

WG: C37.09 - IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers
Rated on a Symmetrical Current Basis (Under Revision)

Chair: Xi Zhu
Vice Chair: Victor Hermosillo
Secretary: Mike Skidmore

Session 1 – September 21, 2015 (10:15 AM to 12:00 PM)

Location: San Diego, CA
Participants: 34 Members
38 Guests

1.) The meeting started with the chair introduction and introductions of the attendees. The chair asked all attendees to sign the roster and provide affiliation if not noted on the roster.

2.) The agenda for the meeting was shown on a projector and the chair reviewed the agenda for the meeting and the expected timeline. Refer to Doc. 095 for agenda presented. The agenda shown included:

- Greetings, Introductions, Members & Guests Sign in
 - Approval of MOM (Doc 085) from St. Pete
- Review of Project Status
 - Discussed and resolved 99% of internal 340+ comments on versions D1.9 and D2.0 (Refer to Doc 079)
 - Draft 2.2 with all the comments disposition included and distributed to all WG members and guests for review (Refer to Doc 061 for revision history)
 - 97 documents archived in Central Desk. A few important ones:
 - Doc000 – Master document, topics, history of discussion, WG doc List
 - Doc061 – History of Draft Revisions
 - Doc079 – Internal Comments and Resolutions up to now
- Project Outlook
- Discussions and Resolutions on D1.9 and D2.0 comments
- Areas in D2.2 for improvements
- Any Spontaneous Topics?

3.) The chairman discussed the minutes of the meeting (MOM) from Saint Pete, FL. There is no need to obtain a motion for approve the meeting minutes from previous meeting. This was discussed at the main switchgear committee at Saint Pete (spring of 2015). The meeting minutes are posted on the IEEE PES Switchgear website:

<http://www.ewh.ieee.org/soc/pes/switchgear/minutes/Minutes.html>. The chair asked the working group to review the meeting minutes for errors. Please notify the secretary or chair for any

corrections needed. Any corrections will be noted on the new revision of meeting minutes. The old meeting minutes will not be re-posted with the corrections.

4.) The chairman discussed the structure of the meetings for C37.09. He said 2 sessions will be held on 9-21-15. (A 3rd session became available in place of C37.06.1 (See below).

5.) The Chairman discussed the project outlook:

- First Ballot done by Spring 2016 Meeting depending on progress
- Recirculation No. 1 ~ 4 by Fall 2017
- Submit to Revcom
- Revcom decision
- Completion by Dec. 2017

Xi Zhu plans to have the first ballot by spring 2016. Depending how fast issues are resolved. The working group expects to have one to four re-circulations. By fall 2017, we hope to submit to RevCom.

No additional comments received from the Working Group (WG).

6.) Main topics from discussion are a subset of +340. The following list corresponds to comments that were more significant. The following were discussed in detail:

- Ted Olsen 80 – by Denis Dufournet (Doc 086) (Doc 096)
- Ted Olsen 192 – by Anne Bosma (Doc 089)
- Ted Olsen 241 & Anne Bosma 18 – by Victor Hermosillo & Sushil Shinde (Doc 090) (Doc 098)
- Carmona 2 – by Gilbert & Victor Hermosillo (Doc 091)
- Anne Bosma 6 – John Webb & Xi Zhu (Doc 092) (Xi Zhu suggests removal or revise first sentence in item e))
- Roy Alexander 4 ~ 11 - by Roy (Doc 093)
- Dave Stone: Move Close & Latch and Short Time Current tests (Clauses 4.8.4.1 and 4.8.4.2) to a level 2 Clause 4.x --- TBD
- Stephen Cary: to include validation of 50Hz test for 60Hz on continuous current test. --- TBD. See text modified by Xi.
- Refer to Doc079 for details of the rest of the comments and resolutions

7.) The Chairman reminded the working group documents are in central desktop and should be available to all members and guests if you have access. This includes all presentations and documents that will be integrated into the new standard. Chair can resend an invitation upon request.

Document 079 – All comments received including disposition/resolutions at this point in time. Refer to Doc079 for details of the rest of the comments and resolutions.

8.) Chair asked if there are any other topics to be added to the agenda. No additional agenda topics were proposed.

9.) The working group (WG) membership and guest list was reviewed by the chair. The sign-up sheet is reviewed and contribution is considered. We propose to move individuals with no participation from membership to guest. The WG chair said the officers will adjust the membership list as needed.

10.) The Chair moved to cover selected comments received to date:

Ted Olsen 80 – comment from Mr. Olsen is responded by Denis Dufournet

Denis Dufournet prepared and presented the new test procedure for T100a (Document 086). A new annex C was written and is in the new draft D2.2 distributed before this meeting. In the last 2-3 years the IEC maintenance team has been discussing this new procedure. At his stage the final draft has been agreed. Now it is included in the revision of application guide of IEC. Denis Dufournet explained the procedure used to select the last major loop and be sure that it is the last one. The issue is the determination of minimum arcing time. An example was prepared for 50Hz, opening time, minimum clearing time. Presented graphs breaker interrupts in blue then yellow/red. If contact separation is delayed by 1 ms (18 degrees at 50 Hz) then red phase has maximum arcing time on major loop. Then what is important is the capability of a breaker to interrupt after the minor loop in the blue phase, if the breaker has a minimum clearing time such that it can interrupt after this minor loop, then the major loop with full asymmetry obtained afterwards is the one for which interruption must be demonstrated. Graphs are presented for additional delay of 6ms and then by 2 ms. to define capability the key is to interrupt after the blue minor loop. Table 1 in the draft is for 50 Hz, Table 2 for 60 Hz, provides the values of the major loop for different ranges of minimum clearing time.

John Webb commented that other test duties require performance at minimum control voltage. How does this affect T100a test? In C37.100 eliminated the rated clearing time. The clearing time ranges with limits at 22.5 ms and 39.5 ms which are close to typical values for vacuum breakers.

Denis Dufournet clarified that the table and values involved calculations and studies made for medium voltage breakers for three-phase testing. Then it was extended to higher voltage breakers which are tested on a single phase using a synthetic test procedure. T100a is tested at maximum control voltage. In the calculation of minimum clearing time for T100a the opening time used is that for maximum control voltage.

Denis Dufournet will check the wording to clearly state that the opening time is the time that is declared to be the shortest.

Arben Bufi. How does this relate to single-phase tests?

Denis Dufournet this means that single phase tests are made with three shots with major loop currents. The most important are the minimum and maximum arcing times. The last one is the medium arcing time test. The test is more severe than the existing procedure.

Kirk Smith - Is it allowed to interrupt after minor loop?

Denis Dufournet: yes if the breaker does not clear at the end of the major loop it is OK to interrupt in the subsequent minor loop.

John Webb: some manufacturers basing min arcing time on T100s (also T60, T30) based on three-phase test.

Gilbert Carmona: how is this related to ratings for breaker with different time constants, for example 45 ms, 75 ms?

Helmut Heiermeier: These Tables 1 and 2 are meant for testing. They allow us to select the proper values for the loops. The information and calculation procedure in the application guide C37.010 has the purpose of addressing cases in which the tested values can be converted to different user requirements for asymmetrical interruption.

Xi Zhu stated that this describes the requirement for testing. If X/R is higher than the short circuit symmetrical current is reduced. This application question is discussed between manufacturer and customer.

Ted Olsen 241 & Anne Bosma 18 – responded by Victor Hermosillo & Sushil Shinde (Doc 090) (Doc 098)

Several corrections have been made to the procedure for the low temperature test after receiving comments and suggestions.

1. Definition of t_a (Ted Olsen).
2. Allowance for multiple subsequent tests (Sushil Shinde).
3. Improve wording (Gilbert Carmona).
4. General comment from Anne Bosma regarding deviations from IEC and no mention of leakage rate measurement test.

The following changes have been made in response

1. A definition has been added for the time between close-open operations “ t_a ” (IEC includes the definition is in the mechanical endurance test section).
2. Added item f) that allows subsequent tests at lower temperature. The graph has been changed to reflect this.
3. General wording improvements.
4. Added the leakage rate measurement test as an alternative to measurement of the initial and final density/pressure. Also, it has been added after the stabilization period at the target low temperature. I have added the requirements for measuring the temperature in the vicinity of the breaker during the test.

The following deviations remain from IEC:

- a. Only one soak period of 24 hours, instead of two (one open, one closed).

- b. IEC has an introductory section to the test which: excludes vacuum breakers from the leakage measurement requirement (except if vacuum interrupters housed in an SF6 tank), excludes -5°C indoor and -10°C outdoor breakers (which do not exist in IEEE), allows for reduced phase spacing/bushing length/modules if there are space restrictions in the lab, allows for proof of the test with “similar designs” and allows for field demonstration of performance.

A proposal was submitted by Sushil Shinde which will be discussed with Victor Hermosillo of the draft.

Xi Zhu asked Sushil Shinde and Victor Hermosillo to work together on this topic.

Gilbert Carmona 2 – Topic Grouping of Tests responded by Gilbert Carmona & Victor Hermosillo (Doc 091)

Discussed contents of IEC 62271-1 or IEEE C37.100.1.

David Stone is a member of both committees and there are changes that have been approved. Limitation of four tests objects are going to be eliminated. The test requirements are increasing. Also if there is a small design change, Grouping table is going to be kept as a guide or example to guide manufacturers during test programs, but the number of test objects now is not limited to four.

Chairman asked Gilbert Carmona to find a location for this grouping of test reference.

Ken Edwards: Guidance is needed for users to verify if the test object is the same and that there have been no significant changes. How can it be verified?

Sushil Shinde and JohnWebb type tests include the drawing number and revision of parts in the test object.

Conclusion: Guidance to group test samples in five groups can be recommended, but will NOT be a mandatory requirement. Gilbert Carmona to provide the proposed writing to Xi Zhu.

Anne Bosma 6 – John Webb & Xi Zhu (Doc 092) (Xi suggests removal or revise first sentence in item e)

Dielectric tests

David Stone C37.100.1 only common clauses, so does not include chopped wave. There is an issue with sequence to be used for this test. For wet test they have homologated with IEC on common value for wet test and 1 minute duration AC withstand. There is no SIL wet requirement. Significant parameters are: rain rate, water conductivity, duration.

John Webb said he might not have reviewed the most recent C37.100.1 document and agreed to review the most recent document once more and come back to WG with his recommendations.

WG agreed to remove the first sentence in item e) as Xi Zhu proposed.

11.) The working group committee agreed to adjourn the session. Work will resume after lunch

Session 2 – September 21, 2015 (1:30 PM to 3:15 PM)

Location: San Diego, CA
Participants: 36 members
35 guests

1.) The meeting started with the chair introduction and introductions of the attendees. The chair asked all attendees to sign the roster and provide affiliation if not noted on the roster.

2.) A short review was presented by the Chairman of the topic discussed during the morning session.

3.) The chairman said they will continue with selected comments where the working group left off before lunch:

Three comments to cover in the afternoon session.

- Roy Alexander 4 ~ 11 - by Roy Alexander (Doc 093)
- Dave Stone: Move Close & Latch and Short Time Current tests (Clauses 4.8.4.1 and 4.8.4.2) to a level 2 Clause 4.x --- TBD
- Stephen Cary: to include validation of 50Hz test for 60Hz on continuous current test. --- TBD. See text modified by Xi.

Roy Alexander 4-11 - Capacitive switching

Roy Alexander summarized his comments. After the TRV in a capacitive switching test (latter stages of the TRV the DC voltage has to be maintained after TRV peak for a period of 300 ms. The standard allows for an optional application of AC-DC voltage to test the condition if the lab cannot synthesize the complete transient. This is not an adequate alternative.

Kirk Smith made a comment based on his practical experience in test laboratories. He stated that it is not an option to switch in another voltage source within 16.6 ms in a laboratory. The reason for the sustained voltage is check for delayed restrikes.

Denis Dufournet mentioned that the IEC testing specification, section 6.100.11 is currently under revision. There are two test duties #1 and #2 tested for capacitive switching. The first test duty (for example LC1-CC1) may not meet the requirement, but the laboratory can demonstrate the latter stage of the TRV during the second duty LC2-CC2. This criteria is in drafting by the IEC working group.

Conclusion: Roy Alexander, Kirk Smith and Denis Dufournet agreed to work together and send a proposal to Chairman.

David Stone: Move Close & Latch and Short Time Current tests (Clauses 4.8.4.1 and 4.8.4.2) to a level 2 Clause 4.x --- TBD

Move close & latch and short-time & peak-withstand current test to level 2 of Clause 2.X from 4.9.5.2 and 4.9.5.3. Currently these test duties are buried in 4.9 under short-circuit interrupting tests.

D. Stone commented that C37.100.1 does not have interruption tests, so the list of tests is longer in C37.09 for this reason.

Siemens proposal to make “close & latch” test part of interrupting test duty.

Xi Zhu, IEEE states that this test can be performed separately if it is not performed together with the fault interruption tests.

Conclusion: No changes will be made. The move may happen later as C37.100.1 matures.

Stephen Cary: to include validation of 50Hz test of 60Hz on continuous current test. --- TBD. See text modified by Xi.

Stephen Cary submitted a proposal for validation of 50Hz test with 60Hz continuous current test.

4.4.1 Test Conditions

Item g) if 50 Hz test within 95% of limit then valid for 60 Hz.

Steve Cary, KEMA source for comparison between tests at 50 and 60 Hz. Also it is included in C37.100.1. Will remove recommendation if not justification is found.

Mike Wactor since 60 Hz is worst case than 50 Hz for continuous current test then a test at 60Hz justifies a 50 Hz application. I would need to see evidence supporting 95%. Would never pass with a third party justification. I would vote against this change. Need justification.

Amir Khosravi - Can we find what justifies 95%.

Mauricio Aristizabal. Standards specify 95% rule only open type switchgear according to 62271-306 section 5.3. It is not a universal criterion.

Conclusion: Steve Cary to present justification. If not sufficient, then proposal to be dropped.

Areas of Improvement

The chairman presented several items that need improvement after having read the entire document. When C37.09 is read entirely there are a lot of areas for improvement.

Xi Zhu gave a few examples for improvement below before proceeding to detail discussions:

- Missing 'Test after delivery' in C37.09
- Move Clause 7 to Annex
- Change all C37.06 to C37.04??
- Check if all Normative references are cited in text
- Check all references to Figures, Tables, Clauses are correct
- M1, M2 testing is missing
- Capacitance current switching changes (Denis Dufornet, Doc 097)
-many more, let's review D2.2..

Proceed to review of Draft 2.2 for improvements.

Xi Zhu reviewed the entire document of D2.2 and found dozens of areas that may need to be changed. He has identified each finding by numerical numbers. Some of the items were brought up to this meeting and discussed with the group. The remaining items will be reviewed and commented by the group after the meeting. This markup document is sent to the group after this meeting.

The item # shown below is the number Xi Zhu used in his markup version in D2.2.

Item 2 (refer to Xi Zhu's markup version of D2.2). Design tests are type tests in IEC.

Remove the texts in parenthesis and add a note to explain the terminology used in IEC standards.

Item 3 - Tests after delivery

There are four types of tests in the scope:

- Type tests
- Production tests
- Conformance tests
- Test after delivery

However, Test after delivery is not addressed in anywhere of this document. Do we define these or do we remove them?

Gil Carmona Commissioning test should be included in the instruction book.

Carl Shultz - Is there a standard for installation and operation of circuit breakers?

Devki Sharma: There is standard for field tests in the substation committee. GIS committee is covering commissioning testing guide. It will include guide for site tests specific for circuit breakers. Proposal is to coordinate with this committee to have something similar.

Sushil Shinde. Why not include field tests? The application guide is in the same situation. The users are performing test, perhaps they can list them. These tests are part of the recommendations by manufacturers in the instruction book. This is of interest to the user.

Amir Khosravi - Our utility always perform certain tests after delivery.

Test after delivery from OEM in medium voltage are done after the equipment is installed.

Resolution provided by chairman: Leave list as it is and state that it is out of the scope of this standard.

Item 4 - References

Need volunteers to review all referenced standards and check if they are used in the document. If they are not cited then they will be moved to the bibliography.

Carl Shultz and Terry Woodyard volunteered to perform this task.

Item 5 - Definitions

Check if all of the terms are adequately defined. If not this C37.09 standard should define. C37.100.

Devki Sharma - The medium voltage groups have created their own document that includes all definitions.

Tom Mulcahy - Study group is looking at creating a specific document for definitions. Alternatively request the medium voltage group to add HV definitions.

Mauricio Aristizabal is leading a study group that will look into this with the purpose of not having repetition.

Roy Alexander: Must keep definitions in this standard until the new document is ready.

Gilbert Carmona C37.100 is going away.

Chairman: Definitions should be kept in C37.09 for now.

Item 7 - Topic: S1/S2 versus indoor/outdoor

Incorrect replacement of S1=indoor, S2=outdoor done previously per Ted Olsen's comment No.78 (Refer to Doc 079), Revision is needed.

Denis Dufournet: There are sections in which what matters is indoor/outdoor use. Do not include S1/S2 because it becomes confusing. Denis to review the entire document and revise as deemed appropriate,

Item 8 - 4.5.2 Test Conditions

“e) Correction factors should not be used in power frequency dry tests”. This seems incorrect.

Internal insulation, external insulation is the right differentiation for applying or not correction factors.

The first sentence is to be deleted.

Chairman: Gilbert Carmona to make correction.

Item 9 - Page 16, item (m) “wet power frequency test are only applicable to breakers above 362 kV.

Chairman will remove sentence.

Item 10 - Page row 624 (p) test values should be at least the rated value. No negative tolerance is permitted.

Sushil Shinde: Confusing if the correction involves going higher than value (900 kV corrected to 925 kV) should you consider this is OK for 925 kV. The tolerance value is only for the value targeted value. If corrected 890 kV then you are allowed to test 890 kV or higher.

Mauricio Aristizabal There is no negative tolerance. Correction gives you the nominal value. Test must be this value or higher.

Stan Billings. You still have to meet the rated value of, for example, 900 kV for the internal insulation.

David Stone. There are a lot of tolerances in this standard that are different from the others. Tolerances are everywhere in the standards which is difficult to follow. Put these in only one place so user or lab can see that they are different from standard clauses. Committee should have time to look at all tolerances. C37.100.1 already has a table. It is not a large job.

Gilbert Carmona. Why do not use IEC. Need to go through every single item and check.

Hua Ying Liu SCE volunteers to check tolerance and prepare summary table.

Kirk Smith: There are nine places in the standard in which “tolerance” is mentioned. Need to check plus/minus symbols also.

Xi Zhu: It should clarify this is only for external insulation. It should state “corrected value” instead of “rated” value. This gives you a limit on which tolerance should be made. Needs to be clarified further. Table to be prepared by Hua Ying Liu and then submitted.

Item 11- Row 642

Atmospheric paths states “dry power frequency test”

Proposal to state “dielectric test”.

Chairman If a corrected value is used then 900 kV corrected down to 890 kV is not testing the internal. If no objection he will change.

Item 12 - Row 677 Waveform modification allowance by test objects.

Proposal by chairman: “if capacitance and/or resistance alter the shape the closest obtainable shape should be used subject to agreement between manufacturer and user.” This is related to waveform requirements. Example 1.2/50 us waveform cannot be obtained.

Standard 4 addresses distortion of waveform.

Chairman: No disagreement, agreed then.

Item 13 - Line 711-712

Change in polarity

“80% of magnitude when change polarity” does not agree with previous sentence stating 50%.

Proposal: “Make it consistent at 50%” Delete it and then use only one reference to this requirement.

Amir Khosravi - Proposes to make it consistent.

Item 14 - Line 727 Reference to C37.06 should it be kept or replace it by C37.04.

C37.04 should be completed first.

Previous experience discussed regarding footnote that was removed before final draft was published.

Perform correction with automatic replacement.

David Stone recommends to change all to C37.04 and then change back if necessary.

Resolution: Change to C37.04 and add a footnote, stating that at the time of publication there is a revision of C37.04 to integrate C37.06. If C37.04 is not updated then refer to both C37.04 and C37.06.

Item 15 - Check entire document for correctness of all references to Figures, Tables and Clauses since there are many changes to them and update in the references in the text need to be verified.

Volunteers: Carl Shultz and Wei Zhang.

Item 16 - 4.5.8.3 Delete Atmospheric correction factor.

Text incorrect. Delete it.

Item 17 - symbol $d\alpha$ in formula is not defined.

Denis Dufournet needs to check and define if missing

Item 18 - Line 928 Graphs in color

Reference in the text body refers to a 'blue' trace on the waveform. Will there be any problem if the colors are lost in print.

Denis Dufournet: Same figures in IEC will be in color.

Resolution: keep graphs in color, they are easier to follow.

Item 21 - Line 1060

Increase severity of TRV. Why 60 Hz current pulse. This injection current is at a much higher frequency.

Kirk Smith. This is a way to check the intrinsic TRV with a low current injection to confirm inherent characteristics. This is OK.

Conclusion: 60Hz in text is correct. No changes will be made.

Item 22 - Line 1071

Reference to the 'have substantial amounts of shunt impedance specifically intended to' to be replaced by 'are designed to' to avoid the impression that it is the high impedance that modifies the TRV.

Resolution: can be modified.

Time runs out. Chairman will send comments to all members and guests. Please send back comments. Comment by exception.

Devki Sharma made a comment that there is no cantilever test of the bushings.

4.) The working group committee agreed to adjourn the session. Sushil Shinde suggested replacing his meeting for C37.06.1 with a 3rd meeting session for C37.09. The WG agreed to this idea and will work with then main committee to change the schedule.

Session 3 – September 23, 2015 (8:00 am to 10:00 am)

Location: San Diego, CA

Participants: 29 members

24 guests

1.) The meeting started with the chair introduction and introductions of the attendees. The chair asked all attendees to sign the roster and provide affiliation if not noted on the roster.

2.) A short review was presented by the Chairman of the topic from previous sessions.

Cover areas for improvement in D2.2

Coordination with C37.04: timing, what actions if amendment to this standard

Important dates in the next few months

Chairman gave background for additional session.

Central desk is the tool to manage all documents.

Members or guests received an invitation to join central desk.

If invitation was not received or if invitation has to be resent then please let chairman know.

Chairman proceeded to show the central desk website. At this time 97 documents, you can download. Also included are standards that are associated for reference, includes corrigenda, errata, etc.

The central desk website is located at: <https://iee-sa.centraldesktop.com/login>

Instructions to access can be requested to the Chair (Xi Zhu) at: xi.zhu@ieee.org.

The member or guests asking for access must first request permission from the chair via e-mail. A link will then be sent along with instructions to access the website for central desktop.

We have ~40 members showing up per meeting. List has 60 members, some retired, and some have outdated e-mail.

Ken Edwards: P&P has rules to maintain membership. Take action accordingly for inactive members.

Chairman proposal is to use latest version of C37.04 and then if there are further changes they can be addressed by an amendment to C37.09.

Denis Dufournet: Consider also coordination with C37.06.1.

3.) The chairman said they will continue with selected comments where the working group left off on 9-21-15 since the WG did not cover the entire topic.

Comment discussion. There are still ten of them that are significant and can be covered in this meeting. The rest will collect comments through email.

Item 28 - 4.9.4.1 E value in test duty Table 3.

The existing text about how to determine E value is incorrect any more since it assumes certain Kpp value by voltage class. But actually, in existing C37.06, one voltage class could have two different Kpp values. Therefore, the text needs to be revised.

Existing text: E is used for TRV peak. E=0.87 for 100 kV or below, E=0.75 for above 100 kV.

John Webb: Where is the guidance to select kpp?

Denis Dufournet: kpp is a rated value, it will be in nameplate. User specifies depending on their network, manufacturer develops and offers product and indicates kpp.

Conclusion: agreed to change to $E = Kpp \cdot V / \sqrt{3}$.

Item 29 - 4.9.4.3 Test duty T100s

Still discusses 1-cosine shape for TRV, should be revised.

Item 30 - 4.9.4.4 Test duty T100a

The existing test procedure is for old test method. It should be modified to be in line with the new procedure defined by Table 1 and 2 and clauses 4.9.2.4. 2.2 and 4.9.2.4.3.2.

Item 31 - 4.9.4.5 Single phase fault test duties T100s and T100a

Not written very well. Should clearly define options of testing three-phase or single-phase.

Denis Dufournet: There is a plan in IEC to reflect coverage of test with single-phase test. Proposed to keep only the last sentence.

Chairman to work with Denis Dufournet.

Item 33 - 4.9.5.4.3 Condition check after meeting service capability tests

Denis Dufournet IEC has 5 shots of both polarities for impulse voltage condition check.

Conclusion: Add more details on polarity and test sequence. No correction factor.

4.9.6.6 Condition of circuit breaker after test.

Resistance should be less than 200%, issue is that this is associated with 10°C additional temperature rise. There is no basis for the relationship between this resistance increase and the temperature increase.

John Webb - This is equivalent to increasing the temperature by 10-15°C. This is end of life condition. What is relevant is if at end of life you are avoiding a catastrophic condition. 20uohm in bottle, can go to 40 uohm after test, total resistance is about 80 uohm.

Steve Cary - In vacuum when you are closed you have one spot welded. The resistance after test can become high.

In HV, a 2000 Amp breaker has an approximate terminal to terminal resistance of ~200 uohm and a 3000 Amp breaker of about 100 uohm. Increasing the resistance to 200% is likely to exceed the temperature rise by more than 10°C. So the statement in the original text is problematic.

John Webb to help Xi in rewording

Item 37 - Capacitive switching.

Denis Dufournet for three phase line/cable changing test. There are two test duties TD1 has 24 opening operations, requirement of 6 with min arcing time at one polarity and 6 at the opposite polarity. Sometimes it is difficult to control the contact part time to meet these requirements. Then, additional shots are required up to a limit of 36 shots. This limits the number of shots necessary. This is more common for medium voltage breakers. This has been included in latest draft of IEC. My proposal is to include this sentence.

Xi Zhu in case of difficulties at the lab during testing. Denis to work on this item for cap switching and then submit proposal.

Minimum arcing time has a tolerance of 0.5 ms.

Roy Alexander does not agree that it is a good test if not close to 1.0 ms of minimum arcing time. This could be C1 performance but not C2 class.

Kresimir Starcevic - The lab makes the best effort to hit the minimum arcing time, but breakers are not precise in their timing, so a test at minimum arcing time may end up demonstrating maximum arcing time.

Ken Edwards. It is a question of time and money. The lab is required to target the minimum arcing time.

Proposal to have a lower limit for the number of demonstrations at minimum arcing time proposed by Chairman. Agreed by Mike Crawford.

Denis Dufournet. If harmonization is the goal, the wording for 36 shots max has passed CD2 in IEC.

John Webb. Another option is to open up tolerance, for example within 1.0 ms of minimum arcing time. Coordinate with C37.100.2.

Roy Alexander and John Webb will look into this and come up with a proposal.

Item 39 - 4.14 Mechanical endurance test

M1 and M2 mechanical test

Proposal to include procedure from IEC for mechanical endurance test.

To be led by Dan Schiffbauer with assistance from Mauricio Aristizabal, Sushil Shinde. Coordinate with Victor Hermosillo for low temperature test.
(John Webb after meeting said that he would help with the group as well)

Item 39a - Remove clause d of 4.14.1 test conditions. Line 2478.

Item 27 - E2 is being introduced into C37.04. C37.09 needs a test procedure.

There are differences in the treatment of E2 for medium or high voltage breakers. For HV breakers there is a complete technical report. There is no comparison of

Jan Weisker and John Webb to work on E2.

Item 39b - 4.17.2 Pressurized components line 2578

Sushil Shinde referral to ASME Pressure vessel code for tank, the second one is the bushing C37.017. I want to clarify that the cantilever test is only for bushing. The interpretation should be that this test is only for the bushing and not for the tank.

Should this be improved?

Sushil Shinde to propose improvements. Item 39B.

Ben Bufi HVB should there be a requirement for pressure relief devices?
This is already covered in ASME code.

Gilbert Carmona we do not refer to ASME code.

Roy Alexander this has been used for many years, applicable for non-fired pressure vessels.

Conclusion: Sushil will review Clause 4.17.2 to see if additional wording is needed for clarification.

Item 41 - 4.20 RIV tests line 2666

John Webb to read and, if necessary, propose improvements.

Item 42 - 4.21 Noise sound level test

NEMA requirement for SG4.

Reference could be 62271-37-082 (2012) from IEC.

John Webb to check if C37.100.1 has this requirement. No time to work on this, will only provide opinion. There is no reference in this standard to sound level values.

Item 44 - Move clause 7 to the appendix

Agreed it is out of proper place. Move to Annex.

Item 47 - Annex C

Denis Dufournet has prepared text, provided examples and graphs. To help the reader, refer back to the Tables 1 and 2 by stating values obtained in example and referring back to values in the table.

Denis Dufournet comments: the content had the purpose of proposing the background for this procedure and to demonstrate that it appropriate for demonstrating interrupting capability during T100a test.

Chairman asked to assign of Proof Reading Tasks to Members. If you are a member the expectation is that you read the standard. A list will be prepared with reviewers and clauses that will be covered by each.

Chairman will send D2.3 and template for feedback.

Volunteers are requested.

<u>Reviewer Name</u>	<u>Clause to Review by 10-12-2015</u>
John Webb	4.7, 4.9, 4.10, 4.20
Roy Alexander	4.11
Carl Schuetz	4.5, 4.6, Normative reference
Dan Schiffbauer	4.14
Michael Christian	4.14 (after Dan S. submits new proposal), 4.15, 4.16, 4.23
Mike Crawford	4.3, 4.4, 4.12
John Eastman	4.21

Will (Wei Zhang)	4.13
Hua Liu	4.13 (out of phase)
Dan Schiffbauer	4.17
Vernon Toups	4.19, 4.22, all section 6 and 7
Sushil Shinde	4.19
Jan W (Siemens)	4.8-4.13
Stan Billing	All Section 5 (agreed to after session #2)
Humayun Tariq	All section 5 (asked after meeting)
Todd Irwin	All section 5
Neil Hutchins	Annex A
John Webb	Annex B
James Van de Ligt	Review Entire document – asked after session #2
Xi Zhu	Annex C
Mike Skidmore	Annex D
Wei Zhang	Bibliography

What about definitions?

Wei Zhang and Xi Zhu to check definitions if C37.100

Dates to remember

Two weeks to send comments on draft 2.2 for Xi Zhu's comments that were not discussed in the meeting. There are about 20 comments that were not discussed.

All assignments should be in by October 30th (Friday).
Then preparation for ballot.

Invitation to ballot.

Mandatory ballot coordination. 4 weeks.
Can run at same time as invitation to ballot (4 weeks)

Initial ballot 45 days.
Public comment (IEEE takes care).

Proposal to send ballot invitation while it is going through coordination. Perhaps we will need three re-circulations.

Total 3.5 months. Perhaps finish by end of March, 2016.

5.) The working group committee agreed to adjourn the session

Meeting Roster for Session #1, #2, and #3 – San Diego, CA

First Name	Last Name	Company	Role	9/21/2015	9/21/2015	9/23/2015
Mauricio	Aristizabal	ABB	Member	X	X	X
Syed Shahab Uddin	Ahmed	Siemens Energy Inc	Guest			
Roy	Alexander	RWA Engineering	Member	X	X	X
Aasim	Atiq	Siemens Energy	Guest	X	X	X
Roy	Ayers	Nashville Electric Service	Guest			
Katrin	Baeuml	Schneider Electric	Guest			
William	Bane	Nashville Electric Service	Guest			
Amildo	Barrio	Parsons	Guest			
Jerry	Baskin	Federal Pacific	Guest			
George	Becker	Electric Power Research Institute	Guest			
Jean-Marc	Biasse	Schneider Electric	Guest		X	
Stan	Billings	Mitsubishi Electric PP	Member	X	X	X
Anne	Bosma	ABB AB	Member			
Cody	Brehm		Guest			
Jeffrey	Brogdon	Georgia Transmission	Guest			
Steven	Brown	Allen & Hoshall	Guest			
Raymond	Browning	FirstEnergy Corp.	Guest	X	X	X
John	Brunke	Dr. John H. Brunke, P.E.	Guest	X	X	
Arben	Bufi	Hitachi HVB, Inc.	Member	X	X	X
Eldridge	Byron	Schneider Electric	Member	X	X	
Donald	Cantrelle	Georgia Power	Guest	X	X	X
Gilbert	Carmona	Southern California Edison	Member	X	X	X
Stephen	Cary	GE Energy Management	Member	X		
Steven	Chen	Eaton Corporation	Member	X	X	X
Wayne	Cheng	B C Hydro	Member			
Vincent	Chiodo	HICO	Guest	X	X	
Jeonghwan	Cho	HICO America	Guest			
Chih	Chow	PEPCO	Member	X	X	X
Michael	Christian	ABB	Guest	X	X	X
Roggero	Ciofani	Altalink	Guest			
Lucas	Collette	Mitsubishi Electric	Member	X	X	
Dave	Collette	Mitsubishi Electric	Guest			
Lee	Cox, Jr.	Efacec	Guest			
Andrew	Crane	Consumers Energy	Guest			
Michael	Crawford	Mitsubishi Electric	Member	X	X	X
Jason	Cunningham	Hitachi HVB, Inc.	Guest		X	X

David	Dart	NOJAPower	Guest			
Jerod	Day	Vacuum Interrupters, Inc.	Guest			
Patrick	Di Lillo	Consolidated Edison Co. of NY, Inc.	Member	X	X	X
Denis	Dufournet	Retired	Member	X	X	X
Bernie	Dwyer	PECO	Guest			
John	Eastman	INCON	Guest	X	X	X
Doug	Edwards	Siemens Industry, Inc.	Guest			
Ken	Edwards	Bonneville Power Administration	Member	X	X	X
Tanner	Esco	Eaton Corporation	Guest			
Leslie	Falkingham	Vacuum Interrupters Limited	Member			
Thomas	Field	Engergy	Member			
Sergio	Flores	Schneider Electric Inc. USA	Guest	X	X	
Robert	Foster	Megger	Guest	X	X	X
Paul	Fox	Schneider Electric	Guest			
Didier	Fulchiron	Schneider-Electric	Guest			
Sivakumar	Ganesh	ENMAX Corporation	Member			
Douglas	Giraud	Powell Electrical Systems	Member			
Anne	Good	Netshape Technologies, Inc.	Guest			X
Paul	Grein	Circuit Breaker Sales, Co, Inc, - GroupCBS	Member			
John	Hall	Tennessee Valley Authority	Guest			X
Jeffrey	Hanson	Schneider Electric	Guest			
Helmut	Heiermeier	ABB	Member	X	X	X
Charles	Hendrickson	Arizona Public Service Company	Guest		X	
Jeremy	Hensberger	Mitsubishi Electric Power Products Inc.	Guest	X	X	
Victor	Hermosillo	Alstom Grid	Vice- Chair	X	X	X
Jingxuan (Joanne)	Hu	RBJ Engineering Corporation	Member			
Roy	Hutchins	Southern Company Services	Member	X	X	X
Todd	Irwin	Alstom Grid Inc	Member	X	X	X
Carlos	Isaac	Oncor Electric Delivery	Guest			
Anton	Janssen	Liander	Guest			
Joseph	Jasinski	ITC Holdings Corp.	Guest	X	X	X
Jacob	Joseph	Toshiba International Corporation	Member			
Wolfgang	Jung	Siemens AG	Guest			
Mangu	Kang	HICO America	Guest			
Jayamali	Kasige	Crown Technical Systems	Guest			
Amir	Khosravi	BC Hydro	Guest	X		
Sandeep	Kulkarni	CG	Guest			
Carl	Kurinko	ABB Inc.	Guest			
Stephen	Lambert	Shawnee Power Consulting, LLC	Guest			
Carl	LaPlace	GE Industrial Solutions	Guest	X		
Matthew	Lawrence	Doble Engineering	Guest			
HaeKyu	Lee	HICO America	Member	X		

David	Lemmerman	PECO/Exelon	Guest			
Werner	Lesse	Siemens AG	Guest			
Paul	Leufkens	KEMA-Powertest	Guest			X
Wangpei	Li	Eaton	Guest			
Qian	Li	Powertech Labs INC.	Guest			
Hua Ying	Liu	Southern California Edison	Member	X	X	X
Li	Liu	Eaton	Member			
Albert	Livshitz	CE Power Solutions	Member		X	
Bjorn	Lofgren	Siemens Energy	Guest			
Russell	Long	Retired	Member			
Antonio	Mannarino	PSE&G	Guest	X	X	X
Vincent	Marshall	Southern Company Services	Guest	X	X	X
Gary	Martin	Entergy	Member			
Ricardo	Martinez	CFE-LAPEM	Member	X	X	X
Peter	Marzec	S&C Electric Co.	Guest	X	X	
Joel	Mathewson	Siemens	Guest	X		X
Neil	McCord	Southern States	Guest	X	X	
Timothy	McGee	Siemens Energy	Guest			
Dave	Mitchell	Dominion	Guest	X	X	
Terry	Monahan	Schneider Electric	Guest			
Oscar	Montano	Salt River Project	Guest	X	X	X
Tom	Mulcahy	Dominion Virginia Power	Guest	X	X	
Volney	Naranjo	Megger	Guest			
Jeffrey	Nelson	Tennessee Valley Authority	Member			
Joachim	Oemisch	Siemens AG	Guest			
Ted	Olsen	Siemens Industry, Inc.	Guest			
Miklos	Orosz	Schneider Electric	Member	X	X	
Molson	Parvin	CB&I	Guest			
Amit	Patel	GE	Guest			
Shawn	Patterson	US Bureau of Reclamation	Guest			
Thomas	Pellerito	DTE Energy	Member	X	X	X
Alan	Peterson	Utility Service Corporation	Guest	X		
Lise	Phan	Parcific Gas and Electric Company	Member			
Iulian	Profir	Rockwell Automation	Member	X	X	X
Ahmad	Qasem	Bechtel	Guest	X		
Syed	Rahman	The United Illuminating Company	Member			
Samala Santosh	Reddy	Powell Industries	Guest	X	X	
Frank	Ricard	FirstPower Group LLC	Member			
Anthony	Ricciuti	Eaton Corporation	Member	X	X	X
Dave	Riffe	Westinghouse Electric Company	Guest	X	X	
Julian	Rizo	Xcel Energy	Guest	X		
Brian	Roberts	Southern States, LLC	Guest	X	X	
Jon	Rogers	Siemens Energy, Inc	Member			
Ben	Rosenkrans	Eaton Corporation	Guest			

Roderick	Sauls	Southern Company Services	Member	X	X	X
Victor	Savulyak	DNV GL KEMA Laboratory	Guest			
Robert	Sazanowicz	The United Illuminating Company	Guest			
Daniel	Schiffbauer	Toshiba International Corporation	Guest	X	X	X
Carl	Schneider	Schneider Electric	Guest			
Carl	Schuetz	American Transmission Company (ATC)	Member	X	X	X
Jon	Schumann	American Transmission Company	Member	X	X	
Devki	Sharma	Consultant	Member		X	
Harish	Sharma	Southern Company	Guest			X
Sushil	Shinde	ABB Inc.	Member	X	X	X
John	Shullaw	Retired -GE	Guest			
Dean	Sigmon	Eaton Corporation	Member	X		X
Sunita	Singh	Bechtel OG&C	Guest			
Michael	Skidmore	AEP	Secretary	X	X	X
Robert	Smith	Eaton Corporation	Member	X	X	
Hongbiao	Song	GE	Guest			
Erin	Spiewak	IEEE	Guest	X	X	X
Kresimir	Starcevic	DNV GL KEMA Laboratories	Guest	X		X
Don	Steigerwalt	Duke Energy	Guest	X		X
David	Stone	DTS Technical Services	Guest	X	X	
Donald	Swing	Powell Industries	Member			
Dragan	Tabakovic	Hitachi HVB	Guest			
Humayun	Tariq	American Electric Power	Member	X	X	X
Jean-Marc	Torres	EATON	Guest			
Vernon	Toups	Siemens	Member		X	X
Richard	Trussler	Schneider Electric	Guest			
James	van de Ligt	CANA High Voltage Ltd.	Member		X	
Michael	Wactor	Powell Industries, Inc	Guest		X	
Wes	Wadsworth	Hitachi HVB, Inc.	Member			
John	Webb	ABB	Member	X		X
Casey	Weeks	Siemens Energy	Guest	X	X	X
Jan	Weisker	Siemens AG	Guest	X	X	X
Jerry	Wen	BC Hydro	Guest			
William	Wilkie	Eaton	Guest	X	X	
Matthew	Williford	Schneider Electric	Guest		X	
Terry	Woodyard	Siemens Industry Inc.	Member		X	
Lisa	Yacone	IEEE-SA	Guest			
Larry	Yonce	Eaton Corporation	Guest		X	
Dong Sun	Yoon	HICO America	Guest			
Richard	York	Mitsubishi Electric Power Products, Inc.	Guest	X	X	X
Jiong	Zhang	MEPPI	Member			
Wei	Zhang	Hitachi HVB, Inc.	Guest	X	X	X
Xi	Zhu	GE Energy Management	Chair	X	X	X

“X” - individual was at the meeting in San Diego