operating as step-up (e.g., two grounds = harmonics; core design (shielding/grounding)
   - 6.8. …
7. **Transformer designs and potential effects**
   - 7.1. Simple two winding
   - 7.2. Two winding w/ LV taps
   - 7.3. Two winding w/ LV taps, variable flux
   - 7.4. Auto transformers
   - 7.5. Multi winding transformers
   - 7.6. 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

	First Name	Last Name	Affiliation	Membership	Attended Feb 24, 2025 Meeting?
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

	First Name	Last Name	Affiliation	Membership	Attended Feb 24, 2025 Meeting?
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

	First Name	Last Name	Affiliation	Membership	Attended Feb 24, 2025 Meeting?
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

	First Name	Last Name	Affiliation	Membership	Attended Feb 24, 2025 Meeting?
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

	First Name	Last Name	Affiliation	Membership	Attended Feb 24, 2025 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

	First Name	Last Name	Affiliation	Membership	Attended Feb 24, 2025 Meeting?
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
    a. Meeting came to order at 1:50pm
2. Introduction of participants
    a. 31 attendees:
    b. 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
    a. 5 of 10 members, quorum achieved
6. Review/approval of agenda
7. Review/approval of S24, F24 meeting minutes
8. Old business
    a. Scope of TF
        i. Continued discussion on index scope, format
    b. Report on virtual meetings held
9. New business
    a. Moving from Collabratec to OneDrive
    b. Sample results
        i. Split into two indexes, documents and topics
    c. Discuss method to collect data
        i. Will be sending a survey to gather ideas for prioritized topic list
10. Adjourn

Standards SC S24 Attendance List

Role	First Name	Last Name	2025 MAR
Secretary	Ajith	Varghese	X
Member	Alan	Washburn	X
Guest	Alan	Fujimori	X
Guest	Albero	Martinez	X
Guest	Alex	Ayala	X
Member	Alireza	Gorzin	X
Member	Amitabh	Sarkar	X
Guest	Amitkumar	Singh	X
Guest	Anastasia	O'Malley	X
Member	Andrew	Larison	X
Guest	Arvind	Kumar	X
Guest	Ashwin	Iyer	X
Guest	Ashwini	Labh	X
Guest	Balaji	Janakiraman	X
Guest	Benjamin	Guinand	X
Guest	Bernard	Labean	X
Member	Bill	Griesacker	X
Member	Bruce	Webb	X
Member	Carlos	Gaytan	X
Guest	Chanmin	Jeong	X
Chair	Daniel	Sauer	X
Member	Daniel	Blaydon	X
Guest	Daniel	Crockett	X
Guest	Dean	Park	X
Member	Dharam	Vir	X
Guest	Didier	Hamoir	X
Guest	Dinesh	Sankarakurup	X
Guest	Dumitru	Diaconu	X
Member	Dwight	Parkinson	X
Member	Ed	teNyenhuis	X
Member	Egon	Kirchenmayer	X
Guest	Egui	Espitia	X
Member	Emilio	Morales-Cruz	X
Guest	Enrique	Betancourt	X
Guest	Eric	Elson	X
Member	Evgenii	Ermakov	X
Member	Fernando	Tirado	X
Member	Francis	Mills	X
Guest	Fredy	murcig	X
Member	Gabriel	Delgado	X
Guest	Garrett	Bradshaw	X
Member	Gilles	Bargone	X
Guest	Goran	Milojevic	X
Member	Grace	Guang Yuan	X
Guest	Hyounggon	Ryu	X
Guest	Janet	Crockett	X
Member	Jason	Varnell	X
Guest	Jason	Snyder	X
Member	Javier	Arteaga	X
Guest	Jean Carlos	Hernandes Mejia	X
Guest	Jeremiah	Bradshaw	X
Member	Jerry	Murphy	X
Guest	Jerzy	Kazmierczak	X
Guest	Jesse	Duffy	X
Guest	Jesus	SanchezRodrigues	X
Guest	jiohao	xie	X
Member	Joe	White	X
Member	John	John	X
Guest	Jonathan	Reimer	X
Member	Jonathan	Sinclair	X
Guest	Jonathan	Tan	X
Guest	Jose	Izquierdo	X
Member	Jose Luiz	Machain	X
Member	Joseph	Tedesco	X
Guest	Joshua	Watson	X
Member	Joshua	Yun	X

Role	First Name	Last Name	2025 MAR
Guest	Josipa	Brekalo	X
Guest	Juan	Velasquez	X
Guest	Juan	Rodriguez	X
Member	Juan Alfredo	Carrizales	X
Member	Juan Carlos	Cruz Valdes	X
Guest	Kabir	Sethi	X
Member	Kayland	Adams	X
Guest	Komal	Laknai	X
Member	Kris	Zibert	X
Member	Kristopher	Neild	X
Member	Kurt	Kaineder	X
Vice-Chair	Marcos	Ferreira	X
Member	Kyle	Stechschulte	X
Guest	Laslo	Kadar	X
Guest	Leonard	Torchia	X
Guest	Libardo	Lopez	X
Guest	Logan	Merrill	X
Guest	Luc	Loiselle	X
Guest	Luya	Peuc	X
Guest	Marcelino	Perez	X
Guest	Mario	Alonso	X
Member	Mark	Newbill	X
Guest	Matija	Kopriunjak	X
Guest	Matthew	Weisensee	X
Guest	Matthew	Greenhaw	X
Member	Michael	Botti	X
Guest	Miguel	Fernandez	X
Member	Miguel	Garcia	X
Member	Miguel	Plascencia	X
Guest	Monil	Patel	X
Guest	Moonhee	Lee	X
Member	Nabi	Almeida	X
Guest	Namtran	Nguyen	X
Guest	Nick	Jensen	X
Member	Onome	Avanoma	X
Guest	Patrycja	Jarosz	X
Member	Paul	Weyandt	X
Guest	Peter	Werelius	X
Member	Philip	Hopkinson	X
Member	Poorvi	Patel	X
Member	Pragnesh	Vyas	X
Guest	Prudvi	Bhattiprolu	X
Member	Qasim	Khan	X
Member	Ramadin	Issack	X
Member	Raymond	Frazier	X
Guest	Richard	vonGemmingen	X
Member	Rob	Ghosh	X
Guest	Ryan	Musgrove	X
Member	Ryan	Hogg	X
Guest	Salahuddin	Shaikh	X
Member	Samson	Debass	X
Member	Sanjib	Som	X
Member	Scott	Digby	X
Member	Scott	Reed	X
Guest	Shawn	Gossett	X
Member	Stephen	Antosz	X
Member	Stephen	Shull	X
Member	Steven	Snyder	X
Guest	Sunny	Swarna	X
Guest	Thomas	Propts	X
Guest	Thomas	Holifield	X
Member	Tim	Raymond	X
Member	Tim-Felix	Mai	X
Guest	Valori	Valentina	X
Guest	Vijay	Gunja	X
Guest	Vivian	Chan	X
Member	Weijun	Li	X
Guest	Yeounsoo	Kim	X