

## **Annex D Dry Type Transformers Subcommittee**

**November 1, 2017**

**Louisville, Kentucky USA**

**Chair: Charles Johnson**

**Vice-Chair: Casey Ballard**

**Secretary: David Stankes**

### **D.1 Introductions and Approval of Agenda and Minutes**

The Subcommittee met on November 1, 2017 at 1:30PM in the Marriott 7-9 room of the Louisville Downtown Marriott Hotel.

The meeting was convened with 35 people in attendance. 19 of the 26 members of the Dry Type Subcommittee were present, so quorum was reached. Three guests requested membership, with one of the three meeting eligibility requirements. The attendance roster will be kept in the AMS.

The Chairman reviewed the proposed Agenda. A motion to approve the agenda was made by Tim Felix-May and seconded by Mike Iman. The agenda was approved unanimously.

The chairman noted that the unapproved minutes from spring 2017 SC meeting had been posted on the SC Transformer Committee website. A motion to approve the minutes was made by Sanjib Som and seconded by Tim Felix-May. The minutes were approved unanimously.

### **D.2 Chairs Remarks**

None.

### **D.3 Working Group/Task Force Reports**

The next order of business was the presentation of the reports of the various working groups and task forces. See the following sections for the individual reports:

#### **D.3.1 Revision of IEEE PC57.12.01 - Dry Type General Requirements Chair Casey Ballard**

The working group met in the Kentucky F Room of the Downtown Marriott Hotel.

The meeting was called to order at 1:45 PM by Chairman Casey Ballard.

Chairman made opening comments.

Introductions were made by all participants. WG Roster has been distributed and signed.

The meeting was convened with 37 participants, 16 of them are members. Quorum was reached (22 current members). The attendance was reported in the AMS.

The Agenda was approved unanimously being no negative votes.

The Minutes of Spring 2017 New Orleans meeting was approved unanimously.

The chair made a call for known patent issues. No patent related issues were claimed.

## Old business

Chair informed on the revisions that have been incorporated into Draft 3:

- **Maximum system voltage** update in Table 5 to match C57.12.00. The following issues were discussed: typical + 5% HV winding tap range sometimes resulted in the highest tap voltage to be higher than maximum proposed voltage. Several proposals were made: D. Walker proposed a note that the maximum voltage corresponds to the nominal tap voltage; J. Tedesco proposed to eliminate nominal voltage column (this wasn't supported as BIL is based on the nominal voltage). Chair proposed to increase the max voltages as follows: 27 kV for 25 kV nominal, 37 kV for 34.5 kV nominal, 49 kV for 46 kV nominal. 11 participants supported the proposal with several opposed and the rest abstained. The proposal accepted and will be included in the next version of the revision.
- **Short Circuit thermal calculation** methods – added IEC and kept IEEE with both options allowed. R. Marek noted that IEC is working on the revision of the document and, apparently, they are going to correct sc thermal calculation algorithm. Rick will provide more information when available and WG will consider a course of actions at that point. C. Johnson mentioned that we need to keep a reference to a dated IEC standard as it will be revised in the future as well.

- Other topics, volunteer reports and discussion:

- **Short Circuit thermal limits** for insulation relating to insulation temperature rating – Rick Marek proposal: Rick explained his proposal, but admitted that the original information that established the data in the proposed revision of Table 15 is unknown. S. Levin commented that it's difficult to see how one can correlate the final conductor temperatures with the insulation temperature class. S. Chiang mentioned that UL 845 has similar data. C. Johnson commented that the final sc temperature depends on the thermal condition before sc. D. Stankes volunteered to prepare an alternative proposal to address this issue.
- **Cooling ratings:** compared to both C57.12.00 / IEC 60076-11 nomenclature. Chair presented and WG reviewed 2 proposals by Dhuru Patel and Tim-Felix Mai (based on new unpublished IEC revision). C. Johnson pointed that a ventilated transformer can be without any enclosure. C57.12.01 specifically defines the need of enclosure only for outdoor installation. Chair conducted a vote for both Dhuru and Tim-Felix proposals (that are both a significant improvements compared to current C57.12.01 definition), majority supported Tim-Felix proposal that will be included in the next version of the revision.
- **Higher 15 kV class standard BIL rating** of 60/70/95 kV in Table 5. Results of the official survey: 55.6% of responses wanted changes (11.1% abstained). 50 % of responses didn't want 95 kV BIL to be a standard level for 15 kV class voltage (22.2% abstained). Also 50% of respondents didn't agree to add 75 kV BIL as a standard test level).  
Because there was no majority on any of the proposed options, the issue of the BIL test levels in Table 5 will be tabled for the current revision of the standard.

## New Business

- **Environmental testing requirements** such as in IEC-600076:

Climatic/Thermal shock: Casey explained the current IEC test. The question was whether we are doing something similar during the qualification tests of the coil design. The answer was that these

are different tests and R. Wicks noticed that the cold shock test is specified only for cast resin models in the qualification test. Only 4 participants thought we need to include thermal shock test in IEEE document.

- Environmental / Applied voltage while wet: Casey explained the current IEC procedures. C. Johnson mentioned that both cold climate and environmental issues are addressed with auxiliary heating of transformers and it's also considered in the maintenance guides, but there are no special tests. After poll, WG didn't support a consideration of climatic and environmental tests in the current revision of IEEE C57.12.01.

- **On-load tap changers:** topic was raised by T-F. Mai as the application and test of on-load tap changers in dry-type transformers aren't addressed in the standards. C. Johnson commented that these accessories are used in a small percentage of transformers that don't represent the major industry practices. D. Walker would like to see some guidance as he sees more of such designs now. Poll shows that WG doesn't support the consideration of this topic in the current revision of the standard.

- R. Marek commented that IEEE C57.12.80 on definitions is currently under revision and definitions of IEEE C57.12.01 will be conflicting with this upcoming revision and they shall be revised. Rick doesn't mind to be a liaison to C57.12.80 and will make this proposal at the Dry-Type SC meeting on Wednesday.

- R. Wicks questioned the inclusion of voltages less than 601 V in Table 5 as the scope of IEEE C57.12.01 is limited to the transformers with highest voltages more or equal to 601 V. Casey explained that LV voltages are meant to be included in Table 5 as well, not only highest voltage. C. Johnson commented that oil-immersed transformers don't deal with anything lower than 1.2 kV and test voltages for all systems below 1.2 kV are the same as for the 1.2 kV system. Chair invited submitting proposals on this issue for the discussion during the next WG meeting.

Next meeting: Spring 2018, Pittsburg, PA, March 25-29, 2018.

With no further business, the meeting was adjourned at 3 PM.

Chairman: Casey Ballard

Secretary: Sasha Levin

### **D.3.2 Revision of IEEE PC57.12.60 - Dry Type Thermal Aging      Chair Roger Wicks**

The meeting was called to order at 1:45 PM by Chairman Roger Wicks. Introductions were made and attendance sheet was circulated.

The meeting was convened with 45 people in attendance. 32 guests / 13 members present. Quorum was reached. Five guests requested membership.

The Chairman reviewed the proposed Agenda. The agenda was approved unanimously.

The minutes from spring 2017 WG meeting were approved unanimously.

The chairman asked if there were any essential patent issues relevant to this standard. None were noted.

### **Discussion of IEC 61857-41 Work since our last meeting in New Orleans**

The chairman described that since our last working group meeting, an IEC 61857-41 CD had been issued, and a subsequent CD2 is in final stages of completion. The CD2 is expected to be circulated within IEC in November. He suggested that IEEE C57.12.60 WG consider adopting some of the information that will be found in the new IEC document, but that care must be taken not to bring anything in before it is clear it will be accepted in the IEC document.

The following topics were reviewed by WG Chair:

**Changes from CD to CD2**

- CD2 allows for multiple winding styles
- Improved flow, with more logical progression of information
- Inclusion of impulse test as one of the diagnostic tests
- Inclusion of a screening test
- Inclusion of detailed aging examples to make it easier for new users to design and run test

**Areas of “improvement” from IEEE C57.12.60**

- Aging temperature table
  - More realistic (lower) temperatures
- Screening tests
  - One screening test to determine if candidate EIS is capable of achieving desired temperature class
  - A second screening test to identify electrical test failure threshold on unaged units that would be used to determine test voltage used in test. This new way to determine test voltage was described as being needed as current test voltage based on rating of transformer has resulted in VERY long test times to failure. Chuck Johnson asked what halving constant was used to develop cycle times in the new aging temperature table. He recommended the need for some guidance regarding how aging cycles could/should be changed based upon failure rate. Chairman thought that this information was included in new CD2.
- September meeting in Delft and Development of CD2
  - Chairman pointed out that many of the people involved in the development of IEC 61857-41 were also part of the IEEE C57.12.60 WG.
  - Chairman described his work with Ed VanVooren from Eltek to develop section that would help users interpret test data as test is running. This analysis would help determine how to adjust test (i.e adjusted cycle time or addition of new temperature point) if  $r^2$  of life curve was unacceptable. Alexander Levin asked what would happen if test was run and resulting data did not achieve required  $r^2$ . Chuck Johnson questioned the use of only three test coils per temperature, as a failure due to manufacturer defect on one coil would severely impact the data. Joe Tedesco mentioned that there was a report discussed at the IEC meeting that demonstrated how number of test samples could impact test data. The WG Chair explained the option of adding more test coils, as IEC test standard only specifies a minimum of three test coils. Chairman brought up the possibility that an acceptable  $r^2$  could be obtained with less than 5000 hours for low temperature point.

Chairman described that IEC is planning to develop a test standard that would describe method of making substitutions to an EIS. This would be developed after IEC 61857-41 was completed, so

most likely this information we would not be included in this IEEE C57.12.60 revision.  
Chairman raised the possibility of adding information regarding substitutions in the IEEE Annex.

Casey Ballard questioned what type of impulse test is listed in IEC document. (Positive Wave Form), as he thought this may impact results of test.

Review of action items:

Chairman will circulate to the members of the working group the new IEC CD2 as soon as it is publically released. He will also circulate presentation used during this WG meeting.

With no further items to discuss, Chair asked for motion to adjourn.

Rob Ghosh motioned to adjourn and Chuck Johnson seconded.

Meeting was concluded at 3:00PM.

It was confirmed that the WG would meet again at the spring 2018 Transformer Committee Meeting in Pittsburgh.

Chair: Roger Wicks

Co-Chair: Dave Stankes

**D.3.3 Revision of IEEE PC57.12.58 - Dry Type Transient Analysis**

**Chair Roger Wicks**

The WG did not meet IN Louisville as the document was complete and ready for publication. Members of the Dry-type SC will receive a copy of the new document when released.

**D.3.4 Revision of C57.12.51 – Ventilated Dry-Type Power Transformers – Chair Sanjib Som**

The working group met in the Kentucky F Room of the Downtown Marriott Hotel on 10/30/17.

The meeting was called to order at 11:00 AM by Chairman Sanjib Som.

Chairman made opening comments including that we only have 1 more year before the PAR expires.

Introductions were made by all participants. WG Roster were distributed and signed. The meeting was convened with 23 participants, 6 of them are members. No quorum was reached (13 current members). Three members requested membership.

The Agenda were agreed upon, but not approved since there was no quorum.

The Minutes of Spring 2017 New Orleans meeting were not approved since there was no quorum.

The chair made a call for known patent issues. No patent related issues were claimed.

**Old business**

- No old business

**New Business**

**- Review of comments submitted by WG members for Draft 1:**

- The comments were discussed by the submitter, but many of them were addressing the same issues. Therefore, they will be reported in the minutes correlating to the flow of the draft document

- Title and Scope: Several comments regarding changing the wording of the PAR were proposed, but not supported since the PAR was just recently resubmitted with full support of the membership.
- Section 2 – Normative references were reviewed and a decision was taken not to add C57.12.91 as it was not present in the text of the document. It is, however included in the Bibliography.
- Section 5.1 – kVA ratings: All kVA ratings were removed from this section since they are already covered in C57.12.01
- Section 5.2 – Voltage ratings: All voltage ratings were removed from this section, including Table 1 and Table 2, since they are already covered in C57.12.01
- Section 5.5 – Angular displacement – it was decided that the wording of this section would reference C57.12.01 for angular displacement of three phase and polarity for single phase
- Section 5.6 – Impedance – Table 3 was deleted as the group agreed the values did not reflect current industry practice.
- Section 6.6 – Lifting, Jacking, and Moving – Figure number referenced in the text was incorrect and was updated
- Section 6.7 – Ground Pads – All dimensional and location requirements were removed as they were inconsistent and did not necessarily reflect current industry practice.
- Section 6.8 – Enclosure – corrected the reference standard to be C57.12.55.
- Section 9.1 – Forced Air Ratings – section was removed along with Table 6 as its already covered in C57.12.01
- Section 9.6 – Y-Y Connected Transformers – Table 7 and all references were removed
- Section 10.7 – Future Forced Air Cooling – AN designation was removed.
- General – review all standard references that include the year to confirm if it truly needs to point to a specific publication, or simply the latest version (preferred).

**- Draft 2:**

- The Chair will incorporate all of the changes and resubmit to the WG a draft 2 document.
- WG members will be requested vote via email (prior to Pittsburgh) to determine if the document is ready to be sent to the Dry-Type Sub Committee for balloting.

Next meeting: Spring 2018, Pittsburg, PA, March 25-29, 2018.

With no further business, the meeting was adjourned at 12:15 PM.

Chairman: Sanjib Som

(Acting) Secretary: Casey Ballard

**D.3.5 Revision of IEEE PC57.12.91 - Standard Test Code**

**Chair Derek Foster**

**Vice Chair David Walker presented minutes from meeting**

The Working Group met in the Marriott 1-3 meeting room on 10/31/17. The meeting was called to order at 4:45 PM.

There were 21 people present. 10 out of 19 members and 11 guests were present. A quorum was present.

The patent call was given. No one replied with any patent issues.

The agenda was approved unanimously.

The minutes of the April 2017 meeting in New Orleans were unanimously approved with a change in the title.

### Old Business

- David Walker showed the scope of work for the WG and remembered that there were 4 meeting left to make changes. He also showed the ‘work to do’
  - Review C12.12.91 with the new scope in mind
  - Add missing content
  - Delete Obsolete Material
  - Correct Errors
  - Clarify Language
  - Potentially Synchronize with C57.12.90 and IEC
- David Walker will update the draft and include already made decisions (smaller revisions). It will be distributed before the next meeting.
- Adding climatic and environmental classes were rejected by WG C57.12.01. No further actions for this group.
- Joseph Tedesco asked if it would be possible to survey changed sections if they’re ok or not
- The group discussed about PD and sound level tests. In C57.12.90 made a lot of changes to sound level testing. Joseph Tedesco and Tim-Felix Mai volunteered to present changes in the latest IEEE and IEC documents in the next meeting.
- Chuck Johnson started a discussion about how BIL tests should be performed for transformer installed in higher altitudes. How could the air / distances and not the inner insulation be tested?
- David Walker proposed to change 11.5 Hot-resistance Measurement
  - Current Wording:”The ultimate temperature rise is considered to be reached when the surface temperature rises over ambient become constant”
  - Proposed: “The ultimate temperature rise is considered to be reached when the temperature rises over ambient of all surface temperature measurements required in Section 11.3 become stable, which is defined as....”
  - Reason: Clarifies that all sensors readings must be constant. Not just windings.

Casey Ballard made a motion, seconded by Carl Bush, to adopt these changes. The motion passed.

- David Walker started a discussion about how to account for no-load temperature rise in section 11.8. The discussion focused on Section 11.8.5 Empirical Additive Factor- Additive factor from previous tests on similar units. The issue was that some manufacturers use equation 26 with empirical or calculated values. This results in smaller total rises than using additive value. The question was:
  - Is this method acceptable?
  - What methods are acceptable?
  - How must empirical/calculated values be obtained/justified?
  - Should ordering of sections be changed and language added to clarify which methods require separate consideration of NL rises and which don’t

David Walker agreed to present a proposal in the next meeting how this section could be reworded to be clearer.

**New Business:**

- None

With no further business, the meeting was adjourned, without objection, at 5:45 PM.

The Working Group will meet again at the Spring 2018 meeting in Pittsburgh, Pennsylvania.

Chairman: Derek Foster

Vice Chairman: David Walker (acting as Chairman)

Secretary: Tim-Felix Mai

**D.3.6 IEEE PC57.16 – Dry Type Reactors**

**Chair Art Del Rio**

The working group for the revision of C57.16 met in the Kentucky F room of the Downtown Marriot Hotel on Monday October 30, 2017, at 4:45 PM.

**1. Introductions and Call for Patents**

- The meeting was called to order at 4:45 PM by the WG Chair Art Del Rio.
- The meeting was opened with the introduction of participants.
- The WG Chair Art Del Rio did a call for potentially essential patents. None was reported.

**2. Circulation of Rosters**

- The attendance rosters were circulated.

**3. Verification of Quorum**

- There were a total of 21 participants: 8 Members and 13 Guests out of which 3 Guest requested membership. 2 were granted.
- 8 of the current 11 WG Members were present and quorum to carry out business was met.
- The meeting agenda, which was circulated by email among members and guests on September 29, 2017, was presented to the participants.
- There were no objections or comments and the agenda was approved unanimously.

**4. Approval of the minutes of the April 3, 2017, meeting in New Orleans,**

**Louisiana.**

- The minutes from the S17 meeting in New Orleans, which were circulated on September 29, 2017 by email, were presented to the participants.
- There were no objections or comments and the minutes were approved unanimously.

## 5. Continue to discuss and review of the scope, purpose.

- The WG Chair Art Del Rio has got feedback from IEEE SA. It is acceptable to have both normative and informative annexes in the standard.
- We need better explanation of the differences between 2-level, 3-level and multi-level converters. Ulf Radbrandt volunteered to make a proposal. This should also be used to distinguish between converter reactors that will be covered by this standard and the converter reactors that will be covered by IEEE 1277. One main distinction is that the reactors in this standard do not see dc current.
- We must explain ac side converter reactors better in the Scope. Also we should add a normative annex covering ac side converter reactors for VSC applications.
- The text “some restrictions” should be removed from the scope. The text might be transferred to the Purpose.
- Most important for the temperature rise test is the rated power frequency current.
- The seismic acceleration is not enough for seismic verification. A reference to a standard is also necessary.
- There is no sense in testing reactors and resistors together. That text can be removed.
- An excel file is a good tool to control comments and changes. The file with identified comments will be circulated in the WG.
- The track changes function and the line numbering function should be activated in the draft. Art Del Rio will distribute the draft to the WG members.

### 5.a Comment on Dry-type air-core shunt capacitor reactors. Dave Caverly

- References to Technical Report 16 should be added.
- We should also have a reference to IEEE C37.12. Dave will make a proposal to next meeting.
- Should we adopt the "new name" - "Transient Limiting Inductors" (LTIs) instead of "Shunt Capacitor Reactors" or "Damping Reactors" and reflect it in the standard?

### 5.b Comment on Annex A, Filter reactors. Klaus Pointner

- Sound sections should reflect what is written in IEEE C57.12.90 and in IEC 60076-10. Method/procedure how to measure needs to be updated. There should be one general section and one special section according to other lately updated standards.
- Christoph Ploetner volunteered to do update the sound sections.

### 5.c Comment on Annex C, Discharge CLR for series capacitor banks. Mike Sharp

- C3.1, last sentence, It says gaps are in parallel with the reactor. Since the gap is in series with the coil we should delete “gaps” from this sentence. It says that the ‘discharge reactor is equipped with a series connected device (spark gap or MOV). Probably this should read ‘discharge resistor is ... MOV is never used to electrically connect the resistor to the discharge circuit.

### 5.d Comment on Scope

- See clause 5 above.

**5.e Comment on System considerations, TRV**

- How reactors can affect TRV of circuit breakers. This is very much due to the reactors stray capacitance.
- Ideas to add new information regarding TRV should be carefully discussed with the SWG committee first. Last time we revised this document, we had to remove a lot of TRV text due to negative voting from SWG members.
- TRV issues should be handled by the SWG committee. We should only alert the user that there can be TRV issues related to CLR (or TLI) and refer to SWG standards.
- Monty K will contact the SWG committee.

**5.f Comment on main standard Table 6**

- Section 9.1, table 6, Note (a) need changes as the application of an arrester across the series reactor may not be applicable to discharge reactor applications.

**6. New Business**

- No new business.

**7. Adjournment**

- The meeting was adjourned at 5:53 PM.

Respectfully submitted,

Chairman: Art Del Rio (a.delrio@ieee.org)

Secretary: Ulf Radbrandt (ulf.radbrandt@ieee.org)

**D.3.7 IEEE PC57.124 – Dry Type Partial Discharge Guide Chair****Tom Prevost**

The WG met at the Downtown Marriott (Mariott 5) in Louisville, KY on October 31, 2017.

Meeting started in Marriott 6 at 8:0 am. There were 41 attendees with 11 WG members present of a total of 21 and the rest were guests. 9 guests requested membership to the WG.

We had quorum to conduct the meeting.

Essential Patent claims were mentioned. There was no response of an essential patent related to the work of our WG.

Agenda for the meeting was approved.

Minutes of the New Orleans meeting from Spring 2017 were approved.

PAR has been approved and is valid till end of 2021.

There were two presentations one by Detlev Gross (IEC60270) and the other by Alex Kraetge (IEC 60076-03 and IEC 60076-11). Salient aspects of both were described by the presenters with a focus that our WG will concentrate on how to perform the test in the User's Guide? PDF copies of these presentations can be found in the Transformers Committee webpage ([www.transformerscommittee.org](http://www.transformerscommittee.org)) under C57.124 in the Dry-Type Subcommittee page.

Detailed work on the User's Guide will begin from the next meeting in Pittsburgh. Several TFs will be set up to take a shot in developing the different sections.

There was no further New Business.

Meeting was adjourned at 9:15 am

Respectfully Submitted  
Hemchandra Shertukde  
Secretary, C.57.124

#### **D.4 Old Business**

##### **D.4.1 Status of Dry Type Transformers Standards**

- Chairman presented list of active standards and with noted board submission deadlines. Reminded the SC that this list was available online for review.
- PAR Review
  - Chair informed group that there are six active documents
    - C57.12.51 PAR expires at the end of 2018, and reinforced that this must be completed soon.
    - C57.12.60 is proceeding as planned and is making good progress.
    - All other documents have dates out in either 2020 or 2021 and we should have ample time to complete.
    - Chair reminded SC that the last year of a PAR should set aside for balloting to allow ample time for ballot review, recirculation, etc.
  - Chair reminded SC that the Dry-Type SC “owns” approximately 13-14 documents. There are a limited amount of volunteers to complete the needed works on these documents, and the SC members have an obligation to ballot on these documents as appropriate.

#### **D.5 New Business**

##### **D.5.1 Change in WG Chair for C57.12.91**

Chairman informed the SC of Derrick Fosters intent to step down as WG Chair for C57.12.91. Chairman highlighted how Derrick had led this very important WG for 14 years, and under Derricks leadership C57.12.91 had become a much clearer and technically correct document. Derrick received a load round of applause from those in attendance in appreciation of his years of service. Chairman also formally introduced David Walker as the new WG Chair of C57.12.91.

##### **D.5.2 IEEE C57.12.80 Terminology**

Working group has been formed to revise C57.12.80. Rick Marek is a member of this WG and offered to send results of the WG to Chuck Johnson to ensure that Dry-Type SC is in sync with what is being proposed. Chairman informed SC that there was another IEEE group that was working on a definition of a transformer that would not include the need for a core or windings. Chairman strongly recommended that a definition should take into account the original intent of the word. Chairman asked that anyone interested in participating in the review of definitions contact him

#### **D.6 Adjournment**

With no further business, the meeting was adjourned at 2:17 PM.

Chairman: Charles Johnson

Vice Chairman: Casey Ballard

Secretary: David Stankes