Annex K Power Transformers Subcommittee

April 28, 2021
Virtual Meeting
Meeting Time: 12:55-2:10 p.m. CT

Chair: Bill Griesacker
Vice Chair: Alwyn VanderWalt
Secretary: Daniel Blaydon

K.1 Meeting Attendance

The Power Transformers Subcommittee met on Wednesday, April 28, 2021 at 12:55 PM CT. The WebEx attendance record indicated that 99 out of 128 members of the subcommittee were in attendance; a quorum at the meeting was achieved. A total of 253 individuals attended the meeting; 33 guests requested membership.

The complete attendance record is provided in Attachment K.1.

K.2 Approval of Agenda and Meeting Minutes

The Chair asked the membership if there was any objection to unanimous approval of the proposed agenda. The agenda was approved without objection. The approved agenda can be found in Attachment K.2.

The Chair asked the membership if there was any objection to unanimous approval of the Fall 2020 meeting minutes. The minutes were approved without objection.

K.3 Chair's Remarks

The Chair provided an overview the future scheduled meetings and proposed locations.

The Chair provided an overview of the Working Group and Task Force requirements for the scheduling of meetings, submission of minutes, and other administrative tasks.

The Chair provided an overview of the present subcommittee membership statistics, including new members and those members which had been moved to guest status.

K.4 Working Group and Task Force Reports

K.4.1 Liaison to PC57.93a IEEE Guide for Installation and Maintenance of Liquid-Immersed Power Transformers – S. Reed

The first meeting was held in September 2020. There has only been one meeting to date and there has been no communication as to when the next meeting will be scheduled. There was discussion at the meeting about natural ester fluid requirements and consideration was given to doing experiments related to cold weather start up procedures.

Scott Reed brought up various scope issues related to transformer kV/MVA ratings in the existing C57.93 under Clause 4. He asked if the subcommittee would open up a PAR study group to consider a revision of C57.93 to address these issues.

Scott Reed made a motion to open a new task force as a PAR study group for C57.93. This motion was seconded by Marcus Ferreira. The motion was approved unanimously by the PTSC.

K.4.2 Revision of C57.125 Guide for Failure Investigation, Documentation, Analysis and Reporting for Power Transformers and Shunt Reactors – W. Binder

This task force met on Monday. A presentation on the history of the guide was provided. Attendees were informed that they will need to attend the Fall 2021 meeting in order to become members of the new Working Group. A motion was approved in the meeting to advance the PAR with a revised purpose statement to the Subcommittee. Several individuals have volunteered to become officers of the new Working Group.

At the conclusion of the task force report, Wallace Binder made a motion that the PTSC establish a Working Group at the Fall 2021 meeting to undertake the revision of C57.125-2015. The motion was seconded by Craig Colopy. The motion was approved unanimously by the PTSC.

The complete meeting minutes can be found in Attachment K.4.2.

K.4.3 Revision of C57.131 Tap Changers – C. Colopy

Craig provided background on IEC 60214-1 and the attempts to make a dual logo standard. Due to some obstacles, it was decided that the revision of C57.131 would proceed without dual logo status and to that end, a Working group was formed with the goal of completing this effort within a couple years. The current standard expires in 2022.

The working group held their first meeting and established its membership. They have an existing PAR that was approved in December 2020 which expires in 2024. They plan to have meetings in between the Spring and Fall meetings to complete the work in 2 years with the goal being to harmonize with 60214-1. The revision will add in both IEC and IEEE references and it was noted that it will address vacuum tap changers, SF6 tap changers and voltage regulators. The draft document will be sent out to working group members.

The complete meeting minutes can be found in Attachment K.4.3.

K.4.4 Revision of C57.143 – Guide for Application of Monitoring Equipment to Liquid-Immersed Transformers and Equipment – M. Spurlock

This working group met on Monday and a quorum was achieved. There was a patent issue in this working group, a Letter of Assurance was sent last week. A 2 year PAR extension was filed in March and they are waiting for resolution from NesCom. All TF leaders gave updates on their sections. There was a discussion on Chapter 4 to be separated into two different sections. It was decided that new Chapter 4 will be kept as it is. The document will be circulated among the working group and they will be holding a virtual working group meeting to discuss further. They are intending to have it ready for ballot at end of 2021.

The complete meeting minutes can be found in Attachment K.4.4.

K.4.5 Revision of C57.148 Guide for Control Cabinets for Power Transformers – J. Watson

This document has been published. They will likely start work again in 5 years. Key contributors to the document should be receiving recognition in the mail and possibly at the next meeting. This document was finished within the allotted time of the PAR.

K.4.6 Revision of C57.150 Guide for the Transportation of Transformers and Reactors Rated 10,000 kVA or Larger – G. Anderson

This group did not meet. They are no longer taking new material and are preparing to send the document to the working group for a straw ballot. The PAR expires at the end of 2021 and an extension is needed to complete the balloting process.

Dan Sauer made a motion that C57.150 has the approval of the PTSC to proceed with the PAR extension request. This motion was seconded by Bruce Forsyth. The motion was approved unanimously by the PTSC.

K.4.7 Task Force on V/Hz Curve – J. Watson

This task force has completed their assignment. They have examined existing V/Hz curves used by the industry and identified issues and have provided recommended text for C57.116 for its next revision. The task force is recommending that a new working group be formed to develop a V/Hz guide to include the impact of V/Hz on power transformers, issues with existing V/Hz curves, methodology to develop V/Hz curves for transformer designs, and temperature/time criteria for manufactures to use to develop V/Hz curves.

Request approval of this recommendation from the SC and allow time for the new working group to meet for the first time at the Fall 2021 meeting.

Joe Watson made a motion to make a recommendation to AdCom for a new working group that will cover effects of V/Hz on power transformers and related topics. This motion did not receive a second and generated discussion under which subcommittee that the working group would exist.

It was mentioned that it should be a PAR study group (TF) under the PTSC to develop a title and scope to create a PAR and that AdCom may recommend that it go to a different subcommittee if necessary.

The PTSC Chair stated that he would appoint a Chair of the PAR study group, provided the PTSC would approve the formation of the group.

Joe Watson made a motion that the SC approve the formation of a task force to create a PAR for the scope and purpose for a new guide on transformer V/Hz. This motion was seconded by Dan Sauer. This motion was approved unanimously by the PTSC.

The PTSC Chair asked if Joe Watson would accept the Chair position of the task force, which he accepted.

The V/Hz presentation will be posted to the Transformers Committee website.

Will post presentation on website.

The complete update can be found in Attachment K.4.7.

K.4.8 Development of PC57.170 Condition Assessment Guide – K. Mani

This working group met Tuesday and a quorum was achieved. There were 4 presentations given by the various TF working on the document. They hope to have the draft ready for the

working group to review by the Spring 2022 meeting. A question was raised about adding financial considerations to the guide. This will be discussed at the next meeting.

Gary Hoffman mentioned that there are anti-trust issues associated with including financial considerations. He offered to send a document to the working group chair about these issues.

The complete meeting minutes can be found in Attachment K.4.8.

K.4.9 Revision of C57.116 GSU Transformers – W. Li

The working group for revising C57.116 met on Monday and achieved a quorum. The PAR for this effort is valid until the end of 2023. This working group is split into 4 task forces to review various sections of document to identify changes that should be made. Each task force provided updates on their work at the meeting. Noted additions the document include a paragraph added for back-feed operation and a new section to address 3 winding auxiliary unit transformers. They are looking for additional members to contribute to these task forces. They plan to review all figures in the document to see if any of them need to be updated or replaced.

The complete meeting minutes can be found in Attachment K.4.9.

K.5 Old Business

No old business.

K.6 New Business

1. The Chair covered 5 documents which are close to expiring, or up for revision.

   - C57.17 Arc Furnace Transformers
   - C57.135 Phase Shifting Transformers Guide
   - C57.153 Paralleling Guide
   - C57.156 Tank Rupture Guide
   - IEEE 638 Class 1E Xfmrs for Nuclear Stations

   The Chair asked if there is anyone interested in working on these as a PAR study group.

   C57.17 Arc Furnace - Expires Dec 2022
   Dan Sauer made a motion to form a PAR study group to look into PAR issues for C57.17. This motion was seconded by Sheldon Kennedy. The motion was approved unanimously by the PTSC.

   A Chair is needed in to lead this group.

   C57.135 Phase Shifting Transformers Guide – Expires 2021
   Ewald Schweiger made a motion to form a PAR study group to investigate continued use of this document. This motion was seconded by Joe Watson. The motion was approved unanimously by the PTSC.

   IEEE 693 Seismic Requirements for Substations:
   Michael Riley, mjriley@bpa.gov, the chair, has requested that several manufactures of transformers join this working group to help balance their membership and help revise the seismic design requirements for transformers. This is a very important task.

Input was solicited from transformer manufacturers to provide input into this standard. An email will be sent out regarding this to the subcommittee.

The last 3 documents listed on the meeting slide have 4-5 years before expiration.

2. There was no further new business.

K.7 Adjournment

The meeting adjourned at 2:16pm CT.

K.8 Attachments

Attachment K.1 – Attendance
Attachment K.2 – S21 PTSC Agenda
Attachment K 4.2 – C57.125 Minutes
Attachment K 4.3 – C57.131 Minutes
Attachment K 4.4 – C57.143 Minutes
Attachment K 4.7– V/HZ Minutes
Attachment K 4.8 – C57.170 Minutes
Attachment K 4.9 – C57.116 Minutes

Attachment K.1

Role	First Name	Last Name	Company
Member	Kayland	Adams	SPX Transformer Solutions, Inc.
Member	Raj	Ahuja	Raj Ahuja Consulting
Guest	Nabi	Almeida	Prolec GE USA LLC
Member	Gregory	Anderson	GW Anderson & Associates, Inc.
Member	Tauhid Haque	Ansari	Hitachi ABB Power Grids
Guest	Gregory	Ante	Southern California Edison
Guest	Stephen	Anthony	--
Guest	Edmundo	Arevalo	Bonneville Power Administration
Guest	Elise	Arnold	SGB
Member	Javier	Arteaga	Hitachi ABB Power Grids
Member	Onome	Avanoma	MJ Consulting
Member	Donald	Ayers	Ayers Transformer Consulting
Guest	Suresh	Babanna	SPX Transformer Solutions, Inc.
Member	Gilles	Bargone	FISO Technologies Inc.
Guest	Israel	Barrientos	Prolec GE
Guest	Jared	Bates	Oncor Electric Delivery
Member	Christopher	Baumgartner	We Energies
Member	Myron	Bell	Delta Star Inc.
Guest	Olle	Benzler	Megger
Guest	Mats	Bernesjo	Hitachi ABB Power Grids
Guest	Jean-Noel	Berube	Rugged Monitoring Inc.
Member	Enrique	Betancourt	Prolec GE
Guest	Kevin	Biggie	Weidmann Electrical Technology
Member	Wallace	Binder	WBBinder Consultant
Guest	Ryan	Bishop	Minnesota Power
Secretary	Daniel	Blaydon	Baltimore Gas & Electric
Member	William	Boettger	Boettger Transformer Consulting LLC
Guest	Joshua	Bohrn	PacifiCorp
Member	Paul	Boman	Hartford Steam Boiler
Guest	Michael	Botti	Hyosung HICO
Guest	Jeremiah	Bradshaw	Bureau of Reclamation
Member	Elizabeth	Bray	Southern Company Services
Guest	Jeffrey	Britton	Phenix Technologies, Inc.
Member	Steven	Brzoznowski	Bonneville Power Administration
Guest	Erich	Buchgeher	Siemens Energy
Member	David	Calitz	Siemens Energy
Guest	Juan	Carrizales	Prolec GE
Guest	Juan	Castellanos	Prolec GE
Member	Stuart	Chambers	Powertech Labs Inc.
Member	Luiz	Cheim	Hitachi ABB Power Grids

Member	Craig	Colopy	EATON Corporation
Guest	Michael	Craven	Phoenix Engineering Services
Member	Jorge	Cruz	PTI Transformers
Guest	Juan Carlos	Cruz Valdes	Prolec GE
Member	Eric	Davis	Burns & McDonnell
Guest	Brandon	Dent	Memphis Light, Gas & Water
Guest	Stephanie	Denzer	Alliant Energy
Member	Scott	Digby	Duke Energy
Guest	Nikolaus	Dillon	Dominion Energy
Guest	Huan	Dinh	Hitachi ABB Power Grids
Guest	Eric	Doak	D4EnergySolutions LLC
Guest	Jeffrey	Door	H-J Family of Companies
Member	Don	Dorris	Nashville Electric Service
Guest	ANDY	DOWNEY	SPX TRANSFORMER SOLUTIONS
Member	Lee	Doyle	Vaisala
Member	Hakim	Dulac	Qualitrol Company LLC
Guest	Samragni	Dutta Roy	Siemens Energy
Guest	Thomas	Eagle	SPX Transformer Solutions
Guest	Megan	Eckroth	EATON Corporation
Guest	Evgenii	Ermakov	Hitachi ABB Power Grids
Guest	Marco	Espindola	Hitachi ABB Power Grids
Guest	Feras	Fattal	Manitoba Hydro
Member	Reto	Fausch	RF Solutions
Member	Roger	Fenton	Fenton Solutions
Member	Marcos	Ferreira	Beale AFB
Member	Hugo	Flores	Hitachi ABB Power Grids
Guest	Marc	Foata	Maschinenfabrik Reinhausen
Member	Joseph	Foldi	Foldi & Associates, Inc.
Member	Bruce	Forsyth	Bruce Forsyth and Associates LLC
Guest	John	Foschia	SPX Transformer Solutions, Inc.
Guest	Michael	Franchek	Retired
Member	Anthony	Franchitti	PECO Energy Company
Guest	Raymond	Frazier	Ameren
Guest	George	Frimpong	Hitachi ABB Power Grids
Guest	Jose	Gamboa	H-J Family of Companies
Guest	Eduardo	Garcia Wild	Siemens Energy
Guest	James	Gardner	SPX Transformer Solutions, Inc.
Member	David	Geibel	Hitachi ABB Power Grids
Guest	Rob	Ghosh	General Electric
Member	Ramsis	Girgis	Hitachi ABB Power Grids
Guest	Zoran	Goncin	PTI Transformers
Guest	Shawn	Gossett	Ameren

Guest	Jeffrey	Gragert	Xcel Energy
Member	James	Graham	Weidmann Electrical Technology
Guest	Taylor	Gray	Portland General Electric (PGE)
Chair	Bill	Griesacker	Duquesne Light Co.
Guest	Ismail	Guner	Hydro-Quebec
Member	Niklas	Gustavsson	Hitachi ABB Power Grids
Member	Attila	Gyore	M&I Materials Ltd
Guest	Didier	Hamoir	Transformer Protector Corp
Guest	Thomas	Hartmann	Pepco Holdings Inc.
Member	Roger	Hayes	General Electric
Member	Kyle	Heiden	EATON Corporation
Guest	John	Herron	Raytech USA
Member	Gary	Hoffman	Advanced Power Technologies
Guest	Saramma	Hoffman	PPL Electric Utilities
Guest	Ryan	Hogg	Bureau of Reclamation
Guest	David	Holland	ExxonMobil
Guest	Derek	Hollrah	Burns & McDonnell
Guest	George	Jalhoum	PPl
Guest	Paul	Jarman	University of Manchester
Guest	Brad	Jensen	Burns & McDonnell
Member	John	John	Virginia Transformer Corp.
Guest	Toby	Johnson	Pacificorp
Guest	Stephen	Jordan	Tennessee Valley Authority
Member	Akash	Joshi	Black & Veatch
Guest	Laszlo	Kadar	Hatch
Member	Kurt	Kaineder	Siemens Energy
Guest	Jon	Karas	SDMyers, LLC.
Member	Sheldon	Kennedy	Niagara Transformer
Guest	Gael	Kennedy	GR Kennedy & Associates LLC
Member	Stacey	Kessler	Basin Electric Power Cooperative
Guest	Suleman	Khan	Ontario Power Generation
Member	Zan	Kiparizoski	Howard Industries
Member	Egon	Kirchenmayer	Siemens Energy
Member	Peter	Kleine	US Army Corps of Engineers
Guest	Dmitriy	Klempner	Southern California Edison
Guest	William	Knapek	OMICRON electronics Corp USA
Guest	Anton	Koshel	Delta Star Inc.
Member	Axel	Kraemer	Maschinenfabrik Reinhausen
Guest	Krzysztof	Kulasek	Hitachi ABB Power Grids
Guest	Donald	Lamontagne	Arizona Public Service Co.
Guest	Andrew	Larison	Hitachi ABB Power Grids
Guest	Fernando	Leal	Prolec GE

Guest	Olivier	Lejay	Huaming USA Corp.
Member	Weijun	Li	Braintree Electric Light Dept.
Guest	Mario	Locarno	Doble Engineering Co.
Guest	Xose	Lopez-Fernandez	Universidade de Vigo
Guest	Tiffany	Lucas	SPX Transformer Solutions, Inc.
Guest	Nigel	Macdonald	Trench Limited
Guest	Jinesh	Malde	M&I Materials Inc.
Guest	Darrell	Mangubat	Siemens Power Operations Inc.
Member	Kumar	Mani	Duke Energy
Guest	Balakrishnan	Mani	Virginia Transformer Corp.
Guest	Dennis	Marlow	DenMar TDS Transformers
Guest	Rogelio	Martinez	Georgia Transformer
Guest	Lee	Matthews	Howard Industries
Guest	James	McBride	JMX Services, Inc.
Member	Matthew	McFadden	Oncor Electric Delivery
Guest	James	Mciver	Siemens Energy
Member	Susan	McNelly	Xcel Energy
Member	Vinay	Mehrotra	SPX Transformer Solutions, Inc.
Member	Thomas	Melle	HIGHVOLT
Guest	Paul	Morakinyo	PSEG
Member	David	Murray	Tennessee Valley Authority
Member	Ryan	Musgrove	Oklahoma Gas & Electric
Guest	Shankar	Nambi	Bechtel
Guest	Anthony	Natale	HICO America
Member	Kristopher	Neild	Megger
Guest	Ashmita	Niroula	Ergon, Inc.
Guest	Rodrigo	Ocon	Industrias IEM
Member	Anastasia	O'Malley	Consolidated Edison Co. of NY
Guest	Parminder	Panesar	Virginia Transformer Corp.
Guest	Dwight	Parkinson	EATON Corporation
Guest	Sanjay	Patel	Royal Smit Transformers
Member	Poorvi	Patel	Electric Power Research Institute (EPRI)
Guest	Nitesh	Patel	Hyundai Power Transformers USA
Guest	Monil	Patel	Pacific Gas & Electric Company
Guest	Arismendis	Pena	SDMyers, LLC.
Member	Brian	Penny	Retired
Guest	Mark	Perkins	D4EnergySolutions LLC
Guest	Christoph	Ploetner	Hitachi ABB Power Grids
Guest	Tejasvi	Prakash	Schweitzer Engineering Labs
Member	Ion	Radu	Hitachi ABB Power Grids
Member	Kevin	Rapp	Cargill, Inc.

Member	Timothy	Raymond	Electric Power Research Institute (EPRI)
Guest	John	Reagan	Oncor Electric Delivery
Guest	Larry	Rebman	EMLS, Inc.
Member	Scott	Reed	MVA
Guest	Samuel	Reed	EATON Corporation
Guest	Jonathan	Reimer	FortisBC
Guest	Afshin	Rezaei-Zare	York University
Guest	Diego	Robalino	Megger
Guest	Patrick	Rock	American Transmission Co.
Guest	Tim	Rocque	SPX Transformer Solutions, Inc.
Guest	Leopoldo	Rodriguez	Transformer Testing Services LLC
Guest	Oleg	Roizman	IntellPower Pty Ltd
Guest	Andre	Rottenbacher	Ritz Instrument Transformers
Member	Marnie	Roussell	Entergy
Member	Mickel	Saad	Hitachi ABB Power Grids
Guest	Hakan	Sahin	Virginia and Georgia Transformers
Guest	Albert	Sanchez	Knoxville Utilities Board
Guest	Lina	Sandsten	Hitachi Power Grids
Member	Dinesh	Sankarakurup	Duke Energy
Guest	Subhas	Sarkar	Retired
Member	Daniel	Sauer	EATON Corporation
Guest	Roderick	Sauls	Southern Company Services
Member	Alan	Sbravati	Cargill, Inc.
Member	Steven	Schappell	SPX Transformer Solutions, Inc.
Guest	Markus	Schiessl	SGB
Guest	Stefan	Schindler	Maschinenfabrik Reinhausen
Member	Dan	Schwartz	Quality Switch, Inc.
Guest	Pugal	Selvaraj	Virginia Transformer Corp.
Guest	Cihangir	Sen	Duke Energy
Member	Adam	Sewell	Quality Switch, Inc.
Guest	Devki	Sharma	Entergy
Guest	David	Sheehan	HICO America
Member	Stephen	Shull	BBC Electrical Services, Inc.
Guest	Jonathan	Sinclair	PPL Electric Utilities
Guest	Kushal	Singh	ComEd
Guest	Kenneth	Skinger	Scituate Consulting, Inc.
Guest	Christopher	Slattery	FirstEnergy Corp.
Guest	William	Solano	Instrument Transformer Equip Corp
Member	Sanjib	Som	Pennsylvania Transformer
Guest	Mauricio	Soto	Hitachi ABB Power Grids
Guest	Brian	Sparling	Dynamic Ratings, Inc.

Member	Fabian	Stacy	Hitachi ABB Power Grids
Member	Brad	Staley	Salt River Project
Member	Markus	Stank	Maschinenfabrik Reinhausen
Guest	Kyle	Stechschulte	American Electric Power
Guest	Neil	Strongosky	Memphis Light, Gas & Water
Guest	Charles	Sweetser	OMICRON electronics Corp USA
Member	Janusz	Szczechowski	Maschinenfabrik Reinhausen
Guest	Radoslaw	Szewczyk	Specialty Products Poland Sp. z o.o.
Member	Troy	Tanaka	Burns & McDonnell
Guest	Marc	Taylor	Cogent Power Inc.
Guest	Ed	teNyenhuis	Hitachi ABB Power Grids
Guest	Ryan	Thompson	Burns & McDonnell
Guest	Timothy	Tillery	Howard Industries
Member	Mark	Tostrud	Dynamic Ratings, Inc.
Guest	Parag	Upadhyay	ABB Inc.
Member	Ajith	Varghese	SPX Transformer Solutions, Inc.
Member	Jason	Varnell	Doble Engineering Co.
Guest	Kiran	Vedante	Ritz Instrument Transformers
Guest	Kannan	Veeran	Georgia Transformer
Member	Rogerio	Verdolin	Verdolin Solutions Inc.
Member	Krishnamurthy	Vijayan	PTI Transformers
Member	Dharam	Vir	SPX Transformer Solutions, Inc.
Guest	Duy	Vo	Central Maine Power (AVANGRID)
Member	Pragnesh	Vyas	Sunbelt-Solomon Solutions
Guest	Loren	Wagenaar	WagenTrans Consulting
Guest	Hugh	Waldrop	Memphis Light, Gas & Water
Member	Sukhdev	Walia	New Energy Power Co.
Member	David	Wallach	Duke Energy
Guest	Evanne	Wang	DuPont
Guest	Michael	Warntjes	American Transmission Co.
Guest	Alan	Washburn	Burns & McDonnell
Member	Joe	Watson	JD Watson and Associates Inc.
Member	Bruce	Webb	Knoxville Utilities Board
Guest	Drew	Welton	Intellirent
Guest	Peter	Werelius	Megger
Member	Daniel	Weyer	Nebraska Public Power District
Guest	William	Whitehead	Siemens Energy
Guest	Christopher	Whitten	Hitachi ABB Power Grids
Guest	Helena	Wilhelm	Vegoor Tecnologia Aplicada
Guest	Trenton	Williams	Advanced Power Technologies
Member	Dr. Alexander	Winter	HIGHVOLT Pruftechnik Dresden
Member	Jeffrey	Wright	Duquesne Light Co.

Guest	Kipp	Yule	Bechtel
Guest	Joshua	Yun	Virginia Transformer Corporation
Member	Peter	Zhao	Hydro One
Member	Kris	Zibert	Allgeier, Martin and Associates
Guest	Waldemar	Ziomek	PTI Transformers

Attachment K.2

AGENDA

Power Transformers Subcommittee

IEEE PES Transformers Committee

Wednesday, April 28, 2021, 12:55-2:10 PM CDT, Session 2

On-Line Meeting; Virtual

Bill Griesacker – Chair, Alwyn VanderWalt – Vice Chair, Dan Blaydon – Secretary

1. Call to order
2. Determine quorum
3. Approval of agenda, approval of previous meeting minutes
4. Chair remarks
5. Working Group and Task Force reports
    a. WG Revision of C57.116, GSU Transformers ..... W. Li
    b. TF Revision of C57.125, Failure Investigating and Reporting ..... W. Binder
    c. WG Revision of C57-131, Tap Changers ..... C. Colopy
    d. WG Revision of C57.143, Monitoring Guide ..... M. Spurlock
    e. WG Revision of C57.148, Control Cabinet Standard ..... J. Watson
    f. WG Revision of C57.150, Transportation Guide ..... G. Anderson
    g. WG C57.170, Condition Assessment Guide ..... K. Mani
    h. TF Transformer Volts per Hertz ..... J. Watson
    i. Liaison to PC57.93a – Installation and Maintenance Guide ..... S. Reed
6. Old business
7. New business
8. Adjournment

Attachment K 4.2

Meeting Minutes
Task Force on Failure Investigation & Reporting PC57.125
Monday, April 26, 2021
Virtual Meeting via WebEx
3:45pm – 5:00PM CDT

1. Call to Order at 3:45pm CDT / 4:45pm EDT
2. Chair's Remarks
3. Attendees Roster Sign In – Participants
   1 Attendance at TF does not automatically mean WG membership
   2 Indicate interest in membership in WebEx chat
   3 This meeting will be a TF meeting so attendees must return in F21 to honor requests for membership.
   4 Attendance was 75 unique names (although 8 spent under 15 minutes of the 45 so actual attendance was probably 67)

2 Motion to Approve Agenda made by Tom Melle / Second by James Cross (Approved without objection).

3 Call for Patents (no essential patent claims made)

4 IEEE SA Copyright Policy (slide presented to TF)

5 PAR
   1 Motion to Revise the existing C57.125-2015
   - Made by Sam Sharpless
   - Second by Eduardo Garcia
     (Motion Carries – approved without objection)
   3. Discussion – Bruce Forsyth commented that the intended purpose of the TF is to function as a PAR study group. Confirmed by Bill Griesacker.

   B. Motion to withdraw new PAR?

   (No Motion put forward / Motion Withdrawn)

   C. Motion to advance the Revised PAR to PTSC to approve at the SC level

   a.i.1. Made by Bill Griesacker

   a.i.2. Second by Bruce Forsyth
   3. Discussion – None (Motion approved without objection)

8. Motion to revise the Purpose statement of the PAR as follows:

"This document provides a methodology to investigate the cause of any particular transformer failure by applying the scientific method to investigations; . . ."

1. Made by – Bruce Forsyth
2. Second by – Larry Dix
3. Discussion – None (Motion Approved without objection).

9. WG Officers

A. Chair Volunteers
- Bill Griesacker

B. Vice Chair Volunteers
- Tom Melle

C. Secretary Volunteers
- None

D. Editor Volunteers
- None

10. Closing Remarks – WB Binder

11. Motion to Adjourn
    1. Made by – Kris Neild
    2. Second by – James Cross

Adjourned 5:30pm EDT / 4:30pm CDT

Membership Requests:

Wallace Binder (WBBinder Consultant)
Akash Joshi (Black & Veatch)
Ali Naderian (METSCO Energy)
Larry Dix (Quality Switch)
Eric Doak (D4EnergySolutions)
Adam Sewell (Quality Switch)
Axel Kraemer (Maschinenfabrik Reinhausen)
Eduardo García (Siemens Energy)
Everton De Oliveira (Siemens Energy)
Ryan Hogg (Bureau of Reclamation)

Rogerio Verdolin (Verdolin Solutions Inc.)

Ronald Hernandez (Doble Engineering)

Jason Varnell (Doble Engineering)

Hakan Sahin (Virginia Georgia Transformers)

Session detail for 'TF Failure Investigation & Reporting PC57.125':		
Participant	**Name**	**Affiliation**
1	Kannan Veeran	gatransformer
2	Brandon Dent	mlgw
3	Kannan V	gatransformer
4	Eric Theisen	metglas
5	suresh babanna	spx
6	Pragnesh Vyas	solomoncorp
7	Anastasia	coned
8	Ronald Hernandez	doble
9	Troy Tanaka	Burns & Mac
10	HUAN DINH	abb USA
11	Jaber Shalabi	vantran
12	Ryan Bishop	mnpower
13	Mike Thibault	PG&E
14	Krzysztof Kulasek	hitachi-powergrids
15	Tommy Eagle	SPX Transformers
16	akash joshi	Self
17	Sanket Bolar	Megger
18	Gilles Bargone	Self
19	evanne	Dupont
20	Mana Yazdani	trench-group
21	Sheldon Kennedy	Niagara Transformer
22	Eduardo Garcia	Self
23	Tom Melle	HIGHVOLT
24	Larry Dix	quality switch
25	Fernando Leal	Self
26	Evgenii Ermakov	hitachi-powergrids
27	bill griesacker	Duquesne Light
28	Rodrigo Ocon	condume Mexico

29	HSahin	GA Transformer
30	Brandon Dent	Self
31	mfg18	va transformer
32	ROGERIO VERDOL	Shaw
33	Ali Naderian	METSCO
34	John Reagan	Oncor
35	Olle Benzler	Megger
36	Larry Rebman	Self
37	Ryan Musgrove	OGE
38	Axel Kraemer	reinhausen
39	Kris Neild	megger
40	Kevin Rapp	cargill
41	Everton De Oliveira	siemens
42	James Cross	kinectrics Canada
43	Neil Strongosky	mlgw
44	jos veens	Self
45	Janusz Szczechow	reinhausen
46	Megan Kell	eaton
47	Saramma Hoffman	pplweb
48	Robert Mayer	siemens
49	Ed Feloni	lig consultants
50	Timothy Raymond	traymond@epri
51	John Foschia	spx transformers
52	USIORAD	abb USA
53	Dejan Vuković	hitachi-powergrids
54	Bruce Forsyth	Self
55	Rhea Montpool	SE
56	Jorge Cruz	pti transformers
57	Paul Florida	howard industries
58	Didier Hamoir	transproco
59	Eric Doak	d4energysolutions
60	Sukhdev Walia	Self
61	Gregory Ante (SCE)	sce
62	ADAM SEWELL	qualityswitch
63	Jason Varnell	Doble
64	Kris Zibert	amce
65	ISMAIL GUNER	hydro-quebec Canada
66	sam sharpless	rimkus
67	Polo Rodríguez	Self
68	William Boettger	Self
69	Juan Alfredo Carriz	prolec-ge

70	Parminder	va transformer
71	asarkar	va transformer
72	Ryan Hogg	USBR
73	Martín Muñoz	orto Mexico
74	Jonathan Sinclair -	pplweb
75	Wallace Binder	WB Binder Consultant

Attachment K 4.3

Power Transformer Subcommittee

Working Group Report

Document #:	**C57.131**
Document Title:	**Standard Performance Requirements and Test Methods for Tap-changers**

Chair:	**Craig A. Colopy**	**Vice-Chair**	**Axel Kraemer**
Secretary	**Adam M. Sewell**	**Percent Complete**	**0% - initial WG meeting**

Current Draft Being Worked On: **1.0** **Dated:** **TBD**

PAR Expiration Date: **December 31, 2024**

Meeting Date: **26 April 2021** **Time:** **12:55pm-2:10pm CST**

Location: **Virtual Online Meeting**

K.9	**Attendance:**	**K.10**	**Members** **3 / 3**
K.11		**K.12**	**Guests** **16**
K.13		**K.14**	**Guests Requesting Membership** **24 (all become members)**
K.15		**K.16**	**Total*** **43**

*** Attendance list for this meeting is shown at end of meeting minutes**

Meeting Minutes / Significant Issues / Comments:

1. Meeting was called to order at 12:55 pm, April 26, 2021.
2. Opening of meeting and officer introductions.
    a. Chair-Craig Colopy-EATON Corporation, Vice Chair-Axel Kraemer-Maschinenfabrik Reinhausen, Secretary-Adam Sewell-Quality Switch, Inc.
3. Poll - Request for Members
    a. The chair, vice-chair, and secretary were counted as working group members. Since this was the first meeting as a working group, all guests requesting membership were added as members per the chair.
    b. Other participants were recorded as guests.
4. Discussion on past goal of IEC/IEEE dual logo (60214-1)

a. Direct adoption of IEC 60214-1 (2014) was not allowed so a revision and harmonization of existing C57.131-2012 with 60214-1 was next option.

5. PAR approved in December 2020 and expires December 31, 2024.
   a. Need for the Project: The current standard is expiring in 2022. It is being revised to be in sync with the IEC standard 60214-1 Ed. 2.0. May 2014.
6. Timeline – Expiration of C57.131-2012.
   a. Current C57.131-2012 expires in 2022 (10 year cycle). This WG is to bring the standard in harmony with the current IEC 60214-1.
7. Draft 1.0 – Harmonize with IEC 60214-1 (2014) --- addition of IEC references, vacuum tap-changers, SF6 tap-changers and voltage regulators.
   a. Draft will be sent out to WG for review when available
8. Next meeting(s) TBD before the next Transformer Committee Meeting - Oct 18, 2021 in Milwaukee, WI, USA
   a. Chair was asked and will investigate time slots for this working group at the next Transformer Committee meeting due to the time conflict with WG PC57.152 Guide for Field Testing.
9. Close of meeting
   a. Meeting adjourned at 1:23 pm.

Meeting Attendance

First Name	Last Name	Company Name	Role
Craig	Colopy	EATON Corporation	Chair
Axel	Kraemer	Maschinenfabrik Reinhausen	Vice-Chair
Adam	Sewell	Quality Switch, Inc.	Secretary
Allan	Bartek	Spruce Run Engineering LLC	Member
Thomas	Dauzat	General Electric	Member
Larry	Dix	Quality Switch, Inc.	Member
Florin	Faur	SPX Transformer Solutions, Inc.	Member
David	Geibel	Hitachi ABB Power Grids	Member
Saramma	Hoffman	PPL Electric Utilities	Member
Peter	Kleine	US Army Corps of Engineers	Member
Olivier	Lejay	Huaming USA Corp.	Member
Weijun	Li	Braintree Electric Light Dept.	Member
Lee	Matthews	Howard Industries	Member
Kristopher	Neild	Megger	Member
Lina	Sandsten	Hitachi Power Grids	Member
Stefan	Schindler	Maschinenfabrik Reinhausen	Member
Eric	Schleismann	Southern Company Services	Member

First Name	Last Name	Company Name	Role
Hugh	Waldrop	Memphis Light, Gas & Water	Member
Alan	Washburn	Burns & McDonnell	Member
Christopher	Whitten	Hitachi ABB Power Grids	Member
Joshua	Yun	Virginia Transformer Corporation	Member
Peter	Zhao	Hydro One	Member
Kayland	Adams	SPX Transformer Solutions, Inc.	Guest
Edmundo	Arevalo	Bonneville Power Administration	Guest
Christopher	Baumgartner	We Energies	Guest
Olle	Benzler	Megger	Guest
William	Boettger	Boettger Transformer Consulting LLC	Guest
Juan	Carrizales	Prolec GE	Guest
Juan Carlos	Cruz Valdes	Prolec GE	Guest
Brandon	Dent	Memphis Light, Gas & Water	Guest
Jeffrey	Gragert	Xcel Energy	Guest
Ryan	Hogg	Bureau of Reclamation	Guest
Gael	Kennedy	GR Kennedy & Associates LLC	Guest
Jayme	Nunes, Jr	Nynas AB	Guest

Dan	Schwartz	Quality Switch, Inc.	Member
Jeremy	Sewell	Quality Switch, Inc.	Member
Brian	Sparling	Dynamic Ratings, Inc.	Member
Markus	Stank	Maschinenfabrik Reinhausen	Member
Timothy	Tillery	Howard Industries	Member

Tejasvi	Prakash	Schweitzer Engineering Labs	Guest
Eduardo	Ramirez Bettoni	Xcel Energy	Guest
Tim	Rocque	SPX Transformer Solutions, Inc.	Guest
Kushal	Singh	ComEd	Guest

Submitted by: Craig A, Colopy Date: 4/28/2021

Attachment K 4.4

C57.143 – IEEE Guide for Transformer Monitoring

Monday, April 26, 2021

Virtual Meeting

Minutes of WG Meeting

The meeting was called to order at 2:20 PM by Chair Mike Spurlock. Vice-Chair Poorvi Patel and Secretary Elizabeth Bray (writer of Minutes) were also present.

There were 47 of 120 members present. There were 43 guests, and 21 guests requesting membership. A membership quorum was achieved. The attendance for this meeting was as follows:

- Number of Members in Activity = 88
- Number of Members Present = 47
- Percentage of Members Present = 53.4%
- Number of attendees = 120
- Attendees requesting Membership = 21

List of Meeting Attendees is provided below.

First Name	Last Name	Company	Role
Thomas	Prevost	Weidmann Electrical Technology	Member
James	Gardner	SPX Transformer Solutions, Inc.	Member
William	Boettger	Boettger Transformer Consulting LLC	Member
Juan	Castellanos	Prolec GE	Guest
Mahesh	Sampat	EMS Consulting Inc.	Guest
Stephen	Jordan	Tennessee Valley Authority	Member
Emilio	Morales-Cruz	Qualitrol Company LLC	Member
John	Lackey	PowerNex Associates Inc.	Guest
Paul	Jarman	University of Manchester	Member
John	Harley	FirstPower Group LLC	Member
John	Crouse	Roswell Alliance	Member
Michael	Franchek	Retired	Guest
Axel	Kraemer	Maschinenfabrik Reinhausen	Member
Peter	Zhao	Hydro One	Member
Krzysztof	Kulasek	Hitachi ABB Power Grids	Member
Oleg	Roizman	IntellPower Pty Ltd	Member
Kumar	Mani	Duke Energy	Member
Paul	Boman	Hartford Steam Boiler	Member
Rogerio	Verdolin	Verdolin Solutions Inc.	Member
Gary	Hoffman	Advanced Power Technologies	Member
Charles	Sweetser	OMICRON electronics Corp USA	Member
Scott	Reed	MVA	Member

James	Cross	Kinectrics	Member
Douglas	Craig	Richards Manufacturing Co.	Guest
Jean-Noel	Berube	Rugged Monitoring Inc.	Member
Luiz	Cheim	Hitachi ABB Power Grids	Member
John	Chisholm	IFD Corporation	Guest
Roger	Hayes	General Electric	Member
Mike	Spurlock	Spurlock Engineering Services, LLC	Chair
James	McBride	JMX Services, Inc.	Member
Brian	Sparling	Dynamic Ratings, Inc.	Member
George	Frimpong	Hitachi ABB Power Grids	Member
James	Dukarm	Delta-X Research Inc.	Member
James	Dukarm	Delta-X Research Inc.	Member
Donald	Lamontagne	Arizona Public Service Co.	Member
Markus	Stank	Maschinenfabrik Reinhausen	Member
Patrick	Picher	Hydro-Quebec IREQ	Member
Marco	Espindola	Hitachi ABB Power Grids	Member
Claude	Beauchemin	TJH2b Analytical Services	Member
John	Pruente	SPX Transformer Solutions, Inc.	Member
Mark	Tostrud	Dynamic Ratings, Inc.	Member
Poorvi	Patel	Electric Power Research Institute (EPRI)	Vice-Chair
David	Sheehan	HICO America	Member
Ryan	Thompson	Burns & McDonnell	Member
Mark	Faulkner	EATON Corporation	Guest
Xose	Lopez-Fernandez	Universidade de Vigo	Member
Anthony	McGrail	Doble Engineering Co.	Member
Stephanie	Denzer	Alliant Energy	Member
Sukhdev	Walia	New Energy Power Co.	Member
Stephan	Brauer	Morgan Schaffer	Member
Robert	Kinner	FirstPower Group LLC	Member
Anil	Sawant	Virginia Transformer Corp.	Member
Detlev	Gross	Power Diagnostix	Member
Leon	White	H2scan	Guest
Larry	Rebman	EMLS, Inc.	Guest
Elizabeth	Bray	Southern Company Services	Secretary
Christopher	Steineman	Delta Star Inc.	Member
Patrick	Rock	American Transmission Co.	Guest
Robert	Mayer	Siemens Energy	Member
Thomas	Hartmann	Pepco Holdings Inc.	Member
Kristopher	Neild	Megger	Member
Jonathan	Reimer	FortisBC	Guest
Lorne	Gara	Shermco	Member
Ismail	Guner	Hydro-Quebec	Member

Jeffrey	Wright	Duquesne Light Co.	Member
Michael	Frayne	Hammond Power Solutions	Guest
Hakim	Dulac	Qualitrol Company LLC	Member
Paul	Su	FM Global	Member
Attila	Gyore	M&I Materials Ltd	Member
Niklas	Gustavsson	Hitachi ABB Power Grids	Member
Jinesh	Malde	M&I Materials Inc.	Guest
Trenton	Williams	Advanced Power Technologies	Member
Jeremiah	Bradshaw	Bureau of Reclamation	Member
William	Whitehead	Siemens Energy	Member
Anastasia	O'Malley	Consolidated Edison Co. of NY	Member
Florin	Faur	SPX Transformer Solutions, Inc.	Member
Alan	Sbravati	Cargill, Inc.	Guest
Mickel	Saad	Hitachi ABB Power Grids	Member
Travis	Spoone	EATON Corporation	Member
Martin	Munoz Molina	Orto de Mexico	Member
Akash	Joshi	Black & Veatch	Guest
Igor	Simonov	Toronto Hydro	Guest
Malia	Zaman	IEEE	Member
Roger	Fenton	Fenton Solutions	Member
Stuart	Chambers	Powertech Labs Inc.	Member
Stacey	Kessler	Basin Electric Power Cooperative	Member
Janusz	Szczechowski	Maschinenfabrik Reinhausen	Member
Nitesh	Patel	Hyundai Power Transformers USA	Member
Drew	Welton	Intellirent	Member
Caroline	Peterson	Xcel Energy	Member
Lee	Doyle	Vaisala	Member
Gilles	Bargone	FISO Technologies Inc.	Member
John	Reagan	Oncor Electric Delivery	Member
Matthew	Webb	SPX Transformer Solutions, Inc.	Member
Kyle	Heiden	EATON Corporation	Member
David	Calitz	Siemens Energy	Member
Darrell	Mangubat	Siemens Power Operations Inc.	Member
Suleman	Khan	Ontario Power Generation	Guest
Jon	Karas	SDMyers, LLC.	Member
Hugh	Waldrop	Memphis Light, Gas & Water	Guest
Mana	Yazdani	Trench Limited	Member
Dmitriy	Klempner	Southern California Edison	Member
Kyle	Stechschulte	American Electric Power	Member
Jonathan	Sinclair	PPL Electric Utilities	Member
Saramma	Hoffman	PPL Electric Utilities	Member
Matthew	McFadden	Oncor Electric Delivery	Guest
Zachary	Draper	Delta-X Research Inc.	Guest
Stefan	Schindler	Maschinenfabrik Reinhausen	Guest

William	Knapek	OMICRON electronics Corp USA	Guest
Adrian	Silgardo	IFD Corporation	Member
Risto	Trifunoski	Trench Limited	Guest
Tejasvi	Prakash	Schweitzer Engineering Labs	Member
Zlatan	Fazlic	Camlin Power	Member
Anatoliy	Mudryk	Camlin Power	Member
Evgenii	Ermakov	Hitachi ABB Power Grids	Guest
Adam	Smith	Commonwealth Associates, Inc.	Member
Derek	Hollrah	Burns & McDonnell	Member
Balakrishnan	Mani	Virginia Transformer Corp.	Member
Mauricio	Soto	Hitachi ABB Power Grids	Member
Nabi	Almeida	Prolec GE USA LLC	Member
Suresh	Babanna	SPX Transformer Solutions, Inc.	Member
David	Holland	ExxonMobil	Guest
Taylor	Gray	Portland General Electric (PGE)	Guest
Michael	Richardson	Ameren	Guest
Kannan	Veeran	Georgia Transformer	Guest
ANDY	DOWNEY	SPX TRANSFORMER SOLUTIONS	Guest
Markus	Soeller	Power Diagnostix	Guest
George	Jalhoum	PPl	Guest
Bobby	Clift	Xcel Energy	Guest

The WG plans to meet at the Fall October 17 2021 Transformers Committee Meeting in Milwaukee, Wisconsin.

Agenda

1. Welcome & Introduction
2. Call for Patent Disclosure
3. Chair Remarks
4. Recognition and thanks to volunteers
5. Welcome New Members
6. Quorum Check
7. Approval of Agenda
8. Recent Email Ballot Approvals (F2019 and F2020) minutes
9. Task Force Activites:
    a. Task Force 1 (Chapters 1,2,3,4) – Trent Williams
    b. Task Force 2 (5.2 Thermal, 5.3 Cooling, 5.4 Loading) – Poorvi Patel
    c. Task Force 3 (5.5 LTC, 5.6 Tank, 5.7 Conservator, 5.11 Partial Discharge) – Emilo Morales
    d. Task Force 4 (5.8 DGA, 5.9 Moisture, 5.10 Bushings, 5.12 GIC) – Bill Whitehead
    e. Task Force 5 (Chapter 6 Communications) – Zlatan Fazlic
    f. Task Force 6 (Chapter Cost Benefits) – Elizabeth Bray
10. Status of PAR Extension Request
11. Discuss Possible New Chapter to be inserted between Chapters 4 and 5
12. New Business

Chair Mike Spurlock asked of a call for patents disclosure was made and no patent claims were reported. A letter of assurance was received last week from one claimant that had notified the working group of an essential patent claim during the Fall 2020 virtual meeting.

Chair Mike Spurlock reviewed the IEEE Copyright policy.

Chair Mike Spurlock provided chair remarks with accomplishments of 2020 and the March 10, 2021 email ballot approval. The volunteers were also recognized and thanked for their work in supporting this working group. As well as the call for additional volunteers and how to get added to support the areas that need volunteers. Nine new members were welcomed to the working group.

A motion to approve the Spring 2021 Agenda was made by Trent Williams and seconded by Emilio Morales-Cruz. The working group unanimously approved the agenda.

The Fall 2019 and Fall 2020 meeting minutes and agendas were approved by the working group by e-mail ballot on March 10, 2021. On that date, there were 83 members in the Working Group and we needed 42 votes to pass each measure.

Columbus (Fall 2019) Meeting Agenda.
Approved as written: 45
Approved with comments: 0
Disapproved: 0
Abstain: 1

Columbus (Fall 2019) Meeting Minutes.
Approved as written: 44
Approved with comments: 1
Disapproved: 0
Abstain: 1

Virtual (Fall 2020) Meeting Agenda.
Approved as written: 45
Approved with comments: 0
Disapproved: 0
Abstain: 1

Virtual (Fall 2020) Meeting Minutes.
Approved as written: 45
Approved with comments: 0
Disapproved: 0
Abstain: 1

Task forces gave updates to their status as well as a few areas that additional volunteers would be useful.

Task Force 1 - Chair: Trent Williams
Chapter 1 (Overview)
Chapter 2 (Normative References)
Chapter 3 (Definitions)
Chapter 4 (Surveillance Needs)
References definitions are needed to the group. Discussion on the possible split of Chapter 4 was discussed later in the meeting.

Task Force 2 - Chair: Poorvi Patel
Clause 5.2 (Thermal)
Clause 5.3 (Cooling)
Clause 5.4 (Load)
Task force in good shape.

Task Force 3 - Chair: Emilio Morales
Clause 5.5 (LTC)
Clause 5.6 (Tank)
Clause 5.7 (Conservator)
Clause 5.11 (Partial Discharge)
Review close to complete and need support with review. Please contact Emilo to volunteer to support this review.

Task Force 4 - Chair: Bill Whitehead
Clause 5.10 (Bushings)
Clause 5.8 (Dissolved Gas Analyzers)
Clause 5.9 (Moisture)
Clause 5.12 (Geomagnetic Induced Current)
Review is close to complete and most work will be complete in May to early June time frame.

Task Force 5 - Chair: Zlatan Fazlic Chapter 6 (Communications)
Feedback from Brian Sparling stated they are close to having this section ready and asking permission to use Cigre TB 620 and updating to current standards and what does the future look like with future technologies. Brian & Zlatan are working on this alone and ask for any one who would like to volunteer to review please reach out.

Task Force 6 – Chair: Elizabeth Bray Chapter 7 (Cost Benefits)
Requested additional volunteers with utility experience for review the document was requested.

Chair Mike Spurlock mentioned that he had filed for a two-year PAR extension on March 19, 2021 and that the NesCom has this on their agenda for May 4, 2021.

There was discussion about the potential of splitting up chapter 4 into two separate chapters. Work has been done to the proposed chapters and Chair Mike Spurlock will circulate the proposed chapters to the working group members and set up a follow up virtual meeting to discuss the possible Chapter 4 split after the working group members have had a chance to review.

Progress has continued on the C57.143 Guide and the draft version is out on the IEEE Transformers Committee webpage. This will be updated after the next round of revisions.

No other new business was brought up.

A motion to adjourn was made by Poorvi Patel and seconded by Bill Whitehead. The motion passed by unanimous approval. The meeting adjourned at 3:25 pm CST.

Attachment K 4.7

TF on V/Hz Requirements Minutes

Kipp Yule – Chair, Ramsis Girgis, – Vice Chair, Joe Watson – Vice-Chair

The Task Force on Volts/Hz Requirements met on April 27, 2021 at 2:20 PM. The meeting attendance poll indicated 8 Members and 43 Guests with one non-responsive attendee. The final report showed 8 Members and 61 Guests. A quorum was achieved with 8 of the TF's 14 Members in attendance.

The Task Force was assigned by the Power Transformers Subcommittee in the fall 2017 SC meeting to study the topic of V/Hz and to determine if existing Guides or Standards required additional coverage of the topis and/or if a new Guide or Standard was needed. During previous meetings, the TF determined that C57.116, the IEEE Guide for Transformers Directly Connected to Generators could benefit from additional information on V/Hz issues and that a new Guide was recommend to fully cover the subject.

The following text was completed before this meeting and delivered to the C57.116 WG for inclusion as an Annex or in other new or existing sections of the revised document:

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Proposed V / F Text for C57.116

Short-term overexcitation in power transformers

According to IEEE Standard C57.12.00, a transformer is designed to operate indefinitely when excited at least 95 % of rated frequency; and secondary voltage and Volts per Hertz do not exceed 105 % of rated voltage, with a 0.8 power factor, or higher, under load conditions. Depending on a transformer's core design, a significant level of increase in the exciting voltage or a significant reduction in the frequency, or a combination of both, can over-excite the core and increase the core flux density well beyond the saturation level

Overexcitation should be considered when operating transformers directly connected to generators, where the most severe case is normally during generator load rejection when a circuit breaker on the load side of the transformer opens, interrupting the load from a generator and causing the generator voltage to increase significantly while the frequency slows down over 10s of seconds while the generator's rotor gradually spins to a stop.

Relay Practices

Transformers connected to generators are typically protected from moderate over-excitation under normal operating conditions. However, these transformers may not be able to protect from load rejection conditions if a circuit breaker is not located between the generator and the transformer.

Protective relays for this type of very high V/Hz conditions should have inverse time characteristic to allow the transformer to operate under mild overvoltage and/or under-frequency conditions for a longer time than excessive overvoltage and/or under-frequency conditions. Relay settings for this type of protection should be obtained from a V/Hz curve that is applicable for the specific transformer.

Effects of short-term overexcitation on power transformers

The effects of high levels of core overexcitation can vary significantly from one transformer design to another. When such high levels of overexcitation cause magnetic saturation of transformer cores, a portion of the core main flux escapes from the core into and through the active part of the transformer, structural parts, and tank, causing heating of those parts beyond their thermal design limits. This can lead to:

(1) Damage of solid insulation in contact with these parts leading to loss of insulation life if the insulation is not rated for those temperatures

(2) Gas bubbles of oil in contact with the overheated structural parts of the transformers, leading to possibly catastrophic dielectric failure of the transformer

(3) Overheating of the tank walls leading into discoloration of the tank paint.

However, due to the short duration nature of this type of overexcitation and the relatively much longer Thermal Time Constant of the structural parts of transformers, the rise in temperature of these parts caused by this type of over excitation would be small. Also, the short duration of this increase in temperature would significantly decrease the impact of this rise in temperature on insulation life or gas bubble generation

V/Hz Curves

Figure 1 below presents a V/Hz curve that has been used for many types of transformers. It is based on factory measurements conducted in the 1960's on a core-form type transformer that was designed with manufacturers' technology at the time, core steel grade, and with cellulose type insulation to operate indefinitely at approximately 110 % rated V/Hz. The curve has served as an effective damage curve for operation of this type of transformers at various V/Hz values and times. According to this curve, operation of transformers is to be limited to the area below the curve. Also, the transformer should be de-energized if the V/Hz level exceeds the value for the appropriate time to avoid thermal damage. This is a conservative curve that has been used for several types of transformers that did not have a specific V/Hz curve developed or available for the transformer. If a specific V/Hz curve for the transformer is not available and the design of the transformer is unknown, this curve, or another curve from the same manufacturer for a similar transformer, may provide an estimated damage curve for the transformer in question, but the User should recognize that the curve is only an estimate and may want to adjust their relay setting accordingly.

Transformer manufacturers should provide a similar curve that more accurately reflects the specific design of a transformer that will be connected directly to a generator, or other types of transformers when requested.

V/Hz Curve Criteria

A transformer V/Hz curve should accurately estimate the V/Hz levels and the times allowed at those levels when unacceptable insulation aging or oil bubbling may occur over a range from 100-140 % V/Hz. The curve should have the % Excitation or % V/Hz on the Y axis and the time in seconds on the X axis. The manufacturer should consider the following design information when developing the curve:

- Type of core steel, flux densities under the V/Hz range, and corresponding saturation levels
- Temperature rises of all vulnerable structural parts from flux heating over the V/Hz range
- Thermal rating of insulation materials in contact with the core and overheated structural parts
- Bubbling temperature of the insulating fluid
- Maximum oil temperature rise at the worst case load and cooling levels
- Specified maximum ambient temperature

The area below the curve should represent the operating range where the temperatures on any overheated structural parts will not cause oil bubbling or heat the insulation to a temperature greater than the insulation's rated temperature.

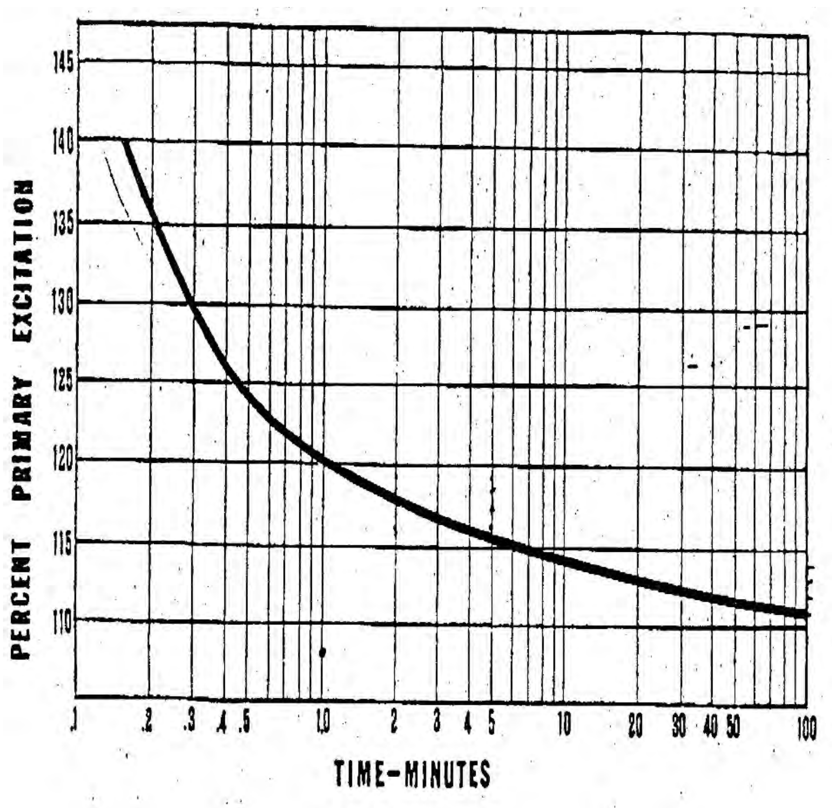

Figure 1: Typical V/Hz Curve

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

The TF also discussed a report that was emailed to the TF Members and Guests with the meeting agenda and viewed a presentation which summarized findings that had been presented previously that explains the need for a new Guide to cover the V/Hz issue for power transformers. The Presentation will be posted on the Transformers Committee website under the TF's section on the Power Transformer SC's page.

The report follows:

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Need for Developing V/Hz Curves
for Transformers Directly Connected to Generators

Background on effect of short term overexcitation in Power Transformers

Short term overexcitation typically drives the transformer core into magnetic saturation for the duration of the overexcitation. The consequence of core saturation is typically overheating of structural parts of the transformer. If excessive, and for longer periods, this overheating can cause solid insulation damage and Gas generation that can ultimately result in dielectric failures.

Transformers connected to generators need to be protected from load rejection conditions if a circuit breaker is not located between the generator and the transformer. Protective relays for this type of very high V/Hz conditions should have inverse time characteristic to allow the transformer to be protected under these conditions. Relay settings for this type of protection should be obtained from a V/Hz curve that is applicable for the specific transformer.

V/Hz Curves presently used by the industry and issues with using these curves

V/Hz Curves presently used by the industry are all based on the curve originally presented to the industry by GE in the mid-sixties. That curve was basically developed by measuring the time it took for the core flitch / tie plates of a specific GE core form transformer to reach 180 C at the different levels of over-excitation applied to that transformer during that test. This represents the following significant issues regarding the applicability of this curve:

1. The time to reach 180 C should not have been used as a temperature limit, since 10s of seconds of this temperature (Corresponding to typical durations of short term overexcitation) would not have much of a degrading impact on the transformer; neither on life of insulation materials nor on oil bubbles. The origin of the 180 C is that it is what the IEEE Loading Guide allows for short term emergency loading which could be as long as 30 minutes.
2. This curve was specific to one core form transformer design at a specific core flux density and having a certain tie-plate design made of mild steel. Therefore, it would not apply to:
    a. Other core form designs with different flitch / tie plates designs, materials, and core flux densities
    b. Designs with different insulation materials in contact with the flitch / tie plates. e.g., fiberglass, etc.
    c. Shell form transformers

<u>Development of appropriate V/Hz Curves</u>

In order to develop the appropriate V/Hz Curve for a transformer design, manufacturers need to follow the following steps:

1. Calculating thermal impact of different levels of overexcitation on the transformer design vs. time; from 10s of seconds up to several minutes
2. Using Standard Temperature – duration requirements that consider:
    - How much deterioration of solid insulation, in touch with high temperature structural parts, would be allowed to take place during each over excitation incident.
    - How much Gas generation / bubbles, of oil in touch with high temperature structural parts, would be allowed to take place during each over excitation incident.

<u>Need for a V/Hz Guide</u>

The proposed Guide will mainly include proposed methodology of developing the right V / Hz curve for a transformer design accounting for the thermal impact of short term overexcitation on transformers as discussed in above. The Guide will also have tutorial information on effect of short term overexcitation in Power Transformers and V/Hz Curves presently used by the industry and issues with using these curves.

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Following the presentation, a motion was made by Bill Griesacker and seconded by Drew Welton as follows: "A Motion is made that the TF recommend to the Power Transformers

Subcommittee that a Guide be drafted to cover Transformer V/Hz." The motion passed unanimously and was presented to the Power Transformers Subcommittee the following day.

The TF reported to the Power Transformers SC on April 28, 2021 that the work of the TF has been completed and Joe Watson made a Motion for the SC to recommend the establishment of a TF to create a PAR for a new WG to create a new Guide. Discussion of the Motion indicated that the new Guide should include the following V/Hz topics:

- The impact of V/Hz on power transformers
- Issues with existing V/Hz curves
- Methodology to develop the V/Hz curves for power transformer designs
- Time-temperature criteria for manufacturers to use to develop V/Hz curves

The Motion passed with unanimous consent.

Bill Griesacker appointed Joe Watson as Chair of this TF and he will work with Kipp Yule and Ramsis Girgis to develop the Scope and Purpose and request the PAR for this project.

Once a PAR is ready, the new WG should be able to meet for the first time in the fall 2021 meeting. We estimate that a room large enough for 75 people should be reserved for this meeting.

The meeting adjourned at 3:35PM.

Meeting attendance:

Hopefully a better process can be developed to provide the meeting attendance data that is listed below. The current process is tremendously work intensive. We recommend that the names of the attendees and their affiliations be reported as listed in AMS under the registered attendee's files, and the report be in a .cvs or similar excel spreadsheet format. The reports should also record the meeting attendance into the AMS system. This would save hours of work for the SC, WG and TF secretaries who need to include the attendance information in these Minutes.

Status	Name	Affiliation
Chair	Kipp Yule	Bechtel
Vice-Chair	Ramsis Girgis	Hitachi ABB Power Grids
Vice-Chair	Joe Watson	JD Watson and Associates Inc.
Member	Javier Arteaga	Hitachi ABB Power Grids
Member	Everton De Oliveira	Siemens Ltda
Member	Bill Griesacker	Duquesne Light Co.
Member	Sanjay Patel	Royal Smit Transformers
Member	Drew Welton	Intellirent
Guest	Kayland Adams	SPX Transformer Solutions, Inc.
Guest	Raj Ahuja	Raj Ahuja Consulting

Guest	Onome Avanoma	MJ Consulting
Guest	Hugo Avila	Hitachi ABB Power Grids
Guest	Suresh Babanna	SPX Transformer Solutions, Inc.
Guest	Jared Bates	Oncor Electric Delivery
Guest	Mats Bernesjo	Hitachi ABB Power Grids
Guest	Piotr Blaszczyk	Specialty Transformer Components LLC
Guest	William Boettger	Boettger Transformer Consulting LLC
Guest	Joshua Bohrn	PacifiCorp
Guest	Erich Buchgeher	Siemens Energy
Guest	David Calitz	Siemens Energy
Guest	Juan Carrizales	Prolec GE
Guest	Jorge Cruz	PTI Transformers
Guest	Juan Carlos Cruz Valdes	Prolec GE
Guest	Eric Davis	Burns & McDonnell
Guest	Nikolaus Dillon	Dominion Energy
Guest	Larry Dix	Quality Switch, Inc.
Guest	ANDY DOWNEY	SPX TRANSFORMER SOLUTIONS
Guest	Thomas Eagle	SPX Transformer Solutions
Guest	Eduardo Garcia Wild	Siemens Energy
Guest	Orlando Giraldo	THE H-J FAMILY OF COMPANIES
Guest	Jeffrey Gragert	Xcel Energy
Guest	Thomas Hartmann	Pepco Holdings Inc.
Guest	Roger Hayes	General Electric
Guest	Ryan Hogg	Bureau of Reclamation
Guest	Nicholas Jensen	Delta Star Inc.
Guest	John John	Virginia Transformer Corp.
Guest	Suleman Khan	Ontario Power Generation
Guest	Peter Kleine	US Army Corps of Engineers
Guest	William Knapek	OMICRON electronics Corp USA
Guest	Anton Koshel	Delta Star Inc.
Guest	Mark Lachman	Doble Engineering Co.
Guest	John Lackey	PowerNex Associates Inc.
Guest	Weijun Li	Braintree Electric Light Dept.
Guest	Rebecca Manderfield	Xcel Energy
Guest	Kumar Mani	Duke Energy
Guest	Balakrishnan Mani	Virginia Transformer Corp.
Guest	Dennis Marlow	DenMar TDS Transformers
Guest	Matthew McFadden	Oncor Electric Delivery
Guest	Paul Morakinyo	PSEG
Guest	David Murray	Tennessee Valley Authority
Guest	Kristopher Neild	Megger
Guest	Rodrigo Ocon	Industrias IEM
Guest	George Partyka	PTI Transformers
Guest	Nitesh Patel	Hyundai Power Transformers USA

Guest	Monil Patel	Pacific Gas & Electric Company
Guest	Branimir Petosic	Boiler Inspection & Insurance of Canada
Guest	Chris Powell	Intermountain Electronics
Guest	Jeffrey Ray	JLR Consulting, Inc.
Guest	Larry Rebman	EMLS, Inc.
Guest	Markus Schiessl	SGB
Guest	Sanjib Som	Pennsylvania Transformer
Guest	Ryan Thompson	Burns & McDonnell
Guest	Jason Varnell	Doble Engineering Co.
Guest	Krishnamurthy Vijayan	PTI Transformers
Guest	David Wallach	Duke Energy
Guest	Bruce Webb	Knoxville Utilities Board
Guest	Dr. Alexander Winter	HIGHVOLT Pruftechnik Dresden
Guest	Jeffrey Wright	Duquesne Light Co.
Guest	Anand Zanwar	Siemens Energy

Attachment K4.8

IEEE PC.57.170 Condition Assessment Guide Working Group Meeting Minutes

Date and Venue: 10:25-11:40 AM CST, Apr 27th, 2021 (Virtual Meeting)
Total Attendees: 121
Quorum Poll: Members- 49 (out of 84) 58% quorum achieved; Guest- 64; Guest Requesting Membership- 21; No answer- 8 and Total Attendees- 121.

1. The chair outlined the IEEE Patent disclosure policy and no disclosure was noted.
2. The chair outlined the IEEE Copyright Policy.
3. A membership quorum was polled, and a quorum was established.
4. Adoption of Fall 2020 Meeting Minutes: Approved Unanimously by acclamation.
5. Adoption of Spring 2021 Meeting 2020: Approved Unanimously by acclamation.
6. The four task force met a few times in the past few months and reports on the proposed sections for this guide were presented by leaders Dr. Luiz Cheim for TF#1(Section 1-2), Saramma Hoffman for TF#2 (Section 3-4-5), Jonathan Sinclair for TF#3 (Section 6-7-8) and Alan Sbravati for TF#4 (Section 9 and Annexes). The basic guide structure as presented by the TF leaders are as follows:

6.1. **Task Force 1**:

6.1.1. **Section 1: Fundamentals of Transformer Condition Assessment**

- Asset management strategies
- Transformer failure modes
- Condition assessment
- Indices utilized in transformer condition assessment (Intro)
- Post-Mortem analysis and feedback

6.1.2. **Section 2: Transformers condition assessment indexes (*TCAI*)**

- Main objectives of implementing/developing a *TCAI* (business drivers)
  - Fleet screening
  - Maintenance and operations
  - Budget allocation
  - Repair/replacement
  - System expansion
- Overview of most common approaches – parameters to consider
- Advantages and disadvantages of most common approaches
- Case studies
  - Common approach to fleet screening (example)
  - Common approach to support maintenance and operations
  - Common approach in support of repair/replace strategy
  - Common approach on system expansion application

6.2. **Task Force # 2:**

6.2.1. **Section3: Dealing with uncertainty in information**

- Dealing with uncertainty (old data, data entry etc.) with available information

- Dealing with missing data
  - Stop assessment, or ignore missing data and manually assess
  - Use a default value
  - Use a default with a range
  - Use of statistical inference on limited number of parameters
  - Use of statistical inference on many input parameters
  - Imputation using external and local circumstances
  - Machine learning imputation (remark only)
  - Examples

6.2.2. **Section 4: Criticality and Consequence of Failure**

- Assessing critically & developing a criticality index

6.2.3. **Section 5: Transformer Active Part**

- Solid insulation degradation assessment
- Dielectric assessment
- Mechanical assessment

6.3. **Task Force #3**:

6.3.1. **Section 6: Bushings and Cable Boxes**

- Transformer bushings
  - Test and diagnostics
  - Failure mode assessment
- Transformer cable boxes
  - Test and diagnostics
  - Failure mode assessment

6.3.2. **Section 7: OLTC (LTC) & DETC**

- Failure Modes -> IEEE C57.140
- Tests and diagnosis

6.3.3. **Section 8: Cooling System, Transformer Tank, & Ancillary Components**

- Cooling System
  - Failure Modes
  - Tests and Diagnosis
- Transformer Tank
  - Failure Modes
  - Tests and Diagnosis
- Ancillary Components
  - Failure Modes
  - Tests and Diagnosis

6.4. **Task Force #4:**

6.4.1. **Section 9: Insulating Liquids**

- Recommend that the mineral oil assessment follow C57.106. May need to refer to other documents related to other insulating fluids (esters, silicon, less flammable hydrocarbon liquids).

- Include insulating liquid condition in the general condition assessment indexes (TCAI)

6.4.2. **Annex A Transformer Condition Assessment Tables (Requires inputs from all sections)**

6.4.3. **Annex B How to develop a TCAI (Requires inputs from all sections)**

6.4.4. **Annex C Literature overview**

7. After the presentations were completed, the floor was opened for questions and discussions about those Sections.
   - There was very good discussion about the presentations made.
   - Several recommendations were made regarding the presentation provided. The chair noted that we need to ensure that we do not duplicate the work of other existing IEEE guides but use them only for reference purposes only.
   - Since the PAR expires in 2023, Bill Griesacker and Hemchandra Shertukde raise the question regarding timeline for the work require to be completed under each TF. The Chair commented that he plans to discuss the timeline with each TF and report back a timeline during the next WG meeting.
   - Tony McGrail suggested considering having a section about the financial aspects of condition assessment. Tim Raymond and Saramma Hoffman stated that this was discussed in Task Force # 2. The Chair suggested that TF #2 further discuss this suggestion within their TF and report back to the WG.
   - Lance Lewand raise the concern about the use of the word moisture in the presentation of TF#4. He suggested the use of the word water for transformer oil in Section 9. Alan agreed with the suggestion.
   - Several guests / members volunteered to join the four task forces (Clauses 1-2, Clause 3-4-5, Clauses 6-7-8 and Clause 9 and three annexures) via the chat section on WebEx.
   - The chair noted that each TF lead and team must request copyright permission of use of any Cigre / IEEE documents and provide references to these documents while writing the guide.
   - A consolidated list of TF volunteer members (with Sections assigned) is being sent with attached with the meeting minutes.
   - There were no new items for consideration.
   - The meeting was adjourned at 11:40 am.

List of attendees (membership status shown during quorum poll):

First Name	Last Name	Member	Guest	Guest Req. Memb.	Company
Raj	Ahuja	X			Raj Ahuja Consulting
Edmundo	Arevalo				Not Known
Hugo	Avila		X		Not Known
Chris	Baumgartner		X		We Energies
Enrique	Betancourt			X	Prolec GE

William	Boettger	X			Boettger Transformer Consulting LLC
Jeremiah	Bradshaw		X		Bureau of Reclamation
Erich	Buchgeher	X			Siemens Energy
Luiz	Cheim	X			Hitachi ABB Power Grids
James	Cross	X			Kinectrics
John	Crouse		X		Roswell Alliance
Eric	Doak			X	D4EnergySolutions LLC
Don	Dorris	X			Nashville Electric Service
Lee	Doyle			X	Vaisala
Zach	Draper		X		Delta-X
James	Dukarm		X		Delta-X
Samragni	Dutta Roy	X			Siemens Energy
Arnold	Elise				SGB-SMIT Group
Evgenii	Ermakov			X	Hitachi ABB Power Grids
Marco	Espindola		X		ABB Enterprise Software Inc.
Roger	Fenton			X	Fenton Solutions
Norman	Field	X			Teshmont Consultants LP
Bruce	Forsyth	X			Bruce Forsyth and Associates LLC
Michael	Franchek		X		Retired
George	Frimpong	X			Hitachi ABB Power Grids
Eduardo	Garcia		X		Siemens Inc
James	Gardner	X			SPX Transformer Solutions, Inc.
Jonathan	Garrity				Tagup
Monty	Goulkhah			X	Kinectrics
Jeff	Gragert		X		Xcel Energy
James	Graham	X			Weidmann Electrical Technology
Taylor	Gray		X		Not Known
Bill	Griesacker	X			Duquesne Light Co.
Ismail	Guner	X			Hydro-Quebec
Niklas	Gustavsson				Hitachi ABB Power Grids
Attila	Gyore	X			M&I Materials Ltd
Thomas	Hartmann				Pepco Holdings Inc.
Roger	Hayes	X			General Electric
Kyle	Heiden	X			EATON Corporation
Giovanni	Hernandez		X		Virginia Transformers Corporation
Gary	Hoffman	X			Advanced Power Technologies
Saramma	Hoffman	X			PPL Electric Utilities
Derek	Hollrah		X		Burns & McDonnell
Paul	Jarman		X		University of Manchester
Toby	Johnson		X		Pacificorp
Akash	Joshi	X			Black & Veatch
Laszlo	Kadar		X		Hatch

Gael	Kennedy	X			GR Kennedy & Associates LLC
Stacey	Kessler			X	Basin Electric Power Cooperative
Suleman	Khan		X		Ontario Power Generation
Egon	Kirchenmayer	X			Siemens Energy
Peter	Kleine	X			US Army Corps of Engineers
Dmitriy	Klempner		X		Southern California Edison
Axel	Kraemer		X		Maschinenfabrik Reinhausen
Michelle	Kutzleb		X		Not Known
Donald	Lamontagne	X			Arizona Public Service Co.
John	Lackey		X		PowerNex Associates Inc.
Aleksandr	Levin			X	Weidmann Electrical Technology
Lance	Lewand	X			Doble Engineering Co.
Weijun	Li		X		Braintree Electric Light Dept.
Mario	Locarno	X			Doble Engineering Co.
Darrell	Mangubat	X			Siemens Power Operations Inc.
Kumar	Mani	X			Duke Energy
Robert	Mayer		X		Siemens Energy
Matthew	McFadden	X			Oncor Electric Delivery
Tony	McGrail			X	Doble Engineering Co.
Susan	McNelly	X			Xcel Energy
Zach	Millard			X	Great River Energy
Emilio	Morales-Cruz	X			Qualitrol Company LLC
Ed	Not Known			X	Not Known
Anatoly	Mudryk			X	Camlin Power
Ali	Naderian				Metsco
Anthony	Natale		X		HICO America
Kristopher	Neild	X			Megger
Joe	Nims				Allen & Hoshall, Inc.
Rodrigo	Ocon			X	Industrias IEM
Anastasia	O'Malley	X			Consolidated Edison Co. of NY
Poorvi	Patel	X			Electric Power Research Institute (EPRI)
Nitesh	Patel				Hyundai Power Transformers USA
Branimir	Petosic			X	Boiler Inspection & Insurance of Canada
Patrick	Picher	X			Hydro-Quebec IREQ
Klaus	Pointner		X		Trench Austria GmbH
Chris	Powell		X		Intermountain Electronics
John	Pruente		X		SPX Transformer Solutions, Inc.
Kevin	Rapp			X	Cargill, Inc.
Timothy	Raymond	X			Electric Power Research Institute (EPRI)
Larry	Rebman		X		EMLS, Inc.

John	Reagan		X		Oncor Electric Delivery
Jonathan	Reimer				FortisBC
Oleg	Roizman				IntellPower Pty Ltd
Timothy	Rocque				SPX Transformer Solutions, Inc.
Mickel	Saad	X			Hitachi ABB Power Grids
Lina	Sandsten				Hitachi Power Grids
Alan	Sbravati	X			Cargill, Inc.
Eric	Schleismann		X		Southern Company Services
Devki	Sharma		X		Entergy
Hemchandra	Shertukde	X			University of Hartford
Kunal	Shukla		X		PECO Energy Company
Jonathan	Sinclair	X			PPL Electric Utilities
Kenneth	Skinger			X	Scituate Consulting, Inc.
Adam	Smith		X		Commonwealth Associates, Inc.
Markus	Soeller				Power Diagnostix
Maricio	Soto			X	Hitachi ABB Power Grids
Arthur	Speegle				Entergy Services, Inc.
Tommy	Spitzer				City Transformer Service Co.
Mike	Spurlock		X		Consultant
Brad	Staley	X			Salt River Project
Charles	Sweetser		X		OMICRON electronics Corp USA
Janusz	Szczechowski			X	Maschinenfabrik Reinhausen
Troy	Tanaka		X		Burns & McDonnell
Marc	Taylor		X		Cogent Power Inc.
Juan Carlos	Cruz Valdes	X			Prolec GE
Rogerio	Verdolin	X			Verdolin Solutions Inc.
Vijayan	Krishnamurthy		X		PTI Transformers
Pragnesh	Vyas	X			Sunbelt-Solomon Solutions
Dieter	Wagner		X		Hydro One
Sukhdev	Walia	X			New Energy Power Co.
Alan	Washburn		X		Burns & McDonnell
Joe	Watson	X			JD Watson and Associates Inc.
Peter	Werelius	X			Megger
Daniel	Weyer	X			Nebraska Public Power District
Leon	White		X		H2scan
William	Whitehead	X			H2scan
Jeffrey	Wright	X			Duquesne Light Co.
Peter	Zhao	X			Hydro One
Kris	Zibert		X		Allgeier, Martin and Associates
Zlatan	Fazlic		X		Camlin Power
Pugal	Selvaraj				Virginia Transformer Corp

Kumar Mani Chair	James Cross Vice Chair	Akash Joshi Secretary

Attachment K4.9

MEETING MINUTES

IEEE PES TRANSFORMERS COMMITTEE
Working Group for Revision of C57.116
IEEE Guide for Transformers Directly Connected to Generators

Chair: Weijun Li, Vice-Chair: Jason Varnell, Secretary: Bill Griesacker

The working group met on Monday 4/26/2021 at 10:45 a.m. via Webex. A total of 51 attendees participated in the meeting. 16 out of 26 working group members were in attendance, therefore a quorum was achieved. The complete attendance record is included in these minutes and is also available in the AM System. 4 attendees requested membership. These 4 attendees need to attend one more meeting to be eligible for membership.

The chair presented the IEEE prepared patent slides and requested any essential patents or patent claims to be made known. There was no response from the meeting participants.

The chair presented the IEEE prepared copyright slides.

The chair presented and discussed the PAR timeline, scope, and purpose. The PAR was approved on 11/7/2019 and is valid until the end of 2023.

The meeting agenda was approved. The meeting minutes from the previous meeting held on October 19, 2020 were approved.

The chair presented the PAR scope and purpose and stated that there was no apparent need to revise them. The WG was asked to comment. There were no comments and no discussion from the WG regarding the PAR scope and purpose so no effort will be taken to revise them.

Task Force reports:

Task Force #1 (sections 3, 4, 5, 9, 10, 11) – Shankar Nambi, Chair:
A number of minor editorial changes were presented in the document sections assigned to this TF. A reference to C57.19.04 on bushings was added. A new paragraph was added for back feed operation to section 11.1. It was stated that a comment should be added on the importance of the purchaser to state intent to operate a transformer in back feed operation to the transformer manufacturer, the wording of this statement will be drafted.

Task Force #2 (section 6) – Toby Johnson, Chair:
The TF chair requested additional members to support the TF and help with revising the section. A request was made to the WG chair to address the MVA equation for VAR loading in section 6.3.4. This will be one of the objectives of the TF.

Task Force #3 (sections 7, 8) – Kayland Adams, Chair:
Minor editorial changes were made to the sections.
Sections were added to address three winding UATs. The material describes the possible under-loading or overloading one terminal during the short circuit test method for temperature rise tests. It also expresses the possible inaccuracies with using the sum losses in the branches of the equivalent three-winding loss network for three winding loss measurement. Section 7.6.1 addresses aspects for three winding axial split windings. Section 7.6.2 addresses 3-winding concentric full height windings. It was questioned if the drafted text would change if the consideration of LTCs designed in each LV circuit was added. The TF chair stated that the text was written in a general enough form that it would not need to be changed, however this would be taken into consideration to see if any changes would be needed.

Task Force #4 (new annex) – Joe Watson, Chair:
A draft of the annex was submitted by the task force. Topics include items to consider when purchasing unit connected transformers, specifying winding voltage ratings, back feeding operation, LV bus considerations, foundation, firewall, and special tests. The document is appended to the end of the minutes.

New Business:

- Sizing GSUs for VAR flow will be addressed by TF #2.
- The TF on Volts/Hertz submitted proposed text to be added to the guide for a new annex; the document is appended to the end of the minutes.
- It was stated that a review will be needed of all figures in the document to determine if any need to be updated or replaced.

The meeting was adjourned at 12 p.m. The group will meet again in Milwaukee, Wisconsin in October 2021.

Role	First Name	Last Name	Company	4/26/2021
Member	Kayland	Adams	SPX Transformer Solutions, Inc.	X
Guest	Raj	Ahuja	Raj Ahuja Consulting	X
Member	Suresh	Babanna	SPX Transformer Solutions, Inc.	X
Member	Peter	Balma	Retired	X
Guest	Gilles	Bargone	FISO Technologies Inc.	X
Guest	Robert	Berland	Kiewit Power Engineers	X

Guest	Mats	Bernesjo	Hitachi ABB Power Grids	X
Guest	Jean-Noel	Berube	Rugged Monitoring Inc.	X
Guest	William	Boettger	Boettger Transformer Consulting LLC	X
Guest	Jeremiah	Bradshaw	Bureau of Reclamation	X
Guest	Michael	Craven	Phoenix Engineering Services	X
Guest	John	Crouse	Roswell Alliance	X
Guest	Everton	De Oliveira	Siemens Ltda	X
Guest	Thomas	Eagle	SPX Transformer Solutions	X
Guest	Norman	Field	Teshmont Consultants LP	X
Guest	Eduardo	Garcia Wild	Siemens Energy	X
Guest	Rob	Ghosh	GE	X
Guest	Ramsis	Girgis	Hitachi ABB Power Grids	X
Guest	Taylor	Gray	Portland General Electric (PGE)	X
Secretary	Bill	Griesacker	Duquesne Light Co.	X
Guest	Didier	Hamoir	Transformer Protector Corp	X
Guest	Ryan	Hogg	Bureau of Reclamation	X
Guest	Nicholas	Jensen	Delta Star Inc.	X
Member	John	John	Virginia Transformer Corp.	X
Member	Toby	Johnson	Pacificorp	X
Guest	Laszlo	Kadar	Hatch	X
Guest	Suleman	Khan	Ontario Power Generation	X
Member	John	Lackey	PowerNex Associates Inc.	X
Guest	Donald	Lamontagne	Arizona Public Service Co.	X
Chair	Weijun	Li	Braintree Electric Light Dept.	X
Guest	Jinesh	Malde	M&I Materials Inc.	X
Member	Kumar	Mani	Duke Energy	X
Guest	Richard	Marek	Retired	X
Member	Vinay	Mehrotra	SPX Transformer Solutions, Inc.	X
Member	Emilio	Morales-Cruz	Qualitrol Company LLC	X
Member	Shankar	Nambi	Bechtel	X
Guest	Nitesh	Patel	Hyundai Power Transformers USA	X
Guest	Monil	Patel	Pacific Gas & Electric Company	X
Guest	Samuel	Reed	EATON Corporation	X
Guest	Michael	Richardson	Ameren	X
Member	Dinesh	Sankarakurup	Duke Energy	X

Guest	Anil	Sawant	Virginia Transformer Corp.	X
Member	Steven	Schappell	SPX Transformer Solutions, Inc.	X
Guest	Adam	Smith	Commonwealth Associates, Inc.	X
Guest	Ryan	Thompson	Burns & McDonnell	X
Guest	Mark	Tostrud	Dynamic Ratings, Inc.	X
Vice-Chair	Jason	Varnell	Doble Engineering Co.	X
Guest	Jos	Veens	SMIT Transformatoren B.V.	X
Guest	Sukhdev	Walia	New Energy Power Co.	X
Member	Joe	Watson	JD Watson and Associates Inc.	X
Member	Kipp	Yule	Bechtel	X (via phone)

Annex XYZ
(normative)

Considerations for Specifying Transformers Directly Connected to Generators

XYZ.1 General

When ordering new or replacement Unit Transformers (UT) or Unit Auxiliary Transformers (UAT), in addition to the performance characteristics and other requirements included in the specifications for regular power transformers, there are some additional items to consider and information to include in the specifications for UTs and UATs.

These additional items include:

a) The process used for determining the XV and HV voltage ratings on the original transformer
b) Back-feed possibilities as covered in 11
c) Iso-phase or segregated phase bus and bus duct design and dimensions as covered in 10
d) Foundation and firewall design information
e) Required special tests and information

It is always good practice to review all of the performance requirements when replacing older existing transformers. The generator and or bus may have been upgraded. The optimal impedance or available fault current may have changed or other requirements such as the sound level may have changed since the existing UT or UAT was specified. New transformers may also need to be specified and designed with requirements that were not considered for the existing transformers such as the ability to withstand seismic and/or GIC events. The following considerations assume that any replacement UT or UAT would be rated closely to the existing transformer, but any significant change to the design could affect weights and dimensions as well as other factors which all need to be considered.

XYZ.2 XV and HV voltage ratings

Some users have changed their practices for specifying the XV and HV voltages on UTs. As covered in Clause 6, it has been common practice to specify the UTs XV rated voltage lower than the generator output voltage and the HV rated voltage at the rated system voltage to compensate for the voltage drop through the transformer and supply an HV voltage that is at the same general voltage level as the system voltage. But some users have changed this practice and now specify the UTs XV rated voltage at the generator's rated output voltage level and specify the rated HV voltage at a value higher than the system voltage to compensate for the voltage drop through the transformer and to avoid operating the UT in an overexcited condition. If the user's practice for determining the required XV and HV rated voltages has changed, and the new UT will replace an existing UT, the replacement UT should not have the same rated voltages as the existing UT.

XYZ.3 Back-feed possibilities

If the UT may be energized when its generator is out of service to provide step-down power to the UATs or other station transformers or loads, this operating condition should be detailed in the specifications. See 11 for details.

XYZ.4 Iso-Phase or Segregated-Phase Bus and Bus Duct Design and Dimensions

For new power plants, with iso-phase or segregated-phase bus connections between the generator and UT and UAT, the bus and bus ducts are often designed after the UT and UAT have been ordered and can be designed to match the dimensions of the bushings and mounting flanges on the UT and/or UAT. Any

available information on the bus and bus ducts should be included with the specifications for the UT and/or UAT, but if the bus and bus duct designs are not complete, the specifications should include, at a minimum,

a) The general location (cover or side wall) for the generator side bushings (XV for UTs or HV for UATs)
b) The general layout or location for each generator side bushing, if different from the standard layout as shown in IEEE Std. C57.12.10.
c) The expected type of bus duct cooling system, pressurized with air flow or not, and maximum air temperature at the UT or UAT bushings.
d) Requirements for bushings to be suitable for the expected temperatures rises from rated load current and maximum air temperatures in the bus duct.

If the grounding of the bus ducts is not known at the time the transformer is specified, it is recommended to assume that the bus ducts will be electrically isolated from the UT or UAT at the turret/bus duct flange connection and grounded to a ground pad near each turret with a ground cable. The bolt holes in the turret flanges should be sized to accommodate the collar washers or insulated bolts that are expected to be used to connect the bushing turret flanges to the bus duct flanges and the turret flange should be designed to accommodate the isolating gasket or washer.

If the new transformer is being ordered to replace an existing UT or UAT and the existing bus and bus duct should not be replaced or modified, in addition to the information listed above, the following bus duct flange details should also be included in the specifications:

e) Type of bus duct design, a single-phase bus and bus duct for each bushing or a common enclosure for all 3 generator side bushings (assuming a three-phase transformer).
f) Exact locations of each generator side bushing on the existing transformer including the heights above the base, distances from the tank centerlines and the phase-to-phase spacing.
g) Inside diameter or inner dimensions of the bus duct and the required minimum strike distances for the bushings inside the bus ducts.
h) Inner and outer diameters of the bus duct flange
i) Bolt circle diameter
j) Number, size and orientation of the bolt holes. A sketch is recommended.
k) Grounding and isolation details of the bus duct flanges to turret flanges.
l) Location of the shorting plate for iso-phase bus ducts

XYZ.5 Foundation and Fire Wall Design Information

For a new powerplant, the foundation can often be designed to accommodate the base, weight and dimensions of the new transformer. In this case, the only information that should be included with the UT or UAT specifications would be any dimensional or layout limitations such as firewalls or similar obstructions and the overall area planned for the transformer bay, along with any user's required clearances between the transformer and the obstructions.

If the new transformer is being ordered to replace an existing UT or UAT and the existing foundation should not be replaced or modified and the transformer bay dimensions will be maintained, in addition to the information listed above, the following information should also be included in the specifications:

The foundation sketch or drawing showing the type of foundation (flat pad, piers, rails or other types), dimensions and locations of all of surfaces in contact with the transformer, locations of all conduits for connections to the control cabinet and any other cabinets or components, and locations of any anchoring points such as plates or bolts in the foundation that the transformer may be welded or bolted to for seismic or other requirements. Additionally, the foundation's designed total transformer weight limit and the footprint for any oil retention area, and the maximum oil volume limit should be included.

It should also be noted that firewalls and transformer bay designs can adversely affect the flow of air around UTs and create micro-environments with significantly higher ambient temperatures than open areas in the same region. If the existing UT has experienced higher than expected operating temperatures or high temperature alarms during its service life, it is recommended to consider the locations of the radiators or heat exchangers and if they are located in areas of poor air circulation on the existing UT, if they can be located on the open side of the transformer bay on the replacement transformer, the ambient air may be cooler in that area and the operating temperatures may be improved. The maximum ambient temperature may also need to be determined and specified at a higher level for the replacement transformer.

XYZ.6 Required special tests and information

In addition to the Routine tests listed in IEEE C57.12.00, the following tests are recommended as Routine tests for all UTs and UATs.

- Sound level
- Sweep Frequency Response Analysis
- Zero sequence impedance

The manufacturer should develop and provide a V/Hz curve for all UTs and UATs that is specific to the UT or UAT and its core design, insulation materials and thermal performance capabilities. The curve should identify operating conditions that could result in oil bubbling, accelerated insulation aging, or any other damaging conditions.

Proposed V / F Text for C57.116

Short-term overexcitation in power transformers

According to IEEE Standard C57.12.00, a transformer is designed to operate indefinitely when excited at least 95 % of rated frequency; and secondary voltage and Volts per Hertz do not exceed 105 % of rated voltage, with a 0.8 power factor, or higher, under load conditions. Depending on a transformer's core design, a significant level of increase in the exciting voltage or a significant reduction in the frequency, or a combination of both, can over-excite the core and increase the core flux density well beyond the saturation level

Overexcitation should be considered when operating transformers directly connected to generators, where the most severe case is normally during generator load rejection when a circuit breaker on the load side of the transformer opens, interrupting the load from a generator and causing the generator voltage to increase significantly while the frequency slows down over 10s of seconds while the generator's rotor gradually spins to a stop.

Relay Practices

Transformers connected to generators are typically protected from moderate over-excitation under normal operating conditions. However, these transformers may not be able to protect from load rejection conditions if a circuit breaker is not located between the generator and the transformer.

Protective relays for this type of very high V/Hz conditions should have inverse time characteristic to allow the transformer to operate under mild overvoltage and/or under-frequency conditions for a longer time than excessive overvoltage and/or under-frequency conditions. Relay settings for this type of protection should be obtained from a V/Hz curve that is applicable for the specific transformer.

Effects of short-term overexcitation on power transformers

The effects of high levels of core overexcitation can vary significantly from one transformer design to another. When such high levels of overexcitation cause magnetic saturation of transformer cores, a portion of the core main flux escapes from the core into and through the active part of the transformer, structural parts, and tank, causing heating of those parts beyond their thermal design limits. This can lead to:

(1) Damage of solid insulation in contact with these parts leading to loss of insulation life if the insulation is not rated for those temperatures

(2) Gas bubbles of oil in contact with the overheated structural parts of the transformers, leading to possibly catastrophic dielectric failure of the transformer

(3) Overheating of the tank walls leading into discoloration of the tank paint.

However, due to the short duration nature of this type of overexcitation and the relatively much longer Thermal Time Constant of the structural parts of transformers, the rise in temperature of these parts caused by this type of over excitation would be small. Also, the short duration of this increase in temperature would significantly decrease the impact of this rise in temperature on insulation life or gas bubble generation

V/Hz Curves

Figure 1 below presents a V/Hz curve that has been used for many types of transformers. It is based on factory measurements conducted in the 1960's on a core-form type transformer that was designed with manufacturers' technology at the time, core steel grade, and with cellulose type insulation to operate indefinitely at approximately 110 % rated V/Hz. The curve has served as an effective damage curve for operation of this type of transformers at various V/Hz values and times. According to this curve, operation of transformers is to be limited to the area below the curve. Also, the transformer should be de-energized if the V/Hz level exceeds the value for the appropriate time to avoid thermal damage. This is a conservative curve that has been used for several types of transformers that did not have a specific V/Hz curve developed or available for the transformer. If a specific V/Hz curve for the transformer is not available and the design of the transformer is unknown, this curve, or another curve from the same manufacturer for a similar transformer, may provide an estimated damage curve for the transformer in question, but the User should recognize that the curve is only an estimate and may want to adjust their relay setting accordingly.

Transformer manufacturers should provide a similar curve that more accurately reflects the specific design of a transformer that will be connected directly to a generator, or other types of transformers when requested.

V/Hz Curve Criteria

A transformer V/Hz curve should accurately estimate the V/Hz levels and the times allowed at those levels when unacceptable insulation aging or oil bubbling may occur over a range from 100-140 % V/Hz. The curve should have the % Excitation or % V/Hz on the Y axis and the time in seconds on the X axis. The manufacturer should consider the following design information when developing the curve:

- Type of core steel, flux densities under the V/Hz range, and corresponding saturation levels
- Temperature rises of all vulnerable structural parts from flux heating over the V/Hz range
- Thermal rating of insulation materials in contact with the core and overheated structural parts
- Bubbling temperature of the insulating fluid
- Maximum oil temperature rise at the worst case load and cooling levels
- Specified maximum ambient temperature

The area below the curve should represent the operating range where the temperatures on any overheated structural parts will not cause oil bubbling or heat the insulation to a temperature greater than the insulation's rated temperature.

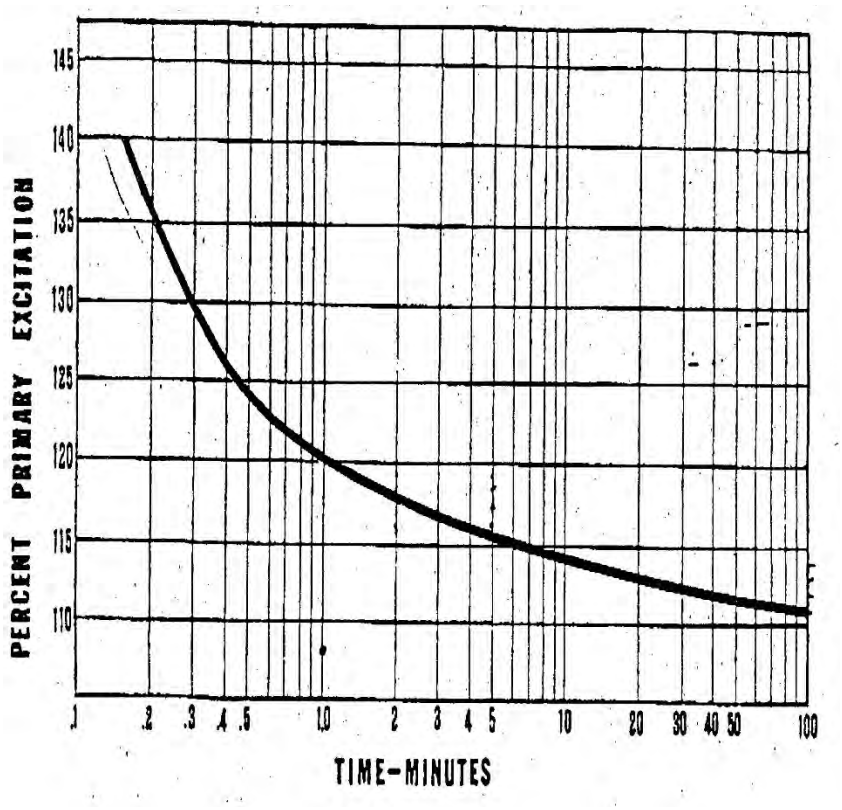

Figure 1: Typical V/Hz Curve