Minutes for Task Force on PD Testing of Class 1 Power Transformers

Chair: Don Ayers
Vice Chair: Javier Arteaga
Secretary: Israel Barrientos
Meeting Date: Monday 15th November of 2021
Time: 10:50

Total Attendance: 94
Members: 17
Guests: 77

Meeting was called to order at 10:50 AM by the Chair (Don Ayers).

The Patent and Copyright Slides were presented, no comments were made.

Membership requirements were explained.

The TF membership is 25
Quorum was 13 or more.
As 17 members were present, Quorum was attained.

The Chair then proceeded to display the Meeting Agenda.

A motion was made by P. Hopkinson, seconded by H. Shertudke, to:
Approve the Minutes as presented.
It was unanimously accepted.

A motion was made by H. Shertudke and seconded by P. Hopkinson to:
Approve the Agenda as presented.
At this point, D. Sauer raised a point of order, indicating that this motion was to be made before the approval of the Past Meeting Minutes, and the Chair asked the Secretary to made a note of this point.
The motion was voted and passed unanimously.

The TF then proceeded with the next agenda Item, discussing the Task Team report.

The following are the members of the Task Team that met on Oct 22nd 2021, and provided the TF with their recommended verbiage as a proposal to add to the C57.12.00 and C57.12.90 Standards.

Pugal Selvaraj – Leader

Daniel Sauer	Sheldon Kennedy
Kris Neild	Suresh Babanna
Kyhle Heiden	Rodrigo Ocon
Larry Dix	Suresh
Mark	Tony Franchitti

The two proposals for Text to be sent to the C57.12.00 and C57.12.90 SC's were displayed.
A question was made by D. Sauer about the possibility of changes to the PD levels on the main standards, and D. Ayers indicated that the proposed text (to be shown at a later time) will avoid this.

The wording for 12.00 was presented and there was no discussion.
As well for the Voltage/Time graph.
A modified version of Table 4 was presented.

B. Poulin indicated he felt that as the Users would not want to impose such a long test (1 Hr) on Manufacturers, a shorter, Routine, test should be specified, but did not want to make a motion at this time.
D. Ayers replied that this was out of the TF Scope and that the Users may always specify a shorter test as required.

A motion was made by Sheldon Kennedy to:

Accept Changes as Presented by the Task Team to the Task Force.
P. Hopkinson seconded the motion.
Some discussion ensued,

S. Kennedy accepted to amend his Motion to include these two changes:

The Title of Table 4 to include : “and Class I when PD testing is required” (J. Wright)

Add only those elements on Columns 6 and 7, and Rows 1 to 4, of Table 4. as required to define the Induced test. (Ajith Varghese)

A vote was taken.
13 In Favor
0 Against
2 Abstain

The motion passed.

A proposal was then presented for Clauses 10.8.5.1 and 10.8.5.2.
Peter Kleine moved to: Accept Proposal with a small typographical correction for 10.8.5.2 for C57.12.90.
P. Hopkinson seconded:

A Vote was then taken.

13 In Favor
0 Against
1Abstain

The motion passed.

After this, the only remaining point in the agenda was the decision of the TF to send the approved recommendations to the TF for Continuous Revision LF tests.
Pater Kleine made this motion, and Detlev seconded it.

The Chair asked if anyone opposed this motion, hearing no opposition the motion carries.

As this would conclude the commission to this TF, it is expected that this would be the last meeting of this TF.

The Chair expressed warm thanks to all our members and guest volunteers.

Finally, a motion to adjourn was approved unopposed.

Respectfully submitted
Israel Barrientos
TF Secretary.

Attendance as recorded.

Role	Name
Guest	Aaron Meyers
Guest	Adam Polson
Member	Ajith Varghese
Guest	Alain Bolliger
Guest	Aleksandr Levin
Guest	Alexander Kraetge
Member	Ali Naderian
Guest	Allan Bartek
Guest	Alvaro Portillo
Guest	Anand Zanwar
Guest	Arturo Nunez
Guest	Arup Chakraborty
Guest	Baitun Yang
Guest	Bertrand Poulin
Guest	Brandon Dent
Guest	Chris Powell
Guest	Chris Slattery
Guest	Dan Sauer
Guest	Daniel Weyer
Guest	Darrell Mangubat
Member	David Calitz
Member	David Larochelle
Guest	David Murray
Guest	Deepak Kumaria
Guest	Dejan Vuković
Guest	Dervis Tekin
Member	Detlev Gross
Guest	Dominique Bolliger
Chair	Donald Ayers
Guest	Alexander Winter
Guest	Edmundo Arevalo
Guest	Eduardo
Guest	Evan Knapp
Guest	Feras Fattal
Guest	Fernando Leal
Guest	Gary King
Guest	Hakan Sahin
Guest	Hampton Steele
Guest	Harry Pepe
Guest	Hemchandra Shertukde
Secretary	Israel Barrientos
Guest	James McIver
Member	Janusz Szczechowski
Co-Chair	Javier Arteaga
Guest	Jeff Britton
Guest	Jeff Gragert
Guest	Jeff Ray
Guest	Jeffrey Wright
Member	Jorge Cruz
Member	Jose Gamboa
Guest	Joshua Yun
Guest	Juan Carrizales
Guest	Kris Neild
Guest	Kurt Carlson

Guest	Kyle Stechschulte
Guest	Kyle Heiden
Member	Leopoldo Rodriguez
Guest	Loren Wagenaar
Guest	Mana Yazdani
Guest	Marc Taylor
Guest	Mark Perkins
Guest	Markus Söller
Guest	Matthew Pinard
Guest	Michael Haas
Guest	Michael Zarnowski
Guest	Miman
Guest	Moonhee Lee
Guest	Nathan Katz
Guest	Norman Field
Member	Parminder Panesar
Member	Peter Kleine
Guest	Peter Sheridan
Member	Philip Hopkinson
Guest	Pranav Pattabi
Member	Pugal Selvaraj
Guest	Raj Ahuja
Guest	Reto Fausch
Guest	Rhea Montpool
Guest	Risto Trifunoski
Guest	Rodrigo Ocon
Guest	Ross McTaggart
Guest	Samragni Dutta Roy
Guest	Sanket Bolar
Member	Sergio Hernandez
Guest	Shawn Gossett
Guest	Sheldon Kennedy
Guest	Stephen Oakes
Guest	Steve Brzoznowski
Guest	Steve Snyder
Guest	Tammy Behrens
Guest	Thomas Hartmann
Guest	Wallace Binder
Guest	William Boettger

10/22/21

Proposed Changes to IEEE Std. C57.12.00-2015 to support proposed changes for PD Testing of Class I power transformers.

- **5.10.5.1 General**

Low-frequency test requirements for distribution and power transformers shall be applied-voltage tests and induced-voltage tests. Table 3 specifies test levels for distribution and Class I power transformers; Table 4 specifies test levels for Class II power transformers.

For Class I power transformers, when specified, partial discharge test shall be conducted as per section 5.10.5.5

- **5.10.5.3 Induced-voltage test requirements for distribution and Class I power transformers without partial discharge testing**

A voltage shall be developed in each winding in accordance with the levels specified in Table 3. Induced voltage tests shall be conducted at 2.0 x nominal voltage for 7200 cycles.

- **5.10.5.5 Induced-voltage test for Class II, and when specified each Class I, 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.

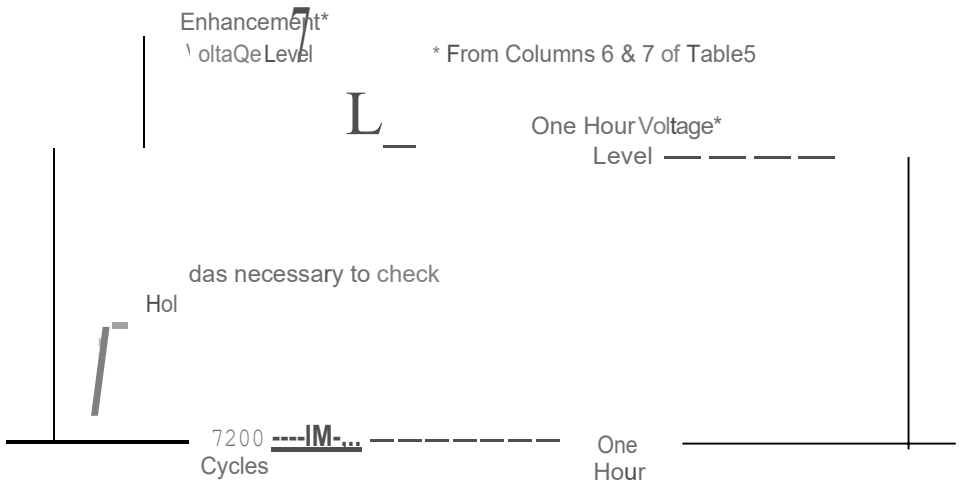

Figure 2 -Induced voltage test for Class II, **and when specified Class I,** power transformers

Table 4 - Dielectric insulation levels for all windings of Class II, and Class I when **PD** testing is required, power transformers, voltages in kV

		Applied voltage test (kV rms)			Induced voltage test[b] (phase to ground) (kV rms)		Winding line-end BIL[d] (kV crest)				Neutral BIL[e] (kV crest)	
Maximum system voltage (kV rms)	Nominal system voltage[a] (kV rms)	Delta and fully insulated wye	Grounded wye	Impedance grounded wye or grounded wye with higher **BIL**	Enhanced 7200 cycle	One hour	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	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[c]	475[c]	1425	1550	1675		110	350
765	735	N/A	34	140	880[c]	750[c]	1950[c]	2050			110	350
800	765	N/A	34	140	885[c]	795[c]	1950[c]	2050			110	350

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

[b] Induced voltage tests shall be conducted at 1.58 x nominal system voltage for one hour and 1.80 x nominal system voltage for enhanced 7200 cycle test.

[c] Column 6 and Column 7 provide phase-to-ground test levels that would normally be applicable to wye windings. When the test voltage level is to be measured phase-to-phase (as is normally the case with delta windings), the levels in Column 6 and Column 7 must be multiplied by 1.732 to obtain the required phase-to-phase induced-voltage test level.

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

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

[f] For 500 kV to 765 kV nominal system voltages, induced voltage test levels do not follow rules in footnote b, and 1950 kV BIL is not a standard IEEE level.
If user specifies a different BIL for the neutral than indicated above, the applied test voltage shall also be specified.

Change in this Note on Table 4: As noted in the minutes the values in the first 4 rows and in Column 4 and Column 5 were specified as within the scope of work of the Task Force. The remaining columns, added for clarification, were copied from Table 3 of C57.12.00. Dielectric insulation levels for distribution and Class I power transformers voltages in kV

10/22/21

Proposed Changes to IEEE Std. C57.12.90-2015 to support proposed changes for PD Testing of Class I power transformers.

10.7 Induced-voltage tests for distribution and Class I power transformers without partial discharge testing

10.8 Induced-voltage test for Class II power transformers and Class I power transformers, when specified

10.8.1 General

Each Class II power transformer, and Class I power transformers when specified, 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 1 h test are x times their maximum operating voltages, as specified in ANSI C84.1, where xis the ratio of the test voltage on the high-voltage winding to the maximum operating voltage.

10.8.2 Test procedure

The voltage shall first be raised to the 1 h level and held for a minimum of 1 min or until a stable partial discharge level is obtained to verify that thereare 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 1 h 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 115 kV and above. These measurements shall be made in accordance with 10.9.

10.8.3 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.

10.8.4 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 ofthis induced test.

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:

10851 Class II Power Transformer

a) The magnitude of the partial discharge level does not exceed 500 pC during the 1-h test period.
b) The increase in partial discharge levels during the 1-h period does not exceed 150 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.

10852 Class I Power Transformer

a) The magnitude of the partial discharge level does not exceed 500 pC during the 1-h test period.
b) The increase in partial discharge levels during the 1-h period does not exceed 150 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.

10853 General

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.

10.9 Partial discharge measurement

10.9.1 Internal partial discharges

Apparent internal partial discharges (apparent charge) shall be measured at the terminals of the transformer windings under test and reported in units ofpicocoulombs (pC).
Where agreed to by both the purchaser and the manufacturer, radio influence voltage (RIV) measurements may be used in lieu of, or in conjunction with, apparent charge measurements. The procedure for RIV measurements is included in Annex A.

10.9.2 Instrumentation

A partial discharge meter shall be used to measure the apparent charge generated by any internal partial discharges. The partial discharge detector, based on IEEE Std CS7.113 , is used to measure the partial discharge levels at the terminals. The partial discharge meter shall be coupled to the line terminal(s) of the winding(s) under test through the voltage tap of the bushing(s) or through a suitable coupling capacitor connected in parallel with the bushing. General principles and circuits are described in IEEE StdC57.113.

External shielding may be used to avoid air corona, such as may occur at the bushing terminals or grounded projections. Radio-frequency chokes or tuned filters may be used to isolate the transformer under test and the partial-discharge-measuring circuit from the remainder of the test circuit, including its energy source.