ANNEX A Bushings Subcommittee

October 17, 2018
Jacksonville, Florida, USA

Chair: Peter Zhao
Secretary: Eric Weatherbee

A.1 Opening of the Meeting

A.1.1 Introductions

The Chair opened the meeting but declared we would forgo group introductions to allow more time for discussions.

A.1.2 Attendance

Membership count was taken with the following results: 41 of 68 members were present with 73 guests for a total of **114 attendees**. There were 11 new membership requests. There was a quorum.

A.1.3 New Members

Six new members were introduced to the SC and added to the roster. The new members were Mr. Arup Chakraborty, Mr. Anthony Franchitti, Mr. Thang Hochanh, Mr. Stacey Kessler, Mr. Arnaud Martig, Mr. David Stockton.

A.1.4 Meeting Minutes Approval

The Chair asked for a motion to approve the S18 minutes which are hosted on the IEEE Transformer website. Mr. Matthew Weisenee made a motion to approve which was seconded by Mr. Dave Geibel and passed with no objections.

A.1.5 Chairman's Remarks

The Chair asked that everyone verify that their AMS information is current. It was also request that WG and TF Chair be diligent in updating the website and providing their minutes in a timely fashion. The Chair presented the Standards Status Report for bushings, see Appendix A.

A.2 Working Group and Taskforce reports

A.2.1 PC57.19.00-2004 – Peter Zhao, Chair; Eric Weatherbee, Secretary

See complete WG minutes in Appendix B of this report.

A.2.2 C57.19.100-2012 – Tommy Spitzer, Chair; Jeff Benach, Secretary

. See complete WG minutes in Appendix C of this report.

A.2.3 WG PC57.19.01-2000 – Dr. Shibao Zhang, Chair; David Wallach, Secretary

No meeting held as the latest revision was published July 2018.

A.2.4 WG PC57.19.02 Distribution Transformer Bushings – Ed Smith, Chair; Steven Shull, Vice Chair

See complete minutes in Appendix D of this report.

A.2.5 WG PC57.19.04 – Scott Digby, Chair; JD Brafa, Vice Chair; Rich vonGemmingen, Secretary

No meeting was held as the document was published June 2018.

A.2.6 IEC/IEEE 65700.19.03 – Les Recksiedler (IEEE) and John Graham (IEC, retired), Co-Chairs

The first dual logo standard was approved June of 2014, as such, no meeting was held.

A.2.7 TF Bushing Overload – Matthew Weisensee, Chair; Alwyn VanderWalt, Secretary

The TF Chair reviewed the responses to survey that had been received from Transformer and Bushing OEMs. See complete minutes in Appendix E of this report.

A.3 External Liaison Reports

A.3.1 IEC Bushing Standards Activity – Bruno Mansuy, IEEE/IEC Liaison

Mr. Mansuy reported that the IEC Bushing Standard revision passed last year, 60137-2017. He noted that dry impulse lightening test for bushings rated 350BIL and above was added as a routine test requirement for bushing OEMs. Secondly, he noted that there currently is a survey underway regarding standardizing the inboard end of bushings. The Bushing SubCom Chair asked if they could use 19.01 as a starting point for dimensions. Mr. Mansuy stated that it will be extremely difficult task as IEC is a dimensionless international standard and therefore each country has their own dimensional requirements.

A.3.2 IEEE 693 – Eric Weatherbee, IEEE Liaison

Mr. Weatherbee informed the SubCom that Michael Riley of Bonneville Power Administration is the new Chair for 693. Former Chair Eric Fujisaki retired from PG&E 1.5 years ago and decided to step down. The document was submitted for approval to RevCom at their 10/15/18 meeting. Mr. Weatherbee informed the SubCom of ballot process history. The document opened for ballot 06/2016, recirculation passed 10/2017 with 81% approval. The document went through 6 circulations during the ballot process.

A.3.3 WG PC57.160 Guide for PD Meas. in Bushings and Inst. Trans. – Thang Hochanh, Chair

No meeting was held due to the status of the document. The guide is currently in process of going to Ballot.

A.4 Unfinished Business

A.4.1 Dielectric Frequency Response (DFR) Test for Bushings

The Chair asked Ms. McNelly if there was any new information she could share with SubCom regarding the creation of this new document. Ms. McNelly stated that a small room will be scheduled for an invite only oversight TF. She stated that any interested individuals should contact the Bushing SubCom Chair.

Following the S18 meeting the following people had contacted the Chair to participate in this new TF: Sanket Bolar, Mario Locarno, Deigo Robalino, Wesley Schrom, Charles Sweetser, Eric Weatherbee, Shibao Zhang, and Peter Zhao

A.5 New Business

A.5.1 Dr. Zhang, volunteered to be liaison to C57.91, Transformer Loading Guide

Dr. Zhang informed the SubCom that he attended the WG meeting for C57.91 and informed them that Annex B needs to be removed or updated as it is no longer part of 19.100 Application Guide. He informed the WG for C57.91 that there is a TF assigned from the Bushing SC to investigate what the

proper course of action should be regarding bushing overload. Dr. Zhang stated he will work as liaison to the WG to keep them updated as new information becomes available.

A.5.2 Mr. Joe Foldi, concerns with the venting of bushings

Mr. Foldi informed the SC that he is not comfortable with the allowance for Transformer OEMs to vent bushings during factory testing to alleviate PD by the Bushing OEMs. Mr. Foldi has brought his concerns up over the last several days in various meetings and most recently he was informed that PD is not an issue with all designs and therefore, he requests that the bushing manufacturers reconsider their stance on venting and instead conquer the issue through design changes.

Dr. Zhang stated that the PD issue is matter of physics with OIP bushing and his company has manufactured OIP bushings for 70 years and have always handled the issue the same way. Dr. Zhang stated that the taking of DGA samples is allowed and that also breaks the bushing seal. If the venting is performed in accordance to each manufacturers instruction there should be no issue. Dr. Zhang stated that a study group which consisted of users, transformer OEMs and bushing OEMs discussed the issue and concluded that adding the statement that venting can be performed per the manufacturer's instructions to 12.90 was the best solution.

Mr. Bill Griesacker stated he is the Chair for the TF For Continuous Revision to Low Frequency Dielectric Tests which formed the Study Group to investigate PD in OIP bushings during Transformer OEM testing. It was originally brought up in the Bushing SC meetings and passed to DiTest SC which assigned the task to Mr. Griesackers TF. The Study Group submitted a statement for inclusion into 12.90 and his TF approved it for submission to the DiTest SC for review.

The Bushing SC Chair asked Dr. Zhang if he could provide an Annex for addition into 19.100 Application Guide. Dr. Zhang deferred the request to Mr. Dave Geibel, as Mr. Geibel was the lead for the Study Group. Mr. Geibel accepted the task as requested.

Mr. Geibel will also keep the Bushing SC updated with the progress.

See Annex F for proposed statement that was to be submitted to the DiTest SC, however this was not displayed during the Bushing SC and was included as reference only.

A.5.3 Transformer Bushing Reliability

The Chair asked if anyone had been WG member for Cigre A2.43 Transformer Bushing Reliability. Mr. Dave Geibel stated that he had been a member. The Chair asked if Mr. Geibel could provide a summary of highlights for the SC. Mr. Geibel stated that the document has been published and is very large and therefore he would not be able to provide a summary but he recommends reading the document as it is interesting.

A.6 Other

A.7 Adjournment

Bushing Standards Status F18 (unoffical-reference only)					
SubCommittee Chair - Peter Zhao, peter.zhao@HydroOne.com					
Standard **Project**	**Title**	**WG Chair**	**Pub Year** **Rev. Due Date**	**PAR Issue** **Par Expiration**	**Comments**
PC57.19.00	IEEE Standard General Requirements and Test Procedure for Power Apparatus Bushings	P. Zhao	**2004** 12/2020	**2018** 12/2022	WG Draft Development
C57.19.01	IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings	S. Zhang	**2017** 12/2027		IEEE Std C57.19.01-2017 (12 July 2018)
PC57.19.02	Standard for the Design and Performance Requirements of Bushings Applied to Liquid Immersed Distribution Transformers	Ed Smith	New	**2016** 12/2020	WG Draft Development
65700-19-03	IEC/IEEE International Standard -- Bushings for DC application	L. Rechsiedler	**2014** 12/2024		
C57.19.04	Standard Performance Characteristics and Dimensions for High Current Power Transformer Bushings with Rated Continuous Current in Excess of 5000 A in Bus Enclosures	S. Digby	**2018** 12/2028		IEEE Std C57.19.04-2018 (6 June 18)
C57.19.100	IEEE Guide for Application of Power Apparatus Bushings	T. Spitzer	**2012** 12/2022		Revision discussion meetings, work in progress, PAR to be submitted

PC57.19.00 - WG for the Revision of IEEE Standard General Requirements and Test Procedure for Power Apparatus Bushings

11:00 AM to 12:15 PM, Monday October 15, 2018
Hyatt Regency Hotel, Jacksonville, Florida USA

Unapproved Meeting Minutes

WG Chair Peter Zhao presided over the meeting, with Eric Weatherbee as Secretary. Introductions were made, and meeting rosters were circulated to record the attendance.

Total Attendance	58
Members in Attendance	23 out of 57 members, no quorum
Guests in Attendance	35
Guests Requesting Membership	6

The WG Chair noted that 56 comments have been received from the volunteer review group. At our current rate of review and disposition of 4-5 per meeting it will take approximately six years to complete. The Chair asks all participants to review the comments that are hosted on the website prior to the meeting to increase our pace of disposition. The Chair has a target date of 2020 to have a completed Draft.

The meeting focused on review of the comments received from the review group with the attendees. The following is a summary of those discussions and resulting disposition or follow up action to be taken:

Review Section: 4. Service Conditions: Page 5, Subclause 4.1, Line 30 – **Comment**: add 105°C maxi temp limit. **Proposed Change**: Add: and does not exceed 105°C maximum.

Discussion, disposition, and/or follow up action:

- After much discussion the group decided to add the following:
  - 105°C maximum oil temperature in contact with the bushing over a 24-hour period

Review Section: 4. Service Conditions: Page 5, Subclause 4.1, Line 31 – **Comment**: add temperature limit for bottom terminal connection, say, 105°C maxi temp. **Proposed Change**: Add: - The bottom terminal and lead connections do not exceed a 105 °C.

Discussion, disposition, and/or follow up action:

- Sebastien Riopel noted that IEC 60137-2017 has a table with temperature limits.
- Matthew Weisensee stated that the temperature of turret should be considered.
- It was decided that a Study Group would investigate the issue with a review of the IEC table and provide a suggested disposition by the next meeting.
  - Dave Geibel volunteered to be the lead for the Study Group. Additional volunteers: Juan Castellanos, Bruno Mansuy, Ryan Musgrove, Egon Kirchenmayer, Amitabh Sarker, Matthew Weisensee, Shibao Zhang and Peter Zhao.

Review Section: 3. Definitions: Page 2, Subclause 3.1, Line 25 – **Comment**: Ambient should be clearly the temperature outside any bus duct or enclosure. **Proposed Change**: Add: … the surrounding air in contact with the apparatus onto which the bushing is mounted, not inside bus ducts or enclosures.

Discussion, disposition, and/or follow up action:

- Accepted for addition by those in attendance.

Review Section: 3. Definitions: Page 3, Subclause 3.4, Line 6 – Comment: Some bushings are horizontal and have no "bottom end" **Proposed Change**: Change to suitable connector at the inboard end of the bushing for the transfer of current.

Discussion, disposition, and/or follow up action:

- Accepted for addition by those in attendance.

Meeting was adjourned.

Respectfully Submitted,
WG Secretary Eric Weatherbee

C57.19.100 Bushing Application Guide Meeting Minutes - 10/15/18 Fall Meeting

The meeting was called to order at 3:17 with people present, 19 members (out of 29), 14 guests and 17 new guests with 2 requests for membership. Quorum was achieved.

After introductions, a request for patent disclosures was made and none were presented.

The PAR will be submitted today.

No new proposals for change to the Guide were received prior to the meeting.

Discussion held regarding CB bushings, no new designs are being made for CB applications. C57.19.01-1991 is referenced for CB Bushing applications.

Discussion that Bushings are not designed for overload conditions. A bushing needs to be specified as needed for overload conditions that would be above the bushing rating. Only OIP bushings are mentioned in the guide and the calculations may not apply to non OIP bushings. A separate Task Force is being formed to discuss non-OIP bushings.

Discussion held on the test method for 55C rise in bushings. The test did not change, the maximum temperature is still 105C. Motion made by David Geibel seconded by Shibao Zhang to remove the 55C Derating Chart in section 5.2. Motion passed with 16 for and none against.

Motion made by David Geibel and seconded by Don Platts to approve the Spring 2018 Minutes.

Discussion held on proper handling of a bushing with PD that occurs during test. The bushing is vented to remove the condition and then re-tested allowing contaminated air inside and that It shall be resealed according to the bushing manufacturer's instructions.

The meeting was adjourned at 4:07 PM

Tommy Spitzer, Chair
Jeff Benach, Secretary
October 15, 2018

Distribution Transformer Subcommittee
Task force / Working Group Report

Document #:	PC57.19.02
Document Title:	Standard for Design and Performance Requirements for Bushings Applied to Liquid Immersed Distribution Transformers

Chair:	Ed Smith	Vice-Chair	Steve Shull
Secretary	Fred Friend		

Current Draft Being Worked On:	D1.2	**Dated:**	October 2018
Meeting Date:	October 16, 2018	**Time:**	11:00 am – 12:15 pm

Attendance:	**Members**	31
	Guests	28
	Total*	59

*** For details of attendance, please refer to AMS system of the Transformers Committee**

Meeting Minutes / Significant Issues / Comments:

The meeting was called to order by the Chair at 11:00am, the roster was circulated, followed with introductions of members and guests. The Chair made a call for any Essential Patent Claims and none were brought forward. A check for quorum was made and achieved. A motion was made by Dave Geibel and seconded by Jerry Murphy for approval of the agenda. The motion was unanimously approved. A motion was made by Dave Geibel and seconded by Jerry Murphy for approval of the spring 2018 meeting minutes. The motion was unanimously approved. Steve Shull informed the group that he and Ed Smith were exchanging roles. Going forward Ed will be the Chair and Steve will be the Vice-Chair.

The various Task Forces presented reports:

Taskforce report – Cantilever Design Test Requirements

This discussion was led by Steve Shull as he switched to the D1.2 document. He showed two sections that he had created for the bushing cantilever testing from the taskforce's report. One designed for leak detection and the other for ultimate strength testing. The discussion of the leak detection section led to these conclusions:

- It should be made clear somewhere in this section that leak detection would not be a part of the bushing manufacturer design testing but be solely the responsible of the entity making the application on the oil filled equipment.
- There will be a working torque value maximum based on the ultimate torque value developed from the ultimate strength test. A task force was formed to research C57.19.100 and IEC 60137 to develop what this level should be. The taskforce will be chaired by Steve Shull and the members will be Dave Geibel, Ed Smith, and Carlos Gaytan.
- The test conditions for this item were modified to 7 psi to coordinate with C57.12.39. There was some discussion concerning the temperature of the test but it was finally decided that the temperature would stay as shown but guidance would be added to how this test could be interpreted at higher temperatures. It was suggested that the test be at a fixed temperature then apply some type of margin could be applied. The taskforce will add this to their list for study.

The discussion of the bushing ultimate strength testing led to these conclusions:

Distribution Transformer Subcommittee
Working Group Report

- The application of the test load would be located at the minimum stud length point of the type of bushing that was being tested.
- The test on a stud mounted bushing will need more work as the direction of the force was not specified. It could be defined by either being in line with the stud mounting bolts or otherwise particularly when applied to the three bolt mounting design. A comment was made that if the three bolt pattern was mounted with the one bolt sustaining the full load, the rating of the bushing could be reduced as much as 20%. Another suggestion was just to state the bushing should be mounted in the worst case orientation which creates the lowest torque value. This item was added to the previous task force's research.
- It was suggested we change the word "distortion" shown in section 3.3.2 to "permanent deformation" to better match the terms used in C57.12.39. There was no opposition to this change.

Taskforce report – Standard Mounting Holes

Rhett Chrysler reported for Martin Rave. This task force was charged to develop the minimum stud length shown in Figure 4, Standard Mounting Hole and Stud Patterns. They surveyed three manufacturers and develop the following levels.

Mounting Hole Designation	Minimum Mounting Stud Length Recommendation	Minimum Mounting Stud Length Manuf. 1	Minimum Mounting Stud Length Manuf. 2	Minimum Mounting Stud Length Manuf. 3
SA	38 (1.50)	38 (1.50)	41 (1.63)	38 (1.50)
S	38 (1.50)	38 (1.50)	41 (1.63)	38 (1.50)
S1	38 (1.50)	51 (2.00)	41 (1.63)	38 (1.50)
S2	51 (2.00)	51 (2.00)	54 (2.13)	57 (2.25)

These minimum mounting stud lengths would be placed in the table shown in Figure 4.

Taskforce report – Stud Sizes

Al Traut reported that they developed a new drawing to show the stud mounted bushing with an internal spade connection. During the discussion it was found that a dimension was left off the drawing in that the spade width was not specified. Al and Steve Shull would work on adding the minimum width values to the drawing. Also a new stud size was discovered and added to standard stud size table. This task force was to verify the thread designation and useable thread lengths. These items will reported at the next meeting. As well the statement designating the measurements minimums would be removed and placed into the table headings so that it will be more than informative.

It was announced that the next meeting would be on March 26, 2019 in Anaheim, CA. The meeting was adjourned at 12:15 pm.

Submitted by: Fred Friend

Date: 10/17/2018

Bushing Overload Task Force

Meeting Minutes
Hyatt Regency Riverfront Hotel

Jacksonville, FL, USA
Monday, October 15, 2018
4:45 PM – 6:00 PM

The meeting was called to order by Chair Matt Weisensee at 4:45 pm on Monday, October 15, 2018 in Jacksonville, FL. Shibao Zhang was the acting Secretary due to the absence of Secretary Alwyn VanderWalt. The Vice-chair position is vacant.

There were a total of 59 attendees, including 15 members out of 22 listed members, so a quorum was achieved. 10 attendees requested membership.

A call for essential patent claims was made, but none were identified.
The attendees were asked to identify themselves and their affiliation.

The minutes of the last meeting in Pittsburgh, PA and the meeting Agenda were unanimously approved.

Per agreement in the last TF meeting the Chair created and ran two surveys.

The first survey was among bushing manufacturers, which was sent to 12 companies, and the Chair received 6 responses. The second survey was among transformer manufacturers, which was sent to 16 companies, and the Chair received 8 responses.

The Chair shared the 6 survey questions that were sent to the manufacturers and gave a short summary of the answers for each question. A documents with all the answers listed will be posted on IEEE Transformer Committee website for participants to review and discuss in future meetings.

There were wide and lengthy discussions of overload conditions of transformers and some general cases of bushing failures in specific applications such as solar farms which may not be related to the bushing overload.

The bushing Subcommittee Chair, Peter Zhao, suggested that the task force choose some reasonable content to be delivered within 2 or 3 years. Sebastien Riopel of Electro Composites suggested that we revise the task force scope to be "Bushing Selection Guide for Transformer overload conditions", which was echoed by other participants. Since many participants had left due to the meeting running overtime, no vote was held on this scope revision. The Chair agreed to email the full task force regarding the proposal to revise the task force scope and if possible conduct an email vote before the next meeting.

The meeting was adjourned at 6:15 pm

TF Chair: Matt Weisensee, PacifiCorp
TF Secretary: Alwyn VanderWalt, PNM
TF Acting Secretary: Shibao Zhang, PCORE Electric

Study Group on Bushing PD During Factory Transformer Testing

Proposed text to add to standards:

"If partial discharge is observed during the induced testing of the transformer and appears to be generated within an OIP bushing(s), it is permissible to "vent" the bushing(s) to atmosphere using the bushing manufacturer's instructions to allow for the dissipation of gas bubbles in the oil. Gas bubbles sometimes form following a temperature rise test during cool down or may be present for other reasons. Reestablishment of the bushing gas space blanket and resealing of the bushing must also be performed in accordance with the bushing manufacturer's instructions following completion of the induced test."