Annex G **Insulating Fluids Subcommittee**

March 27, 2019
Anaheim, CA

Chair: David Wallach
Vice-Chair: Jerry Murphy
Secretary: Scott Reed

G.1 Introductions, Roll Call of Members for Quorum, Meeting Agenda Approval, F18 Minutes Correction and Approval, and Chair's Comments

G.1.1 Chair's Opening Remarks:

a. When balloting, the resulting document must be reviewed and approved by the WG with majority approval after comment resolution is complete before recirculation.

b. Reminded that the WG and TF meeting minutes are due for submittal to the Insulating Fluids Subcommittee (IFSC)Secretary Scott Reed due within 15 days of their meetings.

G.1.2 Roll Call of SC members: (Quorum requirement: 28 minimum)

a. 31 Members signed in. Quorum was achieved.

b. 66 Guests attended, and 2, who were eligible, requested membership. One member requested to be changed to Guest status.

G.1.3 Agenda Approval:

a. A motion was made by Kent Miller and seconded by Kumar Mani to approve the agenda. The agenda was approved unanimously without objection.

G.1.4 Approval of minutes from the F18 meeting in Jacksonville, FL:

a. A motion was made by Clair Clairborne and seconded by Don Platts to approve the minutes. The minutes were approved unanimously without objection.

G.1.5 Chair's review of key SCIF Standards:

a. The chair reviewed the status of each guide under the Sub-Committee Insulating Fluids. C57.111 and C57.121 are up for review but they will be superseded by C57.166 so these PARs will not be renewed. C57.147 has nine years remaining until its expiration, but will also be replaced by C57.166.

b. There was a discussion on whether or not to renew the C57.146 PAR that expires December 31, 2021 for the Dissolved Gas Analysis of Silicone Filled Transformers. It was determined that there are enough parties with an interest in

keeping the guide active. Jim Graham made a motion to renew the PAR and Claude Beauchemin seconded the motion. The motion unanimously passed.

c. C57.637, C57.106, C57.130, C57.139, and C57.155 all have PARs that will expire in 2024 or beyond so no activity is required at this point.

G.2 **WG & TF Reports Presented at the SC Meeting**

G.2.1.1 C57.104 – IEEE Guide for the Interpretation of Gases Generated in Oil – Immersed Transformer (PAR Expiration: 12/31/19)

WG Chair - Claude Beauchemin

The report of the WG Meeting was presented at the SCIF meeting by Claude Beauchemin:

a. The WG meeting had 160 attendees. Of these, 58 of 85 members were present so a quorum was achieved.

b. At the Fall 2018 meeting, a balloter challenged the rejection of a comment and filed an appealed to the Insulation Fluids Subcommittee (IFSC) Chair. An Appeal Review Group was formed and chaired by Jim Graham. The Appeal Review Group determined the denial was in accordance to protocol, but allowed his comments to be reviewed by the members of the C57.104 via an electronic ballot managed by the IFSC. The election results were 90% of voters were in agreement with the Comment Resolution Group's decision.

c. The PAR was modified to reflect changes to the scope and purpose and was approved February 8, 2019.

d. The first recirculation after the initial ballot had a 93.5% return rate and an 95% affirmation rate. 19 comments were received and the Comment Resolution Group (CRG) reviewed all of the comments. The CRG results were submitted for an electronic acceptance vote on February 22, 2019. The resolutions passed with a 98% approval rate and were incorporated into Draft 6.2.

e. Draft 6.2 was released March 11, 2019 to the ballot group and had a 94.6% return rate and an 98.8% affirmation rate. Nine comments were received and resolved during the meeting, however, the comments did not address draft modifications or unresolved negatives and were considered out of scope. Seven of the nine comments were deemed editorial changes and will be forwarded to the RevCom editor for consideration.

f. This was the last meeting of C57.104 and the draft will be forwarded to RevCom for approval.

See ***Appendix I*** for the S19 Minutes (unapproved) of C57.104 WG Meeting as submitted.

G.2.1.2 IEEE C57.166 Consolidation of Insulating Liquids Guides (PAR Expiration: Dec 2022)

WG Chair: Tom Prevost

The report of the WG Meeting was presented at the SCIF meeting by Tom Prevost:

a. The WG meeting had 86 attendees. Of these, 24 of 33 members were present so a quorum was achieved.

b. Five Task Forces chairs each gave a status report of their respective sections. TF1 will will adopt the ASTM nomenclature for Less Flammable Hydrocarbons (LFH). TF2 will adopt TF1's format for reporting liquid tests by voltage class so that there is consistency between the sections within the guide. TF3 has started drafting language for the mixing of mineral oil with both natural and synthetic esters.

See ***Appendix II*** for the S19 Minutes (unapproved) of C57.166 WG Meeting as submitted.

G.3 Old Business

No Old Business to review.

G.4 New Business

a. It was discussed whether or not retrofilling should become its own guide, A motion was made by Tom Prevost that retrofilling is a subject that should be covered under C57.166, Task Force 3 led by Alan Sbravati. Depending on how the content evolves, it may be up for review at a later time to remove the content and create a separate guide. The motion was seconded by Alan Sbravati. During the discussion, Paul Bowman shared that retrofilling is discussed in Annex B of C57.147. The motion carried with a vote of 27 in favor, 2 abstentions and 0 opposed.

b. Juan Castellanos, who serves as the Chairman of the IEC Mexican chapter, raised the issue of mixing new and re-refined mineral oil, and stated that IEC6092 wants TC10 to remove the requirement of excluding re-refined oil from the IEC standard. Tom Prevost pointed out the issue is with ASTM (D3487), not IEEE. The matter was considered out of scope for the IFSC.

c. As a follow up to the motion to renew the C57.146 PAR, Deanna Woods volunteered to serve as Chair. In addition, Jon Karas volunteered to serve as Vice Chair and Toby Johnson volunteered to serve as Secretary.

G.5 **Next SCIF Meeting:**

October 30, 2019—Columbus, OH

G.6 **Adjournment**

The motion passed unanimously and adjourned at 3:55 p.m.

Respectively Submitted, Scott Reed, Secretary IFSC

Unapproved Minutes from the F17 SCIF WG and TF Meetings

Appendix I – WG C57.104 Minutes

C57.104 – IEEE Guide for the Interpretation of Gases Generated in Oil – Immersed Transformers

Tuesday, March 26. 2019

Anaheim, CA, USA

Minutes of WG Meeting

The meeting was called to order at 3:20 pm by Chair Claude Beauchemin.

There were 160 total in attendance. Of these 58 of 80 members were present. A membership quorum was achieved. There were 102 guests. The WG does not plan to meet at the Fall 2018 Transformers Committee Meeting in Columbus, Ohio.

The list of meeting attendees will be maintained in the AMS system.

Agenda

1. Welcome & Introductions
2. Patent Call
3. Quorum Check
4. Approval of Agenda
5. Approval of Minutes from Fall 2018 Jacksonville, FL
6. Ballot and Comment Resolution Group status
7. New Business
8. Adjourn

Introductions of the Chair Claude Beauchemin, Vice Chair Don Platts, and Secretary Susan McNelly (writer of Minutes) were made. Vice Chair Norm Field was not able to attend.

A call for essential patent claims was made. No new or additional essential patent claims were identified. It was mentioned by Donald Lamontagne that a patent response had been made at a previous meeting.

A motion to approve the Spring 2019 Anaheim Meeting Agenda was made by Dave Wallach and seconded by Marcos Ferreira. There were no objections or additions to the agenda.

A motion to approve the Fall 2018 Jacksonville Meeting Minutes was made by Jerry Murphy and seconded by Jim Thompson. There were no objections or additions to the minutes.

Ballot and CRG before F2018

- Ballot pool call issued in December 2017 and Ballot pool consisted of 184 participants, including 32 members of the WG
- At the spring 2018 meeting, draft 4.3 was approved unanimously and was issued to the ballot group, as draft 5.0, on April 13, 2018 for a two months ballot review and reached consensus (>75% approval) with 88% affirmative.
- Comment Resolution Group completed their review of the ballot comments (409 comments) in time for the Fall 2018 meeting
- Major draft changes were reviewed at the Fall 2018 meeting
- WG voted acceptation of the CRG work and Draft 6.0 was distributed to the ballot group on November 26 for a one month recirculation (recirculation #1)

Activities since F2018 meeting

Challenge to Comment Resolution Group (CRG) resolutions to initial Ballot comments

A balloter of the initial ballot (C57.104 Draft 5) challenged the Comment Resolution Group's (CRG) rejection of comments i350-i352 and requested to present additional material supporting the challenge to the working group at the fall 2018 Jacksonville, Florida working group meeting. The request was ruled out of order by the WG chair based upon the agenda sent in advance.

The balloter subsequently filed an appeal with the Insulating Fluid Subcommittee (IFSC) Chair. An appeals group was formed and tasked with reviewing the process of submission of the comments via the ballot process, the handling of these comments by the WG Chair, and whether the commenter had reasonable opportunity to support the submitted . The Appeal Review Group did not review the technical aspects of the comments. The Appeal Review Group was chaired by Jim Graham.

The Appeal Review Group found that the balloter had been given multiple opportunities to present and defend the comments, and that it agreed that the denial to allow a presentation at the fall 2018 meeting was proper and not due to personal bias. However, since it was not clear that the WG as a whole had been exposed to the technical arguments presented in the ballot comments, it was recommended that the balloter's presentation and documents be circulated to the WG for review and comment.

The 85 WG members were presented with the background and materials provided by the challenger in an email poll sent out on December 13, 2018 by the IFSC Chair to all C57.104 WG members. The vote was managed by the IFSC. A total of 43 responses to the poll were received, which met the minimum quorum requirement. With the 43 respondents, 22 votes or greater were required for a majority approval. There were 36 votes in agreement with the CRG resolutions on comments i350, i351, and i352. The following is the result of the electronic vote:

Agree: 36

Reject: 3

Abstain: 4

Approval rate (%): 90% (abstentions do not count toward approval percentage, only toward quorum)

PAR Changes

In accordance with comments i-299, i-386 and i-387 resolution, a PAR change request was made on November 1, 2018:

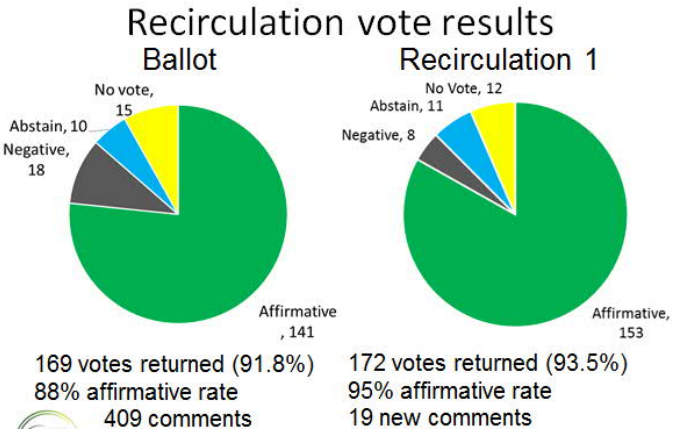
This work is the continuation of the advancement of C57.104 as set forth by the working group, balloted, and approved in 2008.

The PAR was modified to reflect changes made in the Scope and Purpose clauses of the revised draft.

PAR modification was approved on February 8, 2019

Changes in scope (changes shown in red strikethrough text): This guide applies to mineral-oil-immersed transformers and addresses: ~~1.~~a) The theory of combustible gas generation in a transformer; ~~2.~~b) The interpretation of gas analysis; ~~3.~~c) Suggested operating procedures; ~~4.~~d) Various diagnostic techniques, such as ~~key~~Key ~~gases~~Gases, ~~Dornenberg and~~ Rogers ratios;, Duval ~~triangle:~~, and other methods; ~~5.~~e) ~~Instruments~~Case ~~for~~studies ~~detecting~~ and ~~determining~~examples ~~the~~f) ~~amount of combustible gases present; 6. Case studies; 7.~~ Evaluation criteria and guidelines; ~~8.~~g) A bibliography of related literature.

Changes in purpose: The purpose of this document is to provide a ~~Guide for evaluating transformer condition using analytical tools and methods involving transformer mineral oil associated developed gases~~ guide for evaluating dissolved gases analysis results from mineral oil immersed transformers using statistical based analytical tools and fault interpretation methods



Comments Resolution Group

Don Platts	Jerry Murphy	Kumar Mani
Norm Field	Brian Sparling	Arturo Nunez
Sue McNelly	Marcos Ferreira	Tom Prevost
Dave Wallach	Jim Dukarm	Bob Rasor
Luiz Cheim	Michel Duval	Hali Moleski
Don Doris	Paul Boman	C. Beauchemin
Muhammad Ali Masood Cheema		

Ballot and CRG status

Comment Resolution Group completed their review and disposition of recirculation 1 comments.

Their review and disposition was circulated to the WG for an electronic acceptance vote on February 22, 2019.

A contest of the WG electronic vote validity was received on February 27, 2019 as follows:

"I respectfully object to this working group electronic vote based on the IEEE bylaws I-300.4(4). I also request time at the upcoming working group meeting to present and discuss information to support my first recirculation negative ballot for IEEE PC57.104, "IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers." I also request to present overhead material with text, and graphs, and equations for discussion at the meeting. Thank you."

IEEE SA confirmed to the commenter the validity of the WG electronic vote on March 1st and also specified to the commenter the channel for presenting related material: "We checked with Governance staff, according to the WG policies, the decision to have an email ballot is at the discretion of the WG chair (the applicable rule is sentence 1 of Clause 7.2 WG policies) and the paragraph in the bylaws which you asked about: '*If a majority consent, which sets forth the*

action, is signed, or acknowledged via e-mail by a majority of all the voting members of the board or committee, as the case may be.'"

"That statement in the IEEE Bylaws discusses verification of who voted; i.e., is there confidence in the email address of each balloter, which sets forth whatever action is in the email ballot. I hope this interpretation clarifies the bylaws for you."

"The draft is in the hands of the balloting group and the consensus ballot is the Sponsor Ballot (Standards Association Ballot) not the WG. So if you have material that the consensus group needs to decide upon, please share it in the Ballot group as an official record of your comments. "

The result of the WG electronic vote is as follow:

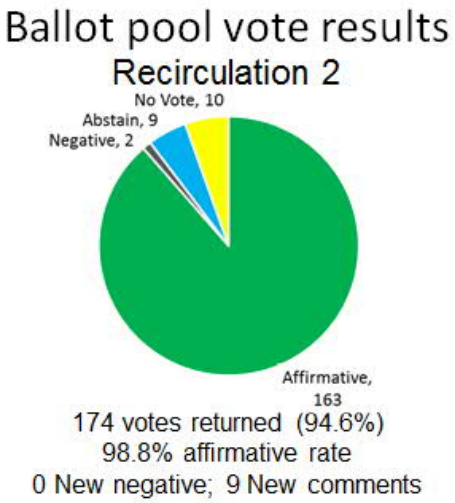
66 Returned votes (Quorum = 43)

58 Approves (98% approval rate)

1 Disapprove, with comments

7 Abstains

The review and disposition of Recirculation #1 new comments (19), with updated PC57.104 Draft 6.2, was sent for a 10 days recirculation (no. 2) on March 11, 2019 to the ballot group.



Comments received in recirculation 2

Once the proposed standard has achieved 75% approval, comments in subsequent ballots shall be based only on the changed portions of the balloted standard, portions of the balloted standard affected by the changes, or portions of the balloted standard that are the subject of unresolved comments associated with Do Not Approve votes.

If comments are not based on the above criteria, the comments may be deemed out-of-scope of the recirculation. Such comments need not be addressed in the

current standards balloting process and may be considered for a future revision of the standard.

R02-1. Comment (5.4, p29, line 38): “It is my understanding that the normative values in the Tables were based on manual DGA sampling. Particularly as it relates to Table 4 gassing rates, the tables will not be applicable to on-line DGA monitors which can sample multiple times per day. The DGA rates for on-line monitoring will be much higher than that proposed in Table 4 and will be more accurate.”

> Proposed change (5.4, p29, line 38): “Change the sentence to : “The norms shown in Table 1, Table 2, Table 3 and Table 4 below were obtained by statistical analysis of a large database of ***manual*** DGA results.” Note: “laboratory” is used in the draft instead of “manual” and for Table 4 the title does refer to “laboratory DGA”.
>
> Claude asked if there was a motion to pass this on to the IEEE Editor to consider this as an Editorial revision. A motion was made by Jim Thompson and seconded by Kumar Mani. The motion was successful.

R02-2 and R02-3 Comments: “Normative values for on-line monitoring will be different than that in Table 4, if the samples are taken at frequencies typically used by on-line monitors; i.e., multiple samples per day.”

> R02-2. (5.4, p31, line 4) Proposed change: “Change the sentence to ‘Values in Table 1, Table 2, Table 3 and Table 4 might need to be adjusted to meet specific user requirements, ***such as on-line monitoring data interpretation***, or for a specific transformer population’”
>
> Claude asked if there was a motion to pass this on to the IEEE Editor to consider this as an Editorial revision. No motion was brought forward.
>
> R02-3. 6.1.4, p39, line 8 Proposed change: “Insert at the end of line 10 ‘Use of on-line monitors simplify the gassing rate calculation and establishment of gassing rate limits. Samples taken at consistent intervals, with known repeatability and accuracy, help the transformer owner and operator to better detect changes in the gas levels and gas rates of change, and to more accurately calculate their values, compared with manual samples taken at less consistent intervals.’”
>
> R02-3. 6.1.4, p39, line 8 Proposed change (suite): “Gassing rates for on-line monitors are not addressed in Table 4. Transformer owners and operators are strongly encouraged to perform their own study based on their own on-line monitoring data."
>
> Claude asked if there was a motion to pass the above two proposed changes on to the IEEE Editor to consider this as an Editorial revision. No motion was brought forward.
>
> R02-3. 6.1.4, p39, line 8 Proposed change (suite): “Change the first sentence in line 11 to ‘However, the work performed in the analysis of

manual DGA results indicated that obtaining ...'. Note: "laboratory" is used in the draft instead of "manual"".

Claude asked if there was a motion to pass this on to the IEEE Editor to consider this as an Editorial revision. A motion was made by Tom Prevost and seconded by Jerry Murphy. There was discussion on whether these are really editorial The motion was successful.

R02-4. Comment (Annex B, p51. line 21): "The Annex is describing a "false positive". In a similar vein, samples taken one day apart and theoretically containing the minimum amount of laboratory equipment error can give a false indication of a small or no change (a "false negative") in the gas generation or generation rate."

Proposed change: "Add 'Similarly, samples taken one day apart and theoretically containing the minimum amount of laboratory equipment error can give a false indication of a small or no change in the gas generation or generation rate.' to the end of the paragraph."

Claude asked if there was a motion to pass this on to the IEEE Editor to consider this as an Editorial revision. A motion was made by Mickel Saad and seconded by Marcos Ferreira. Discussion: Tom Prevost indicated he believes this to be technical not editorial. Jerry Murphy asked if this was written as part of the document, it was indicated that it was. He indicated that he agreed it was not editorial. The motion was called to a vote. Three were in favor of the motion, fifteen opposed, five abstained. The motion did not carry.

R02-5. Comment (Annex B.1, p53. line 11): "It is my understanding that the normative values in the Tables were based on manual DGA sampling. Particularly as it relates to Table 4 gassing rates, the tables will not be applicable to on-line DGA monitors which can sample multiple times per day. The DGA rates for on-line monitoring will be much higher than that proposed in Table 4 and will be more accurate."

Proposed change: "Revise sentence to: 'Table 4: 95th percentile of rates (slopes) obtained from 3 to 6 consecutive *manual* DGA over a period of 4 to 24 months (Rates) normalized in µl/l/year (ppm/year).'" Note: "laboratory" used instead of "manual" in the guide.

Claude asked if there was a motion to pass this on to the IEEE Editor to consider this as an Editorial revision. A motion was made by Jerry Murphy and seconded by Dave Wallach. The motion carried

R02-6. Comment (Annex B.3, p58. line 10): "Point 12 should be excluded when calculating the gassing rate for segment 2."

Proposed change: "A second group of data indicating a stable gas level (points 8 to 14; *excluding point 12*) (Dashes - Dots line)"

Claude asked if there was a motion to pass this on to the IEEE Editor to consider this as an Editorial revision. A motion was made by Kumar Mani and seconded by Marcos Ferreira. There was discussion regarding whether the addition of this was out of order with the next statement regarding the outlier. The graph above includes the indication of point 12 as an outlier. The motion carried

R02-7. Comment (Annex B.3, p59. line 24): "The sentence refers to a 'priority confirmation sample' yet the sample is taken 26 days later. Additionally, the term priority sample is not defined."

Proposed change: "Remove the word 'priority' but continue to refer to it as a 'confirmation sample' or refer to it as a surveillance sample consistent with Clause 4.3."

Claude asked if there was a motion to pass this on to the IEEE Editor to consider this as an Editorial revision. A motion was made by Emilio Morales-Cruz and seconded by Deanna Woods. The motion carried

R02-8. Comment (Annex H.2.3, p101. line 18): "Although successfully in use for over a decade in large on-line DGA monitoring fleets, no mention of Artificial Neural Networks was made in the guide as an analysis method. The method was presented to the IEEE Transformers Committee in Montreal in 2006 and to date has successfully analyzed approximately ten million samples."

Proposed change: "Add as B130: 'Lamontagne, D. R. 'An Artificial Neural Network Approach to Transformer Dissolved Gas Analysis and Problem Notification at Arizona Public Service', EPRI Substation Equipment Diagnostics Conference XIV, San Diego, Jul. 2006'"

R02-9. Comment (Annex H.2.3, p101. line 19): "Both Annex A.3, Lines 27 - 28 and Annex B.3 Example 2 discuss or demonstrate the need for a peicewise linear approximation method for accurately calculating gassing rates. The method was first presented at the EPRI Substation Equipment Diagnostic Conference over a decade ago. This method has accurately predicted high energy arcing event gassing rates and severity with sufficient warning to successfully de-energize multiple transformers and preventing catastrophic failures."

Proposed change: "Add as B131: 'Lamontagne, D. R., 'Utilizing Harmonic Regression and Piecewise Linear Approximation to Analyze Power Transformer Insulating Oil Dissolved Gas Samples', EPRI Substation Equipment Diagnostics Conference XV, Orlando, Mar. 2008'"

Claude asked if there was a motion to pass this and the previous bibliography addition on to the IEEE Editor to consider this as an Editorial revision. A motion was made by Jerry Murphy and seconded by Marcos Ferreira. A question was asked whether the comment was indicated as Technical or Editorial in the Ballot. The ballot commenter indicated that they were Editorial. The motion carried

Resolution: Comment R02-1 to R02-9 are not addressing changes or unresolved negative in draft 6.2 distributed for recirculation 2. Therefore they are out of scope and were rejected.

New Business:

There was a question regarding the e-ballot with negative ballots and whether these comments will be included in the minutes. The Chair indicated that the minutes will be published on the web site as unapproved since this will be the last meeting of the WG and the response to the electronic ballot from Jim Thompson would be included (see Attachment A).

Claude expressed his thanks to Don Platts and Norm Field for their work as Vice Chair and to Susan McNelly for her work as Secretary. He also expressed a special thanks to Dave Hanson for it support and comprehension in regards of the time Claude used in the preparation of this guide. Jim Graham also expressed his appreciation to Claude for the significant efforts on this document.

Finally, the WG Officers wish to thank all of the Task Force chairs, the DGA data contributors, the hosts of many multi-day meetings that occurred throughout the years of developing this Guide to the TF members, to the WG Members and to the previous Chair, Rick Ladroga.

- Framework – Jim Dukarm, Dave Hanson, Rick Ladroga
- Data – Norman Field, Luiz Chiem, Claude Beauchemin
- Diagnostic Methods – Michel Duval, David Wallach
- Case Studies – Paul Boman, Arturo Nunez
- Arc Furnace Transformers – Tom Lundquist
- Bibliography – Jerry Murphy, Tom Prevost

Beauchemin, Claude	Fenton, Roger	McNelly, Susan	Reed, Scott
Boettger, William	Ferreira, Marcos	Moleski, Hali	Roizman, Oleg
Boman, Paul	Field, Norman	Morales-Cruz, Emilio	Saad, Mickel
Brauer, Stephan	Forrest, George	Murphy, Jerry	Selvaraj, Pugazhenthi
Castellanos, Juan	Frimpong, George	Murray, David	Shem-Tov, Mark
Cheatham, Jonathan	Frotscher, Rainer	Mushill, Paul	Simonelli, Richard
Cheema, Muhammad Ali Masood	Galbraith, Shawn	Naderian, Ali	Som, Sanjib
Cheim, Luiz	Gardner, James	Nims, Joe	Sparling, Brian
Christodoulou, Larry	Golarz, Jeffrey	Nunes, Jr, Jayme	Sullivan, Kevin
Claiborne, C. Clair	Hanson, David	Nunez, Arturo	Sweetser, Charles
Cox, Paul	Hayes, Roger	Patel, Poorvi	Thompson, James
Crouse, John	Hochanh, Thang	Perjanik, Nicholas	Thompson, Robert
Damico, Frank	John, John	Petosic, Branimir	VanderWalt, Alwyn
Denzer, Stephanie	Joshi, Arvin	Pinon, Oscar	Veillette, Michel
Dolloff, Paul	Kiparizoski, Zan	Platts, Donald	Wallach, David
Dorris, Don	Lau, Michael	Prevost, Thomas	Wang, Evanne
Doyle, Lee	Mani, Kumar	Pruente, John	Weyer, Daniel
Dukarm, James	Martin, Terence	Rasco, Jimmy	Williams, Trenton
Duval, Michel	McCullough, Douglas	Rasor, Robert	Woods, Deanna
Fairris, James	Mciver, James	Ray, Jeffrey	Yeboah, Kwasi

The meeting was adjourned at 4:29 PM

Claude Beauchemin
WG Chair

Don Platts
WG Vice-Chair

Norm Field
WG Vice-Chair

Susan McNelly
WG Secretary

Excel line no. 3, BRG PC57.104 1st recirculation ballot responses and electronic vote comments to working group from Jim Thompson.

This issue was addressed by the BRG after the original ballot. It was rejected then, and should be rejected again.

1. There are other more widely used laboratory methods, such as ASTM D3612 Method C. ***[Comment (JT.3/8/2019) Method has no stated precision statement for reproducibility. For repeatability it has only an "Interim Precision Statement for Repeatability for One Laboratory" reporting on twelve samples tested repeatedly. In that data, with the exception of CO2, the test method uncertainty is greater for each individual gas (repeatability interval is greater) than method B.]***

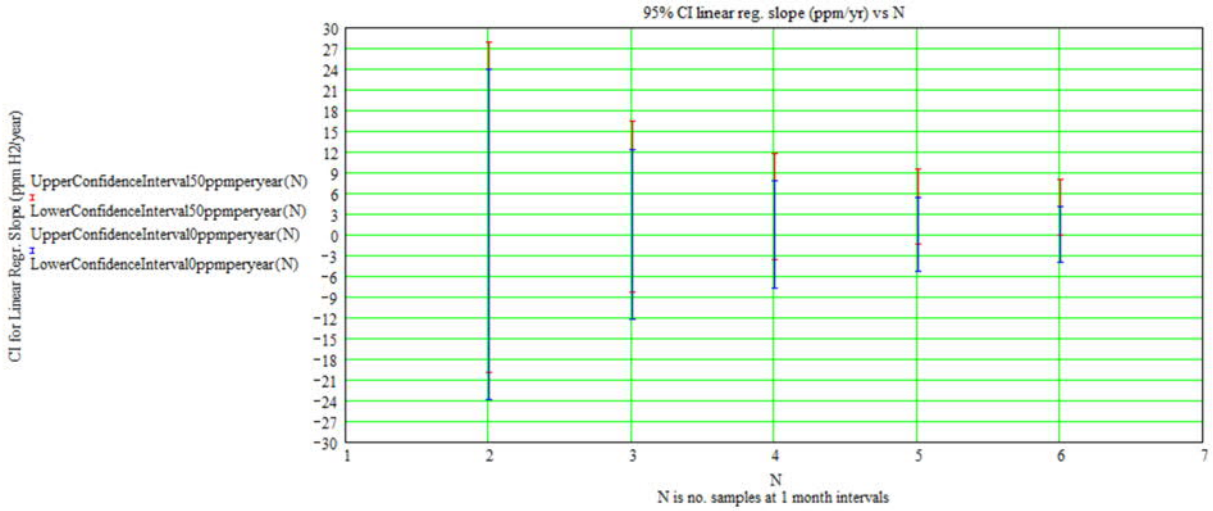
2. The values in Table 4 of Draft 6 are based upon an examination of 3 to 6 samples, which is a great improvement upon the 2008 edition which only requires a comparison of 2 oil samples. This change alone is a significant step towards addressing the challenge of measurement equipment accuracy/repeatability of results, which the 2008 edition did not address. ***[Comment (JT.3/8/2019) The linear regression of three to six samples does not resolve the precision of the test method resulting in false rates due to the method variations for each sample test result. This is due to the fact that the table 4 rates (ppm/year) are so low that the signal to noise ratios for table 4 are under 1:2 (1/2 signal amplitude vs. 1 noise amplitude). The uncertainty inherent with the test methods, ASTM D3612 A, B and C, results in repeatability and reproducibility ppm variations that exceed the real changes that would be sought in Table 4. For example, look at just the table 4 value for variation of 50 ppm/year H2 over a period of four months. The method B repeatability standard deviation is (0.17/1.96)*(200 ppm) for a 200 ppm H2 start value. That gives 200 +17 and – 17 ppm for a 95% confidence interval for the first test. But the monthly rate sought is (50/12 ppm per month or 4.2 ppm per month).***

3. The proposed change is to ""reintroduce the tables in C57.104-2008 to replace Table 4."" Only Table 4 of C57.104-2008 pertains to dissolved gas generation rate, and that table only utilizes Total Dissolved Combustible Gases (TDCG) to assess severity of gassing. This proposal does not address the comment's concern, and in fact worsens the problem. TDCG masks the possible severity of the rate of individual gases generated in the oil, and being a summation of individual measurements, the accuracy/repeatability problem would be compounded, not lessened. TDCG also has the inconvenient that all gases have the same impact on the evaluation, so for example C2H2 change is treated at the same level as CO. while in fact it should be of much more concern. ***[Comment (JT.3/8/2019) The 2008 document tables would be enhanced by using the tables 1 and 2 in the draft as well as guidance for sample intervals for retesting based on individual gases as an annex.]***

Excel line no. 4, BRG PC57.104 1st recirculation ballot response and electronic vote comment to working group from Jim Thompson.

This issue was addressed by the BRG after the original ballot. It was rejected then, and should be rejected again. This comment is of the same concern as Comment 25980100023 (r1-18) above, with the same Proposed Change, and therefore is given the same Disposition Status. . ***[Comment (JT.3/8/2019) Again, the uncertainty inherent with the test methods, ASTM D3612 A, B and C, results in repeatability and reproducibility ppm variations that exceed the real changes that would be sought in Table 4. Furthermore analysis of linear regression for 3 to 6 samples, using the ASTM D3612 method precision statements and table 4 values (ppm/year), shows that confidence intervals overlap***

for no change and 50 ppm/year change. Figure one, for H2 for example, shows that the 95 % confidence intervals for linear regression of 2 to 6 samples (1 to 5 sample intervals of one month each). This overlap demonstrates that even with linear regression the rates in table 4 cannot be distinguished from the false rates due to the method variations for each sample test result used in the linear regression.



<u>Excel line no. 10, BRG PC57.104 1st recirculation ballot response and electronic vote comment to working group from Jim Thompson.</u>

Suggesting specific time periods for resampling was purposely omitted. The owner/operator of the transformer must decide their risk tolerance based on DGA Status and fault-type interpretation, and create their own maintenance plan accordingly. Any suggestion of a specific maintenance schedule may or may not be adequate for a given maintenance program, and may or may not expose the oil sampling personnel to safety risk when handling an unhealthy transformer. Recommending more frequent sampling as the DGA status increases is sufficiently clear and useful guidance. ***[Comment (JT.3/8/2019) The suggestions in the 2008 document are for resample intervals to help ascertain fault type(s) in a timely manner. The other suggestions in the 2008 document are well established suggestions to help ascertain fault types. And whether it is resampling over 4 to 6 months described in this draft (without sample interval guidance) or it is resampling days, weeks, or months (with sample interval guidance) – both carry the same risk. Again, there is serious omission in the absence of guidance for time intervals for taking follow-up samples. And while the Surveillance definition***

describes this protocol for testing intervals of days, weeks, and months, still there is no guidance for those sample intervals in this document.

Excel line no. 11, BRG PC57.104 1st recirculation ballot response and electronic vote comment to working group from Jim Thompson.

In the balloter's supporting document to his comment (99276600003), the balloter seems to misunderstand the use of Table 3. The balloter is concerned that 2 consecutive oil samples taken 4 months or less apart will not be considered by Table 3. However, Table 3 is applied to consecutive sample regardless of the time between samples. Therefore, within that 4 month time, there could be any number of consecutive samples that are taken a very short time apart (less than 4 months and with no minimum limit). So, 2 consecutive oil samples taken 4 months or less apart are indeed covered by Table 3 as written. Table 3 does cover punctual change between consecutive samples, not rate, and as such it was never intended to identify a change that exceeds an "acceptable rate", only to identify a ponctual chage as being higher than the usual DGA fluctuations. See section B.1. ***[Comment (JT.3/8/2019) The heart of DGA is ΔV/Δt (rate of change in ppm dissolved gases in oil per change in time). Looking at ΔV, which is indeterminate with regard to rate of change, is not a useful metric unless one knows the associated Δt.***

Excel line no. 12, BRG PC57.104 1st recirculation ballot response and electronic vote comment to working group from Jim Thompson.

This topic that was previously addressed by the BRG. There seems to be multiple misunderstandings by the Balloter.

1. Yes, a subset of DGA data which contained multiple DGA results for the same transformer were used to create the multi-point values shown in Table 4. Just as subsets of DGA data were used to create the ppm values shown in Table 1 as a function of age and O2/N2 ratio. Such subsets were created starting from the entire DGA database. The 2008 edition of the guide, based on a dataset from 1972, could not create such subsets, lacking both the breadth and depth of information to do so. ***[Comment (JT.3/8/2019) Ok, then this subset of data does not represent the entire data. For instance looking at the box plots in the F13 working group presentation on page 41, a value of 173 ppm/year for the 95th percentile is calculated for the monthly sample intervals by using the values in the box plot to determine the standard deviation for that sample interval.]***

2. The oil sample intervals considered to create Table 4 were not restricted to consecutive samples taken at least 4 months apart. The total time interval, for multiple samples, was limited to 4 months minimum. Each pair of consecutive samples may have been much less than 4 months apart. ***[Comment (JT.3/8/2019). Ok,*** **but again these consecutive values and the 95th percentiles used in table 4 are a subset of the entire data set and do not represent the entire data. Again at best it represents variations for quiescent DGA rates in the subset of data.]**

3. The rate of change in DGA test results from factory acceptance tests are completely outside the scope of this guide, and not intended to be extrapolated up from a time period of hours to a time period of one year. Such an action would be completely contrary to good sense. ***[Comment (JT.3/8/2019). The fact that DGA test results from factory acceptance tests are outside of the scope does not mean they cannot be considered as a bench mark. For example if a new transformer is loaded at full load at the factory and at constant factory ambient temperature for a relatively short time does this help to predict how that same unit will fare with regard to Table 4 values when DGA tests are performed on that same unit in a customer's substation in higher ambient temperatures and for longer time frames at full load. That is an important reason consider these values.***

Jim Thompson
T & R Service Company
3/8/2019

Appendix II

Working Group for Acceptance and Maintenance of Insulting Liquids

Tuesday, October 16, 2018

1:45 – 3:00 PM

Jacksonville, FL USA

Minutes of WG Meeting

Chairman Tom Prevost
Vice Chair Scott Reed
Secretary Alan Sbravati

The meeting was called to order at 1:48 pm by Chair Tom Prevost.

There were 24 of 33 members present. There were 62 guests. A membership quorum was achieved.

Agenda

1. Introductions
2. Approval of Agenda
3. Approval of Fall 2018 Minutes
4. Call for Patents
5. New Document:
    a. Title
    b. Scope
    c. Purpose
6. Review of Document Structure and Task Forces
7. Task Force Reports
    a. TF1 Types of Insulating Liquids—Jinesh Malde
    b. TF2 In Service—Scott Reed
    c. TF3 Mixture of Insulating Liquids—Alan Sbravati
    d. TF4 Maintenance of Insulating Liquids—Rich Simonelli
    e. TF5 Insulating Liquids for LTCs—led by Rainer Frotscher
    f. TF6 Editorial—Toby Johnson
8. New Insulating Fluids – Continued Discussion from Fall 2018 Meeting
    a.Voltage Levels within Acceptance Tables- Discussion
9. New Business
10. Adjourn

The Fall 2018 minutes were unanimously approved. Minutes of meeting from Rainer Frotscher, second Don Dorris. The Spring 2019 agenda was unanimously approved. Motion for approval the agenda from Luiz Cheim, seconded by Jim Thompson. No comments were presented, agenda approved unanimously.

Chairman Prevost posted the Patent Claim. No claims were made.

Chair's Remarks:
Chairman Prevost reviewed the scope and purpose of the guide. Next, the chair asked each task force to speak about their respective sections.

TF1-Types of Insulating Liquids, Jinesh Malde
Jinesh shared a draft guide combining all the information from the existing standards. In addition, the task force identified the appropriate liquid tests and their significance as well as evaluate new liquids to be included as part of this guide. A discussion was raised around the inclusion of ASTM D877. The task force position is suggesting to keep as it is used typically for the maintenance. Jim Thompson raised the relevance of using the D877 for voltage regulators, tap changers and other equipment were this is the applied standard. Bob Rasor mentioned that D877 is no longer applied for transformers in the C57.106 guide.

Jinesh presented the suggestion of the TF to use the nomenclature of High Molecular Weight Hydrocarbons. Jimmy Rasco recommended using the ASTM nomenclature, which is High Fire Point Mineral Electrical Insulation Oil. Sasha mentioned the relevance of registering the history of the terminology. Claude suggested including some informative annex with additional history background. Tom suggested using the initial session of the background information. Jinesh will take it back to the task force the task of defining an abbreviation to be used.

The definitions of Unused / New / Prior to use / In Service were discussed. Jeff Valmus expressed the preference for the term "unused". A question around how to classify a liquid in a spare transformer not energized during 25 years. Jinesh and Tom advocated this would be as a "prior to energization" condition. Jim Thompson refers to the C57.93 as a guidance for the storage and the tests to be applied to this situation.

Jinesh asked for help for completing the information about silicone liquids, as the task force was not able to get inputs. Tom asks the audience for reference of were silicone is used. John John from Virginia transformer mentioned they have not received any request for quotation for new transformers filled with silicone liquid during the last 10 years. Rainer F. from MR offered to help with the information about silicone liquid. Bob Rasor mentioned SD Myers is servicing transformers filled with silicone liquid.

TF2- In Service, Scott Reed
Scott reviewed the relevant tables from the existing guides. He reported that TF2 is dependent on the format that TF1 takes on what liquid test values will be reported and also questioned whether any new liquid tests should be added to the guide. The group discussed the quantity of tests to be included for routine tests. For the natural esters tables the reference was table 4 of C57.147. Scott mentioned the absence of limits for dissipation factor, for example. Alan Sbravati explained these values are presented in the Annex B of the standard, as provisional. Tom Prevost mentioned this revision is the moment to collect more data and move the values to the main table. Regarding synthetic esters, Scott mentioned the need to work closely with the TF1, as the ASTM standard for unused synthetic esters is under development. At the moment there are no threshold limits defined in standards. Rainer Frotscher mentioned the existence of an IEC standard, which is valid for up to 35kV. Available information and limits for silicone liquid and HMWH are very limited.

TF3-Mixture of Insulating Liquids, Alan Sbravati
Alan prepared a first draft for this session, including information around the issues of mixing silicone with any other of the liquids, on the impact of mixing mineral oil with natural esters and also with synthetic esters and on the mixing of natural and synthetic esters. New volunteers joined the task force, who will revise the text prepared by Alan. They are: Mike Bonn; Ed Casserly; David Sundin; Nikola Lukenda; Bob Rasor, Jon Karas and Larry Christadoulou.

TF4- Maintenance of Insulating Liquids, Rich Simonelli
Rich is focused on the Reprocessing and Reclaiming of in service fluids. TF4 determine they have enough expertise on mineral oil and esters but needs more support with Less Flammable Hydrocarbon Fluids. TF4 is developing and consolidating guidance on Corrosive Sulphur and application / maintenance of Passivators. TF5 expects to have a draft guide available August.

T5- Insulating Liquids for LTC's, Rainer Frotscher

Rainer presented the application guides his company use as manufactures of tap changer and the available tables from IEC standards. Due to the variety of acceptable limits Tom mentions the need of consolidating the information.

Old Business:
Chairman Prevost addressed ‘New’ Insulating Liquids and Voltage Classes.

New Business:
No new business were presented.

The meeting was adjourned at 3:02 pm.

Alan Sbravati, Secretary
Scott Reed, Vice Chair

Chairman Tom Prevost
Vice Chair Scott Reed
Secretary (Open)

The meeting was called to order at 1:45 pm by Chair Tom Prevost.

There were 27 of 35 members present. There were 78 guests. A membership quorum was achieved.

Agenda
1) Introductions
2) Approval of Agenda
3) Approval of Spring 2018 Minutes
4) Call for Patents
5) New Document:
a. Title
b. Scope
c. Purpose
6) Review of Documents and Task Forces
7) Task Force Reports
8) New Business
9) Adjourn

The Spring 2018 minutes were unanimously approved. The Fall 2018 agenda was unanimously approved.

Chairman Prevost posted the Patent Claim. No claims were made.

Chair's Remarks:
Chairman Prevost reviewed the scope and purpose of the guide. Next, the chair asked each task force to speak about their respective sections.

TF1-Types of Insulating Liquids, Jinesh Malde
Jinesh announced his committee met October 14th and has 11 members. The task force will begin to consolidate information from the existing guides and is in the process of identifying background information for each fluid type. In addition, Jinesh will work to identify the appropriate liquid tests and their significance as well as evaluate new liquids to be included as part of this guide.

TF2- In Service, Scott Reed
Scott shared that his task force has meet and will consolidate information from existing guides that discuss in-service liquids. However, the task force has questions about voltage classes and thresholds for liquids that do not have any established values, as well as consideration for new liquid tests and new liquids. It was decided that TF2 will work with TF1 as they work to establish thresholds for as supplied, as received, and after filling as well as any new liquid tests that should be included. Chair Tom announced that voltage classes will be added to the Spring 2019 agenda.

TF3-Mixture of Insulating Liquids
Alan Sbravati has agreed to take over as task force chair for mixture of liquids. Alan questioned how retrofilling should be handled in this guide, It was decided to bring the question before the Insulating Liquids Sub-Committee of whether to make retrofilling it's own guide.

TF4- Maintenance of Insulating Liquids, Rich Simonelli
Rich reported that he is still looking for volunteers for his task force. Jim Thompson, Mike Lau, Jon Karas, Andrew Holden and Jimmy Rasco volunteered to assist. Rich also questioned whether re-refined oil is a maintenance classification to consider. It was decided it would not be considered as part of the task of maintenance since the oil is treated off site. It was further decided that more information is needed from ASTM to determine if this is a liquid for consideration under this guide.

T5- Insulating Liquids for LTC's, Rainer Frotscher
Rainer delivered a presentation that defined the parameters and the relevance for tap changers and the specific requirements of different liquids used in tap changers. The task force also identified the suitability of liquids for different tap changer types. The task force also identified potentially new liquid tests for both new and in-service liquids that should be considered for tap changer applications as well as developing thresholds for greater than 230 kV.

Old Business:
Chairman Prevost addressed 'New' Insulating Liquids or 'Unused' Insulating Liquid previously questioned.

As supplied by manufacturer: D3487
As received: C57.106 meet D3487 and Table 1.
After filling: C57.106 must conform to Table 2 (230 kV or > 230 kV).

The working group will continue the discussion of new liquids at the next meeting.

New Business:
Chairman Prevost stated that voltage levels within the acceptance tables will be discussed at the next meeting. Introductory material to facilitate this discussion will be distributed before the next meeting.

The meeting was adjourned at 3:00 pm.

Scott Reed, Vice Chair