7.2 Performance Characteristics Subcommittee

7.2.1 Introduction/Attendance

The Performance Characteristics Subcommittee (PCS) met at 11:00 A.M. on Wednesday, March 19,2003 with 76 members and 53 guests in attendance. 16 of those guests requested membership in PCS.

7.2.2 Approval of Meeting Minutes

The minutes of the October 23, 2002, PCS Meeting in Oklahoma City, Oklahoma were approved as written.

7.2.3 Chairman's Remarks

7.2.3.1 Administrative Subcommittee Notes

1) Next meeting dates and locations are as follows:
   Fall 2003: October 5 –9, Pittsburgh, PA,
   Spring 2004: March 7 – 11, San Diego, Ca,
   Fall 2004 is Oct 17 – 21 in Edinburg, Scotland.

2) The Administrative committee is encouraging WG and TF Chairmen to make use of the Fast Track Electronic tool available to IEEE Standards members in the development of their Standards documents.

3) This year's IEEE PES meeting will be held in Toronto, Canada, during the period from July 13–18. The next meeting will be held in Denver, Colorado, from June 6–12, 2004. The next T&D Conference/Exhibition will be held in Dallas in September 2003.

4) In some cases, when an older Standard in a paper-form was sent to IEEE for reaffirmation, IEEE scanning of the document resulted in significant errors as the scanner did not identify tables and equations properly. WG chairmen will need towatch out for such errors. In the meantime, IEEE claims that their scanning equipment has improved significantly. Less number of errors should result. Also, electronically submitted documents can have similar errors due to differences in e-mail systems. A solution to this is sending the document in a PDF form.

5) If a member of a TF, WG, or SC is asked to provide input to a document, it is requested that if this member could not provide the input in time that at least he, or she, should respond indicating when the input will be ready.

6) Decision was made to use vice-chairs rather than co-chairs if there is a need for one.

7) Special awards are being considered for special contributions by members of TF, WG, SC towards new / revised Standards.

8) Minutes of this meeting should be sent to Don Fallon before May 9, 2003.

Note: Individuals who wish to receive invitations to ballots on IEEE Standards have the responsibility to make sure their correct e-mail address is on file with IEEE. Status can

be checked on the following website, or adjacent related websites:
http://standards.ieee.org/db/balloting/ballotform.html

7.2.3.2 Membership

16 new members asked for membership and were added to the PCS Roster:

Robert Veitch, Consultant
Israel Barrientos
Richard Graham, Hipotronics
Vladimir Khalin, Kuhlman
Michael Mitelman, Consultant
Paul Pillitteri, Trans Consulting
Min Jea Lee, HICO
Wayne Hansen, Parsons Bringkerhoff
Bertran Poulin, ABB Varennes
Tom Lundquist, SRP
Jim McBride, JMX Services
Mark Cheatham, Duke Energy
Sanjay Patel, Smit Transformers
S. V. Kulkarri
Marnie Roussell, Entergy
Dana Basel, ABB Jeff City

The Membership roster will be reviewed, and members who have not attended any of the last 4 meetings will be contacted regarding their removal from the PCS roster; thanking them for past participation, and indicating that with renewal of participation they will be welcome to rejoin the group.

7.2.4 Agenda Changes

None

7.2.5 Working Group and Task Force Reports

7.2.5.1 PCS WG for Continuous Revision to C57.12.90 – Bruce Forsyth, Chairman; Rowland James, Secretary

The PCS WG for Continuous Revision to C57.12.90 met in Raleigh, North Carolina on March 17, 2003 at 9:30 AM. There were 31 members and 34 guests in attendance. The following 20 guests requested membership, and are welcomed into the Working Group, bringing the total membership to 113:

Yunxiang Chen, Impulse NC, Inc.
Albert Walls, Federal Pacific
Devki Sharma, Consultant
William Boettger, Consultant
Pat Dooley, Transformer Specialist
Dirk Russwurm, HV Technologies
Mark Rivers, Doble Engineering
Charles Sweetser,Doble Engineering
Richard von Gemmingen, ABB Inc.
Marcel Fortin, Consultant
Anthony Washington, Southern Co.
Robyn Taylor, Teshmont Consultants
Carlo Arpino, ComEd
Virendra Jhonsa, Conectiv
Dilip Purohit, Consultant
Harry Friduan, ELCO Industries Ltd.
Alvin Kupp, ABB, Inc.
Alan D. Peterson, Utility Svc Corp.
Hossein Rezai, Delta Star
Triomphant Ngnegueu, VA Tech-JST

After introductions, the minutes from the October 21, 2002 meeting in Oklahoma City were reviewed and accepted as written. The Agenda was then reviewed and no changes were requested.

Subhash Tuli reported on the current status of C57.12.90. Mr. Tuli announced that the most recent ballot of C57.12.90 has resulted in some negative ballots that must be addressed by this WG. The negative ballots have been forwarded to the PCS Chairman, who in turn has forwarded them to this WG Chairman.

The Chairman reported on the status of working group items. There are currently 6 open items and each of these items is on the agenda for the current meeting.

Old Business

WG Item 11, "Single-Phase Excitation Tests" was discussed at length. The current draft, which incorporates the changes recommended at the previous meeting, was reviewed. The following changes were recommended:

1. Add a note regarding the effect of frequency (50 or 60 Hz) on the single-phase excitation test results. Ramsis Girgis noted that studies have demonstrated the frequency does not influence the results significantly and other IEEE documents are under development that will provide more information on this subject. For the purpose of this document, a general note will be added stating that results of the single-phase excitation test will be essentially the same when performed at either 50 or 60 Hz.

2. Column 1, which refers to "Position" will be removed from each of the tables and a statement added under "Test Set-up" stating that the test shall be performed in the nominal tap position.

3. There was a long discussion regarding the proposed test voltage of 10 kV. Questions were raised regarding lower voltage windings that may not be suitable for 10 kV. It was recommended with general agreement that the test voltage requirement be reworded using the general format contained in Clause 10.10.3, which refers to power factor testing, with the appropriate modifications to reference the applied potential test levels. Subhash Tuli and Mark Rivers volunteered to offer the appropriate wording.

4. It was recommended that a basic schematic be provided to help clarify the test set-up. The Chairman will include a schematic in the next draft.

5. There were several concerns raised regarding the use of abbreviations and terminology that may be equipment specific. Mark Rivers, Charles Sweetser, and Steven Beckman agree to develop a generic description of the test and tables that can be used for data collection that are not equipment specific.

The Chairman will circulate a revised document for review by the WG once items 1 through 5 are completed.

The next item on the agenda was a discussion of WG Item 13, which is a proposal to revise Clause 9.5, the Zero-Phase-Sequence Impedance Test. Since time was beginning to run out, the Chairman handed out copies of the documents provided by the sponsor of the request and asked the WG members to take the documents and review them and be prepared to respond to a request for comments via email in the next several weeks.

During the final minutes of the meeting, a discussion was held regarding WG Item 15, which is a request for the addition of a statement in Clause 9.3.3.2 to clarify that Equations 4, 5, and 6, which develop the impedance values for the equivalent T-diagram

for 3-winding transformers, only apply to concentric windings. It was the consensus of the WG that the statement is not required and that the equations are valid, even for non-concentric windings, if the data used is based on actual measured impedances. It was noted that equations might yield erroneous results if the data used is based on calculations rather than tests, since it can be difficult to accurately calculate the impedances between non-concentric windings. The Chairman will inform the sponsor of the WG's decision.

The justification submitted for WG Item 15 included a recommendation to add the statement "Correct the load losses of each winding to the MVA of that particular winding and then add to obtain total load losses to obtain three winding transformer losses." There was some discussion regarding the correct way to deal with load losses on 3-winding transformers. Alexander Kline noted C57.18.10 has wording that applies to this case. Ramsis Girgis volunteered to respond to the sponsor regarding this issue.

Since time ran out the remaining items on the agenda were tabled for the next meeting.

Follow-up

During the Performance Characteristics Subcommittee meeting at the Fall 2002 meeting, a discussion took place regarding WG Item 14, which was a proposal to develop wording for a test procedure for dissolved gas-in-oil analysis. It was concluded at that time that this item does not belong to PCS and should be referred to the Insulating Fluids Subcommittee. However, during the meeting of the PCS WG for Continuous Revisions to C57.12.00 on March 17, 2003, there was a consensus that the WG for Continuous Revisions to C57.12.90 *should* develop the test procedure with input from the WG for C57.12.00 and the Insulating Fluids Subcommittee. Based on this, the Chairman will re-open WG Item 14 and make the necessary contacts with the chairman of the PCS WG for C57.12.00 and the chairman of the Insulating Fluids Subcommittee.

7.2.5.2 PCS WG for Continuous Revision to C57.12.00 - Steve Snyder, Chairman; Dennis Marlow, Secretary

The Working Group met on Monday, March 17 at 1:45 PM. There were 26 members and 43 guests in attendance. The following 4 guests requested membership, and are welcomed into the Working Group, bringing the total membership to 63 members :

Tom Harbaugh	Pennsylvania Transformer
Ron Daubert	Finley Engineering Company Inc.
Bruce Forsyth	Southwest Electric Company
Donald Cash	ADAPT

Following introductions, the minutes from the October 21,2002 Oklahoma City meeting were approved as submitted.

Subhash Tuli reported that all but 5 of the negative ballots have been resolved from the C57.12.00 ballot, which closed on August 2, 2002. After resolution of these outstanding negatives, the draft will be re-circulated before the next meeting in October.

The Working Group then began discussing the topics of old business, as follows :

WG item 40, a request to add acceptance criteria and descriptions for the various tests that were added into Table 19 of C57.12.00, 2000 revision. All but g) dissolved gasses in oil analysis, were addressed in previous meetings and documented in meeting minutes.

(g) Dissolved Gasses in Oil Analysis

"Note 14 : This test shall be a routine test for Class II power transformers and an other test for less than Class II transformers."

There are several interrelated documents under development now that address this issue. A separate report, consisting of a review of the standards and guides that pertain to DGA testing, was prepared by Steve Antosz and discussed at great length in this meeting. The working group agreed with the conclusions of the report and recommends the following:

A new note 18 will be added to table 19.

> "18—As a minimum, dissolved gasses in oil analysis shall be performed before the start of all tests (after oil filling), and after the completion of all tests."

Limits and procedures for dissolved gasses in oil analysis will be referred to the insulating fluids subcommittee and the PCS C57.12.90 working group, respectively.

WG Item 42, a request to add oil volume as a requirement for type "A" nameplates.

In Table 10 under the column for Nameplate "A", add the statement:

Oil Volume

At the autumn 2002 meeting in Oklahoma City, the Working Group discussed this request. Since distribution transformer users and manufacturers were not well represented in this meeting, it was decided to defer to the Distribution Transformers Subcommittee for their input.

The chairman of the Distribution Transformers Subcommittee has since responded, and reports that the present practice of all distribution transformer manufacturers is to include the oil volume on type "A" nameplates. Accordingly, this WG recommends that we incorporate this change in the next ballot of C57.12.00, as described above**.**

WG Item 45, identifies an editorial error with a heading in Table 5 of C57.12.00,

Dielectric insulation levels for distribution transformers and Class I power transformers

Columns 4, 5, and 6 are all listed under the heading "Front-of-wave impulse levels". Column 6 lists low frequency test levels. It is recommended that this heading for "Front of Wave" be moved to include only columns 4 and 5.

The working group agreed : (1) that this was an editorial change, and (2) to changing the headings on the table as suggested. This change will be incorporated in the re-circulation of C57.12.00.

WG Item 46, a request to add column numbers to Table 7 of C57.12.00,

Minimum phase-to-phase insulation test levels for three-phase distribution transformers and for three-phase Class I power transformers

There are no column numbers used in this table, yet clause 5.10.4.2 refers to "…Column 2 of Table 7 …". It is recommended that column numbers be added to Table 7.

The working group agreed : (1) that this was an editorial change, and (2) to add the column numbers to the table as suggested. This change will be incorporated in the re-circulation of C57.12.00.

WG Item 47, a request to change the title of Table 8 of C57.12.00,

Minimum low frequency insulation test levels at neutral for Class I power transformers

Previous editions of C57.12.00 titled this table as "Minimum Insulation Levels at Neutral". The title listed in the latest edition excludes distribution transformers. It is recommended that the title be changed to "Minimum low-frequency test levels at neutral for distribution transformers and Class I power transformers".

The Working group agreed : (1) that this was an editorial change, and (2) that the title of this table should be changed to correctly reflect it's content and purpose. The new title is

Table 8 – Minimum low-frequency insulation test levels at neutral for distribution transformers and Class I power transformers

This change will be incorporated in the re-circulation of C57.12.00.

WG Item 48, Comment received from drafts 3 and 4 ballots of C57.12.00 – 2000 requested that "Unless otherwise specified by the user," be added to the first sentence of section 7.1.1 and 7.1.4.3 of C57.12.00.

The working group did not believe this change will improve the standard, therefore no change is required.

WG Item 49, C57.12.00 Section 7.1.5.2 Asymmetrical current used for Short Circuit Calculations. Comments received from drafts 3 and 4 ballots of C57.12.00 – 2000 stated that the x/r ratio for the user's system is greatly different from the recommendations in this standard, and also differ from that used in IEEE C37.04 and IEC 56. They also do not reflect the x/r values used for radial feed systems as discussed in the IEC TC 17A and in CIGRE.

The Working Group accepted the offer of Ramsis Girgis to investigate this subject in the relevant ANSI/IEEE and IEC standards. The report will be available in 4 weeks.

WG Item 50, C57.12.00 Section 7.1.5.3 System characteristics. Comments received from drafts 3 and 4 ballots of C57.12.00 – 2000 stated that the default value of X0/X1 = 2.0 is too low (high?). The commenter stated that values of X0/X1 = 0.6 for 345 kV and above, and X0/X1=0.4 for 138 kV and below, are found to be typical on user's system.

The Working Group accepted the offer of Steve Snyder to investigate the background for the commenter's remarks, and report back to the WG at the next WG meeting.

WG Item 51, C57.12.00 Section 7.1.5.4 Present Limitations. Comments received from drafts 3 and 4 ballots of C57.12.00 – 2000 stated that the values given for the fault capacity are too high and may result in transformers being over-designed.

The Working Group discussed this and agreed that the standard should not be changed.

WG Item 52, C57.12.00 Section 9.2 Tolerances for Impedance. Comments received from drafts 3 and 4 ballots of C57.12.00 – 2000 stated that the tolerance for impedance is somewhat confusing and should be corrected. Suggestion was made to halve the tolerance for the rated tap position (i.e., ± 3.75% for two winding transformers with impedance greater than 2.5%, ± 5% for two winding transformers with impedance less than 2.5%, and ± 5% for three winding / auto transformers). Also, the commenter stated that a ± 2.5% per tap position tolerance be added for between taps.

The Working Group discussed this at some length. It was apparent that this issue will require a detailed discussion in the future. The chairman agreed to survey the PCS subcommittee and transformer manufacturers for their comments concerning this proposal, with emphasis on the practicality of manufacturing transformers today with a reduced tolerance on impedance. The results of this survey will be reported back to the WG at the next meeting .

Due to time constraints, the remaining items could not be addressed during the meeting, so the outstanding topics will be discussed at the next meeting. The meeting adjourned at 3:10 PM.

7.2.5.3 TF on DETC Functional Life Testing – Phil Hopkinson, Chairman; John Gauthier, Secretary

The De-energized Tap Changer Functional Life Test Task Force met at 9:30 a.m. on Tuesday, March 18 in Raleigh, NC. There were 24 members and 20 guests present.

The scope of this task force has been changed from developing an entire specification for de-energized tap changers to developing a functional life test to demonstrate stability over the expected 30 year transformer life.

The chairman presented a proposed test that passes 2x rated current for 8 hours in a 130°C bath with 16 hours off for a total of 30 days. The test is passed successfully if the resistance does not change by more than 25% and stability has been reached. A report has also been proposed and distributed by the chairman.

Reinhausen, Cooper Power, and ABB have volunteered to perform the test and report on the results of their evaluation at the October meeting. Sheldon Kennedy has also volunteered to co-author the report.

The meeting adjourned at 10:45 a.m.

Subsequent to the TF meeting, the chairman of the PCS asked in the SC meeting whether members agree with the present roadmap of the Guide to include only this proposed life test, provided it is confirmed and accepted by other manufacturers based on their verification tests.

7.2.5.4 Switching Transients Induced by Transformer / Breaker Interaction, PC57.142 - Robert Degeneff, Chairman; Peter Balma, Secretary

The Working Group on Switching Transients Induced by Transformer/Breaker Interaction was called to order at 8:00 AM on March 18, 2003. There were 94 attendees, 37 members, 7 requesting membership, and 50 guests. The agenda for the meeting was

reviewed, and the Minutes from the October 22, 2002, meeting in Oklahoma City, Oklahoma were approved.

1) Draft 1.4 of the guide was briefly reviewed, and an effort will be made to get it on the IEEE Transformer's Committee website. Additions to this draft included an example, breaker information, and illustrations.

2) A discussion of the impact of the capacitance on the load side of the breaker; capacitance of the transformer versus frequency; and excitation of the system by either reignition (and its repetitive rate) or chopping was revisited. Analysis of circuit behavior must consider all of these factors.

3) A two winding transformer example was added to the guide to illustrate impedance and gain versus frequency and the distribution of voltages across the winding when the resonant frequencies are applied. Review of the example generated a discussion of the importance of the damping of the circuit at resonant frequencies. The presence of a resonant frequency and source will not always result in problem situation. Additional text will be added to the guide to clarify this area.

4) The working group concluded that the snubber portion of the guide should be descriptive only, and not provide design information.

5) Another example is needed, and it appears that the working group will be able to utilize an example from the tutorial that will be presented at this meeting.

6) In the next month several volunteers from the Switchgear Committee will provide additional input for the breaker characteristic clause of the guide. After incorporation of this material, 4 volunteers from this working group (Bipin Patel, Gustav Preininger, Arthur Molden and Bill Griesacker) will provide an overall review of the guide. All comments will be included in a new draft, which will be circulated as an informal ballot of the Performance Characteristics Sub-committee. Results will be discussed at the next meeting, after which the guide will then be sent out for a formal ballot.

7) There was no old business. Under new business the question of a user's understanding of interaction problems was raised. Consensus of the group was that fairly detailed modeling of system and transformer characteristics was needed.

7.2.5.5 Loss Tolerance and Measurement - Ed teNyenhuis, Chairman; Andy Steineman, Secretary

- 17 members and 19 guests attended, with 8 guests requesting membership.

- Minutes from the Oklahoma City meeting, Oct 22, 2002, were read and approved.

- Eddy So reported on the TF meeting for "Guide of Low Power Factor Power Measurements"
  - There were 34 attendees at the meeting
  - The Guide is now being edited by the National Research Council (NRC) of Canada as an NRC guide. This should be complete by the next meeting and Eddy So will make the guide available on a website to the TF and WG at that time. He will also obtain an up to date PAR from the PSIM for the next meeting. The process to preparing the guide for ballot will then commence.

- A new project was presented which will evaluate the accuracy error in the wattmeter of Figure 17 in C57.123 (No load loss measurement for three-wattmeter method, energized winding delta-connected, grounded wye source)

- It was reported that the C57.123 Loss Measurement Guide was released by IEEE Standards in December of 2002 and members of the WG received copies

- Frequency Conversion Factors of Transformer Performance Parameters
  - Stray Loss Factor Investigation – The WG was presented FEM calculated stray loss conversion factors for units with no shielding, magnetic tank wall shielding and two types of aluminum tank wall shielding. The values ranged from 1.19 to 1.28. It was found that the distance to the tank wall did not affect the conversion factor. The WG agreed that a single conversion factor of 1.23 would suffice since the error would be a maximum of 0.5% of the total load loss.
  - New wording in C57.12.00 - The WG was presented proposed wording to be added to Note 4 of Table 19. The WG agreed to the wording with the addition of "While it is most preferred to do the measurement at the rated frequency…".
  - New wording in C57.12.90 Section 8.6 – The WG agreed to proposed wording with the following corrections:
    - "are recommended to" to be "shall"
    - "would" to be "shall"
    - 1.333 to be 1.33
    - Change the 2nd sentence to "Since the value of these conversion factors is an average value for all core materials, this would add 1% uncertainty to the accuracy of the measurement"
  - New wording in C57.12.90 Section 9.4.3 – The WG agreed to proposed wording with the following corrections:
    - "are recommended to" to be "shall"
    - "would" to be "shall"
    - Change the 2nd last sentence to "Since the value of the conversion factors is an average value for the different types of tank wall shielding, this would add 1% uncertainty to the accuracy of the measurement."
  - New Wording in C57.12.90 Section 13.3.7 – The WG agreed to proposed wording with the following corrections:
    - "are recommended to" to be "shall"
    - "would" to be "shall"
    - Change the 2nd sentence to "Since the value of the conversion factor was developed as an average value of actual measurements, this would add 2dB uncertainty to the accuracy of the measurement."
    - Add the sentence "Due to the greater uncertainty and the possibility of resonant frequencies, if the converted measured sound level with the 2dB uncertainty is not less than the guaranteed value, then verification of the sound level at site may be required."

7.2.5.6 TF on Frequency Response Test Standard/Guide – Rowland James, Chairman; Charles Sweetser, Secretary

The PCS Task Force met for the development of a guide for Frequency Response Analysis (FRA) in Raleigh, North Carolina on March 18, 2003 at 3:15 P.M. There were **46** persons in attendance, **14** members and **32** guests.

Rowland James made a brief report on the development of the draft. He reported that Mark Perkins and May Wang provided general comments on the entire draft. Additional comments and contributions were provided by Larry Coffeen, Roger Hayes, and Ernst Hanique. Larry Coffeen was unable to attend due to illness in his family. Jim McBride of JMX Services, Inc., represented Larry.

The submitted comments were discussed with the task force. The comments and concerns centered around how the various methods, sweep, impulse, and enhanced, will be combined and included in the FRA Testing Guide. General wording was discussed to ensure consistency. A brief discussion regarding termination impedance, 50 Ohms or 10 Ohms, resulted in showing that 50 Ohms was more common and accepted as a standard for network analyzer measurements. Both impedances will still be considered.

Ernst Hanique proposed that the FRA application be expanded to determine various transformer characteristics for system modeling. After a short discussion, the task force expressed interest in only pursuing FRA for diagnostic purposes only.

Ramsis Girgis requested that a new outline structure be submitted to the FRA Task Force members. Members will be assigned for contribution according to their expertise. Charles Sweetser will generate the outline.

Bertrand Poulin expressed concern for adapting a versatile data format. That format has not been determined at this point.

After some general discussion of these reports the meeting was adjourned at 4:30 P.M.

7.2.5.7 Tutorial – Design Requirement in ANSI C57.12.00 that Determines Core Excitation. Presented by Dr. Gustav Preininger

Dr. Preininger gave a basic 15-minute tutorial on what parameters affect the magnitude of core excitation when transformers are designed per requirements of Std C57.12.00. The plan is to hold a full tutorial on Utility practices of overexciting GSU and network transformers and impact of these on transformer design. The tutorial is planned for the Pittsburgh meeting with contributions from Mr. Harold Moore as well as representatives from two manufacturers and two users of large power transformers. After the tutorial, TF members identified in the Oklahoma City meeting will decide on needed modifications to the loading section of C57.12.00.

More information on this presentation can be found on transformerscommittee website.

7.2.6 Project Reports Time expired after Dr. Preininger's Tutorial presentation and the PCS meeting was adjourned at 12:15 P.M. Following are the Project Reports even though they were not presented at the meeting.

7.2.6.1 Status of C57.133 - Guide for Short Circuit Testing - Nigel McQuin, Chairman

The republication of this document continues to be denied by the IEEE editorial staff due to the quality of some of the figures. Particularly at issue is the suitability of the old traces used in the Guide. IEEE has insisted that more modern graphics be used, but this is not possible as this is just a republication of the existing document and the original traces

seem to be not available. IEEE has been publishing this document for many years now and should have the originals, but claim not to.

Nigel will make a final push to get this issue resolved and will report on the outcome at the Fall meeting in Pittsburgh.

7.2.6.2 Status of Revision of C57.110-1998 - IEEE Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents – Rick Marek, Chairman

The document is nearing the end of the reaffirmation process, and looks to be in pretty good shape. The ballot closes at the end of March 2003, and will be 99% affirmative. One negative vote is due to conversion errors, and is editorial in nature. In fact there were several editorial comments, and all are related to the problem of converting the document from .doc format to .pdf format. These will likely be resolved relatively quickly and the document ready for publication.

7.2.6.3 Status of Reaffirmation Ballot of C57.21, 1990 (R1995) - Standard Requirements, Terminology, and Test Code for Shunt Reactors Rated Over 500kVA – Peter Balma, Chairman; Richard Dudley report

An overview of the reaffirmation ballot process for C57.21 was provided during the WG meeting for Dry-Type reactors on March 17, 2003 and is reproduced here for the PCS minutes. Ballot results were as follows:

78 in eligible Ballot Group
53 Affirmative votes
5 Negative votes
2 Abstention votes
60 Votes = 76 % Returned
\- 3% Abstention
58 Votes = 91 % Affirmative

Resolution of negative ballots has been ongoing with letters and email and phone calls have been made to those that submitted negative ballots. Four balloters have withdrawn negatives, and one balloter has confirmed their negative.

Remaining negative technical comments considered switching surge levels for dry versus oil filled reactors. In response to this comment the committee reviewed and agreed by consensus that the switching impulse level for dry type shunt reactors is set based on insulation co-ordination practice and should not be a function of construction. Dry type and oil immersed shunt reactors are to be used in power systems interchangeably. Therefore, this version of C57.21 satisfactorily addresses the issue and does not require a change. The second technical comment discussed the voltage at which sound level testing should be carried out. The negative comment suggested 105% of rated voltage. The committee discussed this comment and decided that the current wording of 10.6.3.4 allows for the sound level test to be carried out at voltage levels other than rated if so specified; thus a purchaser could specify 105%.

As a next step, as required by IEEE, the ballot will be recirculated to the ballot group with the remaining negative comments.

7.2.6.4 Tutorial – Switching Transients Induced by Transformer/Breaker Interaction – Presented Mar 18, 4:45 PM by Robert Degeneff, Philip Hopkinson, & Thomas Tobin

1. Abstract

Occasionally, when a transformer is switched into or out of a system, the transient voltage produced at the terminals of the transformer may contain a high frequency oscillatory component. This oscillatory voltage is the result of the system configuration and breaker characteristics. When this voltage has a frequency component near one of the natural frequencies of the transformer, and is of sufficient magnitude and duration, damage to the internal insulation structure of the transformer may result. This is a subject of interest of both the IEEE Transformers Committee and CIGRE.

This presentation explores the internal transient voltages that maybe produced as a result of the application of oscillatory voltages to the input terminal of a transformer. These transients are typically produced by the interaction of the transformer, breaker, load, and system. This presentation defines conditions that may produce voltages adverse to the transformer insulation system. It discusses the electrical characteristics of the system source, breaker, transformer, and load and the nature of their transient interaction. It suggests mitigation techniques. Several examples are provided.

2. Learning Objectives

This presentation will discuss the characteristics of the breaker, transformer and load, and their interaction. Specific topics discussed are:

- Characteristics of switching devices including closing phenomena addressing both ideal energization and repetitive reignitions. Opening phenomena will be discussed addressing both ideal interruption, current chopping, reignitions and repetitive reignitions. Device characteristics will be presented outlining the difference between switches and breakers and the differences between various interrupter mediums.

- Impedance characteristics of transformers will be explored and compared to normal impulse voltage characteristics. An example of a two winding transformer will be used to illustrate the definitions of resonance and internal amplification.

- The dynamic interaction of a system, breaker, and transformer will be explored. The effect of system topology will be examined. Mitigation methods will be suggested. Finally, several examples will be presented.

3. Learning Outcomes

The purpose of this presentation is to provide the participant a review of the characteristics of breakers and transformers and their unique interaction to aid in their recognition of conditions and applications where transformers are subjected to oscillatory switching transients that maybe damaging to their internal insulation structure. Additionally, this presentation will discuss means to quantify their effect, and, if necessary, present methods of mitigation. Additionally, it will discuss the work presently underway by the IEEE and CIGRE.

More information on this presentation can be found on transformerscommittee website.

7.2.7 Old Business

None discussed

7.2.8 New Business

None discussed

7.2.9 Next Meeting

The next meeting is scheduled for October 8, 2003, in Pittsburgh, PA.