

**IEEE/PES
Transformers
Committee**

**Meeting Minutes
November 11, 1998**

***IEEE/PES TRANSFORMERS COMMITTEE
MEETING***

November 11, 1998

Leon, Guanajuato, Mexico

**IEEE/PES TRANSFORMERS COMMITTEE MEETING
LEON, GTO, MEXICO
NOVEMBER 11,1998
ATTENDANCE SUMMARY**

MEMBERS PRESENT

Aho, David	Arnold, Jr., Jim	Arteaga, Javier	Barker, Ron
Binder, Jr., Wally	Borst, John	Cash, Don	Cokran, Jerry
Crofts, Dan	Crouse, John	Dix, Larry	Dohnal, Dieter
Dudley, Richard	Elliott, Fred	Galloway, Dudley	Ghafourian, Ali
Girgis, Ramsis Frank	Graham, Richard	Grubb, Bob	Gryszkiewicz,
Haas, Michael	Hager, Jr., Red	Hanique, Ernst	Hanus, Ken
Harlow, Jim	Hayes, Roger	Henning, Bill	Highton, Keith
Hopkinson, Phil	James, Rowland	Jhonsa, V.G.	Johnson, Jr., Chuck
Jonnatti, Tony	Juhlin, Lars-Erik	Kelly, Joseph	Kline, Don
Lau, Mike	Lewis, Tim	Lindgren, Stan	Lowe, Don
Lundquist, Tom	Marek, Rick	Matthews, John	McShane, Patrick
McTaggart, Ross	Mehta, Sam	Molden, Art	Morehart, Gene
Mulkey, Daniel	Neimann, Carl	Orehek, Paul	Papp, Klaus
Patel, Bipin	Patterson, Jr., Wes	Payne, Paulette	Perkins, Mark
Pierce, Lin	Plaster, Leon	Platts, Don	Poulin, Bertrand
Preininger, Gustav	Prevost, Tom	Puri, Jeewan	Purohit, Dilip
Riffon, Pierre	Risse, Peter	Robbins, Chris	Ruevekamp, Henk
Sampat, Mahesh	Shertukde, Hemchandra	Sim, Jin	Singh, Prit
Smith, Jerry	Sullivan, John	Trummer, Edgar	Tuli, Subhash
Wagenaar, Loren	Ward, Barry	Watson, Joe	Weffer, Felipe
Wilks, Alan	Zhao, Peter		

MEMBERS ABSENT

Allan, Dennis	Allustiarti, Raymond	Altman, Mike	Andersen, Glenn
Anderson, Greg	Aubin, Jacques	Ayers, Don	Bancroft, Roy
Barnes, Mike	Bennon, Sal	Bertolini, Edward	Bishop, Jerry
Boettger, Bill	Bonucchi, Joe	Brown, Charlie	Brucker, Dave
Cambre, Jr., Max	Chu, Don	Clark, Tom	Compton, Olin
Dahinden, Vincenz	Davis, John	Degeneff, Bob	Diamantis, Tom
Easley, John	Ebert, John	Edwards, Kevin	Fallon, Don
Feghali, Pierre	Fleeman, Jeff	Foldi, Joe	Foster, Sam
Franchek, Mike	Frank, P.E., Jerry	Gillies, Jim	Grunert, Bob
Hall, Geoff	Hansen, Wayne	Heinrichs, Frank	Hoefler, Pete
Holdway, Tim	Honey, Charlie	Huddleston III, Jim	Hunt, John
Johnson, David	Jordan, Ron	Kallaur, Gene	Kappeler, Cal

Kennedy, Bill	Kennedy, Sheldon	Koenig, E.	Lackey, John
Lazar, John	Lewis, Frank	Light, Hal	Long, Leonard
Loveless, Mark	Lowdermilk, Larry	Lowe, Richard	Ma, Joe
Maguire, William	Massouda, Tito	McGill, Jack	McMillen, Chuck
McQuin, Nigel	Miller, Kent	Minkwitz, Sr., Russ	Mitelman, Mike
Moore, Harold	Murray, Chuck	Musil, R.J.	Mutschler, Jr., Bill
Norton, Ed	Paiva, Gerry	Patton, Jesse	Pearce, Henry
Pearson, Clyde	Pekarek, Tom	Perco, Dan	Raymond, Charlie
Rizvi, Aslam	Robinson, Butch	Rossetti, John	Rowe, Jerry
Sankar, V.S.N.	Savio, Leo	Saxon, Bill	Scheu, Bob
Sharma, Devki	Shenoy, Vic	Skinger, Ken	Smith, Jim
Smith, Steve	Smith, Ray	Smith, Ed	Stahara, Ron
Stein, Werner	Stensland, Len	Stewart, Peter	Stiegemeier, Craig
Stoner, Ron	Sundin, David	Templeton, Jim	Thenappan, Vis
Thomas, Ray	Thompson, James	Traub, Tom	Vaillancourt, Georges
Veitch, Bob	Whearty, Bob	Wimmer, Bill	Woodcock, David
Wrenn, Bill	Young, Rick		

GUESTS PRESENT

Averitt, Steve	Barrientos, Israel	Espindola, Marco	Gamez, Carlos
Greely, Thomas	Herron, John	Hoch, Derek	Hughes, Bert
Huggerty, N. Kent	Magallanes, L.	Marlow, Dennis	Martinez, George
Morton, Mark	Noe, Reyes	Pa'ez, Gilberto Garzo	Rezai, Hossein
Romano, Ken	Saldivar, Juan Jose	Schweiger, E.	

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IEEE PES TRANSFORMERS COMMITTEE MEETING
WEDNESDAY, NOVEMBER 11, 1998

Chair: J. W. Matthews **Vice Chair: B. K. Patel**
Secretary: H. J. Sim

1.0 Chair's Report - J. W. Matthews

J. W. Matthews called the meeting to order at 8:00 am. Mr. Matthews opened the meeting by complimenting Andrew Lowless and his associates for the excellent meeting arrangements despite many last minute changes in host and the meeting location. The Committee thanked the Host Committee with a round of applause.

Andrew reported on the attendance and other statistics (see Clause 4.0).

Rowland James provided details about the next meeting in New Orleans, LA, on April 12 - 15, 1999. See Clause 4.0 for the details.

Dennis Marlow provided some details about the fall 1999 meeting in Monterey, Mexico, on November 7 - 10, 1999.

Mr. Matthews highlighted the discussions held during the Administrative Subcommittee on November 8, 1998. See the Administrative Subcommittee Meeting Minutes in Clause 4.0 for details.

1.1 Report on the Technical Council Meeting, July 14, 1998 in San Diego, CA, USA

At of the time of the Technical Council meeting there were about 1500 persons registered.

It was noted that the general meetings have, de facto, gone to a five day schedule with 18 meetings of Working Groups on Sunday.

The officers of the Technical Council starting January 1, 1999 are:

Harry Jones - Chair and PES Vice President Technical Activities

Jim Harlow - Vice Chair

Bruce Dietzman - Secretary

1.1.1 Standards Making

Steve Lambert explained that there is the perception that PES does not produce standards in a timely fashion, or that some topics which are the rightful domain of PES are not being covered at all. He observed that there is a significant difference in the level of corporate support for standards from, most notably, companies with a vested interest in computer standards. This has led to the creation of a Task Force chaired by Jim Harlow to explore these points and report.

1.1.2 Editorial Boards/Transactions Editors

Don Russell reported broad support for the new Transactions editors structure and electronic publishing. The three Transactions editors who will report to Bill Schwartz as Vice President of

1.0 Chair's Report (cont'd.)

Technical Information Services, will be named very soon. Each technical committee must name a representative to serve on its Editorial Board by the end of July. (Bipin Patel will serve in this capacity until a replacement can be found.)

1.1.3 Electronic Publishing

Mel Olken made a presentation regarding the plan to go to electronic publishing, starting January, 1999. This involves two different programs: 1) the paper review process and 2) electronic ready manuscript submissions. A motion was made by Harry Jones: Move the Technical Council endorse the electronic review and publication process as explained by Mel (Olken), and that (Chair Lambert) take to the Governing Board that sense of approval and support. The motion passed by voice vote without dissension.

1.1.4 Standards Association Update

There have been reports that not all persons who should have received membership applications did receive them. With ballots now going out there is a box which asks for the balloter's SA membership number, or enclosed is an application for membership to the SA.

1.1.5 Future Technical Development Committee - Tom Pinkham

The Meeting was held in the Bel Aire North Room of the Sheraton San Diego West Hotel on July 14, 1998 with seven present.

We first commented on the Session sponsored by this Committee on Monday afternoon entitled "The Very Real Threat to Power System Control and Information Systems from Hackers". The Session was excellent, with four great speakers. Bill Prince deserves full credit for this fine Session. The attendance was somewhat disappointing, undoubtedly caused by the fact that the location was changed from the Grand Ballroom (listed in the Preliminary Program) to a small room in the West Hotel.

At the request of Steve Lambert, VP of Technology, we listed three subjects not now covered by PES that should be considered:

Information System Security

Superconductivity

Changing Structure of Electric Industry

Discussed topics for Special Sessions for the 1999 WPM. Decided that the Y2K issue should be covered, if not as the Plenary Session then we would cover it from the Technical viewpoint. Another possibility was Diagnostic Test Techniques. (Note: after the Meeting it was determined that the Plenary Session would not be Y2K, therefore we will plan to cover it.)

We discussed the low attendance at our meeting. The Secretary of the Technical Council, Jim Harlow, will urge Technical Committee Chairmen to appoint members.

1.1.6 Topics from Committee Chairs

IEC Dues - Bob Dempsey, Power System Relaying

Members of IEC TAGs are receiving bills which must be paid for the person to participate. This has happened since ANSI, which was the national supporter for IEC representatives is no longer providing the fee. If we are going to push for participation in international standards we will

1.0 Chair's Report (cont'd.)

need some means to support the funding required. Bob feels that this should come from IEEE and PES.

Jim Harlow spoke that this is a topic considered by the Standards Making Task Force on Sunday. It is under consideration whether some governmental body might support this, but there is little basis for optimism. It is estimated that about one-half of present IEC participants will terminate their association because of this.

Gerald Lee proposed that we should be pursuing a new IEEE recognition status within IEC; not going through our national committees. Don Russell stated he would look into this.

1.2 Transformers Committee Report to Technical Council

I reported the following to Technical Council for the Committee:

1.2.1 Committee Meeting Activities

Our Spring '98 meeting was held April 26-29, 1998 in Little Rock, AR, USA. Ms. LuAnn Hensley, Central Moloney, and Mr. Ed Smith, H-J Enterprises, were our co-hosts. A total of 267 members and guests attended the meeting.

Membership of the Transformers Committee currently stands at 168 members and 21 Emeritus members. The regular members consist of 78 producers, 54 users, and 36 general interest. Our invitation list consists of well over 400 engineers and managers in the transformer and utility industry. Attendance at our semi-annual meetings is typically near 300. Anyone with an interest in furthering the technology is welcome at our meetings. With active participation, an invitation is extended to become a member.

The Committee goals are to encourage open participation in transnationalization of transformer standards; to promote technical and educational endeavors such as panel sessions, peer review of technical literature on cognizant subjects; and to support the efforts of the Power Engineering Society.

Future Meetings

November 8-11, 1998, Guanajuato, Mexico

April 12-15, 1999, New Orleans, LA, USA during the 1999 April T & D Conference

November 7-10, 1999, Monterey, Mexico

April 2-5, 2000, Opryland Hotel, Nashville, TN, USA

October 15-18, 2000, Niagara Falls, Ontario, Canada

Spring 2001, Amsterdam, The Netherlands

Fall 2001, Open - Contact one of the Committee Officers.

Spring 2002, Vancouver, BC, Canada

1.0 Chair's Report (cont'd.)

1.2.2 1998 Summer Power Meeting Technical Sessions

The Transformers Committee is not sponsoring any technical sessions at the San Diego meeting. A planned special tutorial was postponed to a later meeting at the request of the presenter.

1.2.3 Transformer Standards and Coordination Activities

A detailed status report on over 100 transformer standards is available from our Committee Standards Coordinator. Anyone wishing to receive a copy should contact Mr. Thomas A. Prevost at (802) 748-8106. They can also be accessed on the Transformers Committee Web page.

The Transformers Committee takes responsibility for development and revision of IEEE Standards that fall within its scope. These Subcommittees currently have fifty Working Groups and Task Forces preparing proposals for standards projects. Information on these standards and projects can be obtained by visiting our WWW homepage:

<http://www.dsUPER.net/~georgev/Transformers.html>

Links to information on our future meeting sites and other information on Transformer Standards can also be found there.

Our WWW site will link you to the IEEE Standards Status Report that contains titles, abstracts, and names of contacts for each of the IEEE standards. This report is updated quarterly by the IEEE Standards Department. The status of transformer standards not listed in the IEEE quarterly report, either because they have been withdrawn, or they are not IEEE standards, are also included on the Transformers Committee Web site.

Transformers Committee officers and Administrative Subcommittee members are also members of the USNC Technical Advisory Group to TC-14 (Transformers and Reactors). We continue to have productive meetings of the TAG at each Committee meeting.

2.0 Approval of Minutes of April 29, 1998 - J.W. Matthews

The minutes of the Little Rock meeting were approved as written.

2.1 Meeting Planning Working Group - G. Anderson, Chair

The third meeting of the new Administrative Subcommittee Working Group - "Meeting Planning" began at 3:30 p.m., Tuesday, November 10, 1998 at the Fiesta Americana Hotel. Thirty-three (33) individuals attended. Greg Anderson, WG Chair facilitated the meeting.

The meeting began with introductions by the attendees. There were no revisions to the minutes from the last meeting. There were no additions or subtractions to the agenda of this meeting.

2.1 .1 Host Guidelines

Greg Anderson gave a brief report of the status of the "Host Guidelines" document. Development of the document continues to proceed slowly. Andrew Lawless was the first meeting host to use the preliminary document in planning his meeting. Andrew will make "lessons-learned" additions to the document.

2.1.2 Past & Present Meetings

2.1.2.1 Past Meeting - Little Rock

J. Ed Smith & LuAnn Hensley, S98 Little Rock meeting co-hosts were not in attendance to discuss their recent meeting.

2.1.2.2 Present Meeting - Leon, Guanajuato, Mexico

Andrews Lawless, the F98 Leon, Guanajuato (GTO) meeting host welcomed everyone to Mexico and gave a brief report of his meeting. Preliminary attendance numbers were reviewed. It was noted that Andrew did an excellent job of preparing for this meeting even with the last-minute change of meeting host and the "last-second" relocation of the meeting venue. It was also noted that availability of meeting registration information on the Internet was extremely helpful.

2.1.3 Future Meetings

2.1.3.1 Locations

The following locations and respective hosts for future meetings were quickly reviewed.

- New Orleans, LA - April 12-15, 1999 ... Rowland James (Entergy)
- Monterey, Mexico - November 7-10, 1999 ... Alfonso Delgado Cruz (GE-Prolec)
- Nashville, TN - April 2-5, 2000 ... Alan Wilks (ERMCO)

2.0 Meetings (cont'd.)

- Niagara Falls - October 15-18, 2000 ... Roger Hayes (VA-Tech)
- Amsterdam - April 8-12, 2001 ... Ernst Hanique (SMIT)
- (open for US meeting) - Fall 2001
- Vancouver, B.C. - Spring 2002 ... Mike Lau (BC Hydro)

2.1.3.2 Upcoming Meeting - New Orleans

The Spring 1999 meeting in New Orleans will be held in conjunction with the 1999 IEEE/PES Transmission and Distribution Conference. Rowland James is coordinating the Transformer Committee meeting. Our meetings will be held at the Ernest N. Morial Convention Center, the same building where the conference will be held. This will make it easy for an attendee to move easily from the Committee meetings and the conference exhibits.

The opening festivities for the T&D Conference will be held Monday morning. Preliminary plans are to schedule Committee meetings Monday (04/12) through Thursday (04/15), with no meetings on Monday afternoon and Tuesday morning to allow attendees to visit the conference exhibits. A few small meetings (that normally meet on Sunday afternoon) may be held Monday morning. The "full committee meeting" will be held on Thursday afternoon.

There will be no registration fees for attending the Committee meeting (although later it was determined that a small registration fee was necessary). It will not be necessary to register for the T&D Conference to attend the Committee meetings. A table or kiosk will be provided in the lobby of the Convention Center as a "home base" for our meeting and provide a location to "check-in" (and to get on the mailing list for the meeting minutes).

Over twenty hotels are identified for accommodations for the Conference. Registration at many of these hotels is available at a discounted rate on the Conference's web-page (www.99ieeed.org). Rowland encouraged people to make hotel reservations as quickly as possible.

There will not be the usual "extracurricular" events associated with the Transformers Committee meeting; i.e. no Sunday Evening Reception, no Tuesday Speaker Luncheon, no Tuesday Evening Social/Dinner, and no Companion Tours. Attendees and companions can attend ample events planned for the T&D Conference.

2.1.3.3 Additional Upcoming Meetings

In the absence of Alfonso Delgado Cruz (F99 meeting host), Enrique Betancourt gave a brief report of the upcoming meeting in Monterrey, Mexico. Arrangements have been made at the Sheraton Hotel (although later moved to the more suitable Holiday Inn Crown Plaza Hotel). Tourist-type brochures of Monterrey were made available to attendees of the GTO meeting.

Alan Wilks (S00 meeting host) gave a brief report about the upcoming meeting in Nashville. The famed Opryland Hotel has been reserved for our meetings.

2.0 Meetings (cont'd.)

Roger Hayes (F00 meeting host) and Ernest Hanique (S01 meeting host) also gave a brief comments to their upcoming meetings.

A meeting host for the Fall 2001 meeting is still needed. Greg commented that he would make special effort to ensure that this meeting will be in the United States.

2.1.4 Registration Software

Two companies that market Internet-based software to coordinate the registration process have been initially contacted. One world-class event management software package, "Events" looks very promising. Greg is planning to provide a brief demo of the software at the New Orleans meeting.

2.1.5 Future Plans for WG

Additional future plans for the Meetings Planning WG include: continued development of the Host Guidelines Document, automate registration process (possibly web-based), and enhanced information on the Committee's web-page.

The meeting was adjourned at approximately 4:45 p.m.

3.0 Vice Chair's Report - B.K.Patel

3.1 PES Technical Council Committees

The following are reports on activities of PES Committees on which the Vice Chair serves as Committee representative. All of the meetings reported were held at the 1998 Summer Power Meeting in San Diego, CA during July 12 - 16, 1998.

3.1.1 Publications Committee

Mel Olken of IEEE made a slide presentation on a proposed Transaction paper electronic review, processing, and publishing procedure. He proposed that 1999 will be a transition year in which the PES will accept electronic submission of transactions papers while continuing to accept hard copies. He also proposed that beginning in 2000 we require complete electronic submission. By a voice vote the proposal was passed to recommend the adoption of this new procedure to the Technical Council.

Don Russell made a presentation on the formation of an Advisory Board whose purpose is to survey the industry to determine on which subjects the PES should focus our General Meeting technical sessions. The Board plans to make recommendations of selected subjects for consideration by the Technical Council as themes for future meetings.

Harry Jones mentioned that the paper review turn around time is expected to be 120 days, that is from the day IEEE receives paper from authors to the day IEEE notifies the authors about the review results. Mel Olken's office will track the actual review times to monitor TCs' performance in the paper review process.

Stan Horowitz was introduced as the General Technical Program Chairman for 99WPM in New York.

3.1.2 Organization and Procedures Committee

3.1.2.1 Technical Committee Activity Reports

No major discussion during the individual TC report.

3.1.2.2 Revision of the Technical Council Organization and Procedures Manual

The revised draft of the Transformers Committee O & P Manual was approved. The new changes recently made in Transaction paper review process, paper presentation/publication, etc., creation of the editorial board, and related changes in the organization chart have been proposed to the Technical council for next revision of the Technical Council O&P Manual.

A topic of resubmittal of rejected papers was discussed. There seems to be some confusion about the procedure on how to handle these papers. Harry Jones will review author's kit and other publications to see what's available on this subject.

3.1.3 Technical Sessions Improvement Committee

Computer Display Projectors - Under the topic of what presentation equipment should be made available at the future meetings, the use of computer display projectors was discussed. Computer aided presentation projectors – light projection, slide projector, etc. were discussed. The major difficulties presented were high cost (ownership or rental), compatibility of computers, connections, especially in foreign countries, etc. It was concluded to make a recommendation to the Technical Council to include "Computer Connected Display Projectors" as an accepted means of presentation at all IEEE/PES functions and that the IEEE should make sufficient projectors available at future meetings to accommodate those who wish to use this medium. Until this is approved and the equipment made available by the IEEE, individual authors will have the option to use this method of presentation, but will have to provide their own equipment.

Commercialization in Presentations - It was agreed that the chair will submit a set of "Basic Guidelines Regarding Commercialization in Presentations" to the Technical Council for publication, to ensure a reasonable standard of presentation behavior at IEEE / PES meetings. The following items were identified to be included in the new guidelines:

- No overt commercialization
- No product/service comparisons
- No company advertising, only discussion of the product/service
- No mention of other competing products
- No sales literature or sales pitches
- No distribution of promotional material

Dress Code - A recommendation will be made to the Technical Council that the issue of dress code be addressed at their next meeting and that the policy appear in the Technical Program and on the Web Site to clarify the present guidelines for attendees.

Professional Education Time Credit - The re-establishment of a "Professional Education Time Credit" form that can be filled in and signed by a session chairman was discussed. Apparently, in some states certain IEEE meeting functions will count for educational credits if a formal document can be submitted to the appropriate body. Therefore, it was felt that the IEEE should make allowance for those who wish this.

The chair will inquire about the old form through IEEE and have it reviewed and modified by the Power Engineering Education Committee. This updated form will be reviewed by the TSIC and upon its acceptance it will be recommended to the Technical council for final approval and implementation.

3.2 Technical Paper Reviews

3.2.1 Technical Paper Review Summary

We received seventeen transaction papers which included five resubmittals, thirteen 99 T&D Conference papers, and eight abstracts for 99WPM proceedings. One of the conference papers requested the transaction paper review also.

Six papers were approved, four approved with mandatory changes, two rejected, one withdrawn, and the remaining are under review. Out of thirteen conference papers, three were approved, four approved with mandatory changes, two rejected, and the remaining are under review. All eight abstracts for the proceedings were approved.

3.2.2 199 IEEE/PES Winter Power Meeting Papers

There will be a transformer session at the meeting in New York with eight papers scheduled for presentation. Five more papers will be presented in a poster session.

Respectfully submitted,

B.K.Patel, Vice Chair

4.0 Administrative Subcommittee - John W. Matthews

4.1 Introduction of Members and Guests

Chair Matthews called the meeting to order at 2:15 p.m. in Jade-Opalo room of the Fiesta Americana Hotel.

The following members of the Subcommittee were present:

W. B. Binder, Jr.	P. E. Orehek
R. F. Dudley	W. F. Patterson
F. E. Elliott	L. W. Pierce
D. J. Fallon	T. A. Prevost
F. J. Gysziewicz	J. Puri
E. G. Hager	H. J. Sim
K. S. Hanus	L. B. Wagenaar
J. W. Matthews	

The following guests were present:

Greg Anderson
Rowland James
Naeem Ahmad
Phil Hopkinson

4.2 Approval of the Little Rock Meeting Minutes

The minutes of the previous Administrative Subcommittee meeting in Little Rock were approved as written.

4.3 Additions to and/or Approval of the Agenda

The previously communicated agenda was generally followed.

4.4 Meeting Arrangements, Host Reports, and Committee Finances

4.4.1 Meeting Arrangements

Meetings Planning WG chair Greg Anderson reported the following.

- Concerns over meeting locations being outside North America were again discussed. Mixed supports of these from employers of the members were reported. We will need to promote the standardization for users. It was also pointed out that our industry is becoming more international and we need to work on harmonization of standards.
- To assist the hosting teams, the WG is evaluating a software (Events) costing about \$8000 or contract registration which will cost each time we utilize this service.
- There are total of 244 registered at this meeting with 50 spouses also attending. It was noted that the producer to user group ratio is about 3 to 1.
- New Orleans meeting host Rowland James discussed several issues associated with IEEE/PES T&D Conference schedule and our committee meetings. Transformers Committee meetings will be scheduled for Tuesday p.m. through Thursday p.m. in New Orleans Convention Center. Rooms at Hilton and Westin are blocked for our committee and the registration forms will include a card for us to check off to request these rooms. The advance program is due out later this month. (November 1998) Administrative Subcommittee meeting will move from Sunday to Monday morning to allow the members to attend the exhibitions. The booth to promote the transformers committee will be coordinated with PES. Rowland will check on this and report.

After our meeting, Rowland provided the following report.

The 1999 Spring Transformers Committee Meeting will be held in New Orleans, LA. in conjunction with the 1999 IEEE/PES Transmission and Distribution Conference and Exhibition at the Ernest N. Morial Convention Center. The dates are April 12-15 with meetings beginning at the Convention Center on the afternoon of April 13 and running until noon on April 15 (Meetings normally held the Sunday before will be held on Monday morning, April 12 at the New Orleans Hilton Riverside. The ASC C57 Main Committee and ANSI WG Enclosure Integrity meetings will be held on Tuesday morning, April 13. The Full committee will meet on the Thursday afternoon, April 15.

A limited block of rooms has been reserved at the New Orleans Hilton Riverside and the Westin Canal Place. Presently, housing reservations can be obtained through the T and D's web site <<http://www.99ieet-d.org/>> <http://www.99ieet-d.org/>. The T and D advanced program is due to be mailed either in late November or early December. Mail in, fax and phone in reservations will be available in this program. All PES members will receive an advance program. In addition the two hotels mentioned above, there are twenty-one other hotels reserved for the T and D conference to choose from.

Since our meeting is concurrent with T and D, Companions' hospitality, and tours will be made available only through full registration with T and D. The same applies for technical tours. Therefore, there will be no registration fee for the Transformers Committee meeting.

4.4.2 Host Reports

The meeting host Andrew Lawless reported the following registration statistics:

Registrations

Members and guests	262
Life Emeritus Members	4
Companions	49
Total	315
Tuesday Luncheon	ALL
Tuesday Evening Social	ALL
Companions Tours	
Monday Tour	49
Tuesday Tour	45

A historical listing of IEEE/PES Transformers Committee meeting locations is attached at the end of these minutes.

4.4.3 Finances

The surplus of \$ 15200 was carried over to this meeting and we expect to maintain this level of surplus to the next meeting.

4.5 Old Business

Our O&P Manual is approved by the Technical Council.

We finally have the volume I of the GSU failure survey approved for publication. The publication will take place this year and will be available for sale at the PES Winter meeting. Ed Cromer will check with Hal Light on resolving the sensitive legal issues on publishing the Volume II.

4.6 Status of ANSI C57 Committee - W. B. Binder

4.6.1 The IEEE delegation has voted affirmative on the following ANSI Standards:

C57.12.28 Pad-mounted Equipment – Enclosure Integrity

C57.12.29 Pad-mounted Equipment – Enclosure Integrity in Coastal Environments.

4.6.2 The IEEE delegation provided additional comments on the January 1998 revision of NEMA TP-1. Due to a mix-up in mailing the original document, the revision was not reviewed by the IEEE delegation until after the Little Rock meeting, well after the due date. It is not clear at this time if any of the comments will be incorporated into this revision of TP-1.

4.7 Committee Service Awards - W. B. Binder

Wally's full report will be shown in the Committee meeting minutes.

The GSU Failure survey was nominated for Donald G. Fink Award and approved by the Administrative Subcommittee.

4.8 Chair's Report - J. W. Matthews

John presented his report which will be included in the Committee meeting minutes. Vice Chair Patel will report on the Editorial Board/Transaction Editors. Our committee will need to identify and nominate for this position soon. Several members of the Administrative Subcommittee members expressed their concerns with activities on IEC. US national committee is trying to charge a fee to be a TA or a TAG which is not received well by the group. It was noted that IEC is more general where IEEE is more specific and we need to focus on specific topics rather than overall recognition by IEC.

4.9 Standards Subcommittee - T. A. Prevost

4.9.1 Standards and Coordination Activities

Tom Prevost reviewed his report which will be included in the Committee meeting minutes.

4.9.2 Documents Submitted to the Standards Board

See the status report.

4.9.3 Recirculation Ballots

There has been several key documents recently recirculated.

C57.12.00 recirculation is complete and is now being submitted to Standards Board.

C57.12.90 recirculation is invalid due to lack of negative ballot documentation. This document will need to be recirculated with cover letter and all negative ballot resolution.

PC57.130 D12 recirculation is also invalid due to lack of negative ballot documentation.

Lin Pierce pointed out that IEEE does not allow enough time (two weeks) for recirculation. Naeem Ahmad responded that WG chair selects the time duration between 10 and 40 days. John Matthews recommended 40 day recirculation to allow sufficient time.

All WG chairs are encouraged to become familiar with IEEE Standards Companion and follow the guidelines and procedures outlined there.

4.9.4 PAR

Electronic submittal of PAR is required using the form on the web, then fax the form with signatures. Problems with coordination can be resolved by parallel coordination with Standards Coordinating Committee to meet the PAR due dates.

4.10 Subcommittee Activities - Subcommittee Chairs

4.10.1 Audible Sound and Vibration - Jeewan Puri

Jeewan reported that transformer siting guide draft 8 is ready for balloting and IEC WG 25 has been invited to review and comment on this draft. He also indicated that this was offered to IEC as new work item on IEC Application Guide.

Forming a new WG to revise the clause 13 of the C57.12.90, noise measurements to include Sound Intensity measurement and sound power as opposed to sound pressure.

4.10.2 Bushings - F. E. Elliott

Fred reported that Keith Ellis is a new WG chair C57.19.00.

4.10.3 Dielectric Tests - L. B. Wagenaar

Loren reported that CIGRE/PSIM is developing a Test Data Generator program with 16 fixed standard waveforms without any transformer wave shapes. Bertrand Poulin and Ernst Hanique will represent Dielectric Test subcommittee as a liaison with PSIM.

4.10.4 Distribution Transformers - K. S. Hanus

Ken reported Jerry Smith will be replacing Angie McCain as co-chair of the WG on Electronic Data Transmittal (P1388) and John Rossetti will be the new co-chair of the WG on Small Power Transformers.

Ken discussed an issue of copyright, which still has not been resolved and now with an IEEE staff engineer assigned to the committee, he felt it would be a good time to revisit the issue. The issue concerns C57.12.34, which is a new document but is essentially a combination of C57.12.22 & C57.12.26 for which both C57 holds the copyrights. The question is who will have the copyright on C57.12.34?

4.10.5 Dry-Type Transformers - W. Patterson

No report.

4.10.6 HVDC Converter Transformers & Reactors - W. N. Kennedy

Richard Dudley reported that C57.129 ballot is incomplete as there were several negatives. He needs to extend the PAR to resolve them and recirculate. He also reported that P1277, Smoothing Reactor standard needs to be surveyed in Performance Characteristics and HVDC subcommittees jointly.

John announced that Richard will co-chair the HVDC subcommittee with Bill Kennedy.

4.10.7 Instrument Transformers - J. E. Smith

No representation and no report.

4.10.8 Insulating Fluids - F. J. Gryszkiewicz

Frank reported that IEEE 637, Guide for reclamation is up for revision or reaffirmation. He also indicated that IEEE 799, Guide for handling and disposing transformer oil with PCB needs to be reaffirmed or due to the liability issues maybe withdrawn.

4.10.9 Insulation Life - L. W. Pierce

Lin reported that he reviewed the August 1998 draft of K3 Working Group document, "Adaptive Transformer Thermal Overload Protection" and made comments. This document is nearing completion. It is an informative document primarily for the IEEE Relay Committee. Lin also attended the Working Group meeting in Ashville, NC on September 16, 1998 and gave a two hour presentation to the group on "Review of Transformer Loading Guide Equations".

Lin also pointed out that C57.91 revision will start next meeting and the annex on bubble evolution needs to incorporate the EPRI information.

4.10.10 Performance Characteristics - D. J. Fallon

Don had responded to an interpretation request which were sent to Naeem Ahmad. The requester is not satisfied with it and Don will need to work on it one more time. Don indicated that Mrs. Adolphson sent him a note requesting that we remove Ed Adolphson from all mailing list. John Matthews indicated that Ed passed away this summer and there will be a special time on Wednesday committee meeting to remember Ed.

4.10.11 Power Transformers - E.G. Hager

Red was concerned that the meeting room sizes were not as requested. John directed him to register this problem to the meeting host. Red reported that Rick Young's to include instrument transformers in his work. He was directed to set up a liaison with Instrument Transformer subcommittee. Red reported that his subcommittee is forming West Coast WG. He received a liaison request from Substations committee on Life Management of Transformers.

4.10.12 Underground Transformers and Network Protectors - P. E. Orehek

No report.

4.11 Vice Chair's Report - B. K. Patel

Bipin was not able to attend this Administrative Subcommittee meeting but submitted a written report which will be included in the Committee meeting minutes.

4.12 Secretary's Report - H. J. Sim

4.12.1 Membership Review

Voting Members - Two new members were added at the last meeting in Little Rock as noted in the meeting minutes. Also there were few changes in voting classification for some members.

Following these changes and prior to the addition of new members at this meeting, membership stands at:

Members -	166
Classifications: Producers -	79
Users -	51
General interest -	36
 Emeritus Members -	 20

Poor Attendance Records - The invitation list has been revised by removing guests with poor attendance record and adding new guests by request. Members who have not attended a committee meeting since fall of 1996 will be contacted to determine their interest in maintaining membership.

4.12.2 New Member Applications

Eight new members were approved and welcomed. They are, Michael Barns (Qualitrol), Craig Stiegemeier (ABB Power T&D Company, Inc., Components Division), Dr. Dieter Dohnal (Maschinenfabrik Reinhausen GMBH), Joseph Foldi (ABB - TPT Canada), Henk Ruevekamp (Electromech/Passoni & Villa), Arthur Molden (AMEESCO), Dr. Gustav Preininger (Consultant), and Rowland James (Entergy Transmission).

4.12.3 PES Directory Rosters

Revised directory information for 1999 IEEE Directory listing for the Transformers Committee was submitted to Secretary of TC on September 12, 1998. Subcommittee chairs are requested to keep the rosters updated as they change constantly.

4.12.4 Meeting Minutes

Minutes of the Little Rock meeting were reproduced at no cost, again compliments of Ken Hanus and TU Electric. Postage costs were \$ 2356.40 for 582 mailings, which averages \$ 4.05 per mailing. Note that the net cost of the minutes varies for each meeting and the \$10 portion of the registration fee is a valid nominal fee.

I request Subcommittee Chairs to submit their minutes by February 12, 1999 for this meeting. The submittal should be an electronic file on a 3 1/2" diskette (Email preferred), formatted in Word 7.0 (or earlier versions). Please indicate total attendance count for each subcommittee, working group, and task force meeting in your minutes. Please do not send me a copy of attendance listing for this attendance count. If someone is preparing minutes for you please let them know these details about submitting the minutes for publication.

4.13 New Business

Naeem Ahmad announced that the SA membership application forms are available at the registration desk. He also announced that all IEEE standards will be available online by the end of 1998.

Phil Hopkinson spoke for need for participation on IEC TC14. He said that ANSI is referenced about 25% of the specifications around world while the other 75% calls for IEC standards. He also mentioned that EEI and NEMA will provide financial supports for their members attending IEC meetings.

4.14 Adjournment

John adjourned the meeting at 5:50 p.m.

Respectfully submitted,

H.J. Sim, Secretary

IEEE/PES Transformers Committee Meeting Locations

<u>Year</u>	<u>Spring</u>	<u>Fall</u>	<u>Committee Chair</u>
2001	Amsterdam, The Netherlands	Open	Patel
2000	Nashville, TN	Niagara Falls, ON, Canada	Patel
1999	New Orleans, LA	Monterey, Mexico	Matthews
1998	Little Rock, AR	Guanajuato, Mexico	Matthews
1997	Graz, Austria (summer)	St. Louis, MO	Binder
1996	San Francisco, CA	Burlington, VT	Binder
1995	Kansas City, MO	Boston, MA	Harlow
1994	Dallas, TX	Milwaukee, WI	Harlow
1993	Portland, OR	St. Petersburg, FL	Borst
1992	Birmingham, AL	Cleveland, OH	Borst
1991	Phoenix, AZ	Baltimore, MD	Veitch
1990	Denver, CO	Montreal, PQ, Canada	Veitch
1989	Chicago, IL	Charlotte, NC	Veitch
1988	Washington, DC	Long Beach, CA	Compton
1987	Ft. Lauderdale, FL	New Orleans, LA	Compton
1986	Little Rock, AR	Pittsburgh, PA	Yannucci
1985	St. Louis, MO	Toronto, ON, Canada	Yannucci
1984	Vancouver, BC, Canada	Boston, MA	Savio
1983	Atlanta, GA	Detroit, MI	Savio
1982	Los Angeles, CA	Philadelphia, PA	McNutt
1981	Portland, OR	Phoenix, AZ	McNutt
1980	Williamsburg, VA	Milwaukee, WI	Bonucchi
1979	San Diego, CA	Houston, TX	Bonucchi
1978	Miami, FL	Chattanooga, TN	Bennon
1977	Charlotte, NC	Montreal, PQ, Canada	Bennon
1976	New Orleans, LA	San Francisco, CA	Honey
1975	Lakeland, FL	Denver, CO	Honey
1974	Pittsburgh, PA	Scottsdale, AZ	Alexander

4.0 Administrative Subcommittee (cont'd)

5.0 Transformer Standards - T. A. Prevost

The Standards Subcommittee met on Tuesday, November 10, 1998 at 8:00 AM with three members and one guest.

We approved minutes with one minor editorial change.

5.1 Working Group Reports

WG on C57.12.70 "Standard Terminal Markings and Connections for Distribution and Power Transformer" reports balloting complete, ready to publish document. C57.12.80 "Standard Terminology for Power and Distribution Transformers" is undergoing resolution of negatives. Tom Traub is still active in this Working Group and is contacting the negative balloters for resolution.

Continuous Revision to C57.12.00 and C57.12.90 - Subhash Tuli.

Draft 4 of C57.12.00 has completed the balloting process with a successful recirculation ballot. This standard draft will be forwarded to IEEE by year end.

C57.12.90 had a procedural error on this recirculation ballot. We omitted the negatives and rebuttals. We will incorporate a change to the draft concerning Clause 15, Certified Test Report, Item 6 with working that was agreed to in the PCS C57.12.90 WG. The recirculation ballot will go out before year end.

Again, C57.12.00 and C57.12.90 are on a 2 year revision cycle.

5.2 New Business

A 20 minute presentation will be given on:

- 1) Submittal of PAR Starting a Project
- 2) Balloting Process

5.3 Other

- 1) Naeem Ahmah was introduced.
- 2) 5 year status will be distributed in 1st Quarter.
- 3) Standards Numbering - Standards will be numbered by the Transformer Committee Standards Coordinator. This will assure that they get a C57 designation.

6.0 Recognition and Awards - W. B. Binder

6.1 Working Group Recognition Awards

Nominations have been accepted for the Transformers Committee Working Group Recognition Award for 1998. The nominations were:

Working Group for Revision of C57.110 – Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents

Working Group for Revision of C57.18.10, Standard Requirements for Semiconductor Rectifier Transformers

Both working groups were considered worthy of recognition. The Administrative Subcommittee has selected C57.110 as the Transformers Committee nomination for 1998.

6.2 Certificates of Appreciation

Transformers Committee Certificates of Appreciation will be presented to the following persons at the Transformers Committee meeting.

<u>Name</u>	<u>Service Rendered</u>
Sheldon P. Kennedy	Chair, Working Group for Revision of C57.18.10 – Standard Requirements for Semiconductor Rectifier Transformers
Richard P. Marek	Chair, Working Group for Revision of C57.110 – Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents
Michael A. Franchek	Chair, Working Group for IEEE 1276-1997, IEEE Trial-Use Guide for the Application of High-Temperature Insulation Materials in Liquid-Immersed Power Transformers

6.3 Transformers Committee Prize Paper Award

Nominations were sought for the Transformers Committee Prize Paper Awards for 1998. No eligible Papers were identified. One paper awaiting publication was nominated for possible consideration for 1999.

7.0 Reports of Technical Subcommittees

The following reports are those of the technical subcommittees of the Transformers Committee. In most cases they are the complete minutes of meetings held earlier and they are identified as minutes.

Secretary's Note: The subcommittee reports have been edited to the format of the IEEE Style Manual. No changes have been made to the content of these reports except for typographical errors and obvious improvements (removal of attendance lists and general items covered elsewhere).

Following each report is a listing of the current status of each of the subcommittee's assigned standards.

7.1 Audible Sound and Vibration - J. Puri, Chair

The Subcommittee met on Tuesday, November 10 at 10:55 A.M. with nine members and fourteen guests present. Five new members were welcomed to this Subcommittee.

The minutes of our previous meeting at Little Rock were approved.

The following items were discussed:

7.1.1. WG Report - Transformer Siting Guide C57.136 (Ms. Karen Weissman - WG Chairman) The WG discussed Draft 8 of this Guide. The group concluded that more information on the sources of sound in shunt-reactors should be added to this document. The WG met in a special session from 3:30pm to 5:30pm and completed the review of this document. It was agreed that Draft 9 this guide will be circulated to the WG for inviting final comments. All the comments will be compiled by March 15, 1999. These comments will be discussed in the next meeting. Draft 9 of this document will be circulated to the voting pool.

7.1.2. Chairman's Report - Participation in IEC TC 14 activities - WG 25: This WG presented the final comments on Committee Draft 14/308/CD for the revision of IEC 60076-10 standard for Sound Level measurements at the TC 14 meeting at Houston on???. This document will now be circulated as a CDV (Committee Draft for Voting) to the members of TC14 for voting.

WG 25 will meet in Nijmegen, The Netherlands and resolve the following issues with this document:

1. The present draft allows the use of Sound Intensity or Sound Pressure measurement methods but does not define their interpretation for demonstrating compliance with customer specifications.
2. No standard sound levels are recognized by this document.

The Chairman (Jeevan Puri) has made a New Work Proposal to write an Application Guide to provide guidance on the following issues:

1. Interpretation of Sound Intensity and Pressure measurements demonstrating compliance with local ordinances.
2. Standard sound levels in transformers-Liquid Filled and Dry Type.
3. Indoor and outdoor Siting of transformers.
4. Sound Abatement in existing transformers.

7.1.3. Presentation by Jan Declercq on “Sound Intensity Measurements”: Mr Declercq (from Pauwels Transformers-Belgium) made a presentation on comparing Sound Intensity and pressure measurements describing what quantities they measure, why and under what circumstances they yield different results.

This presentation concluded that Sound Intensity measurements yield a more accurate of Sound Power.

7.1.4. New Business: The Subcommittee decided to appoint a Working Group to revise Sound Level measurement code to include Sound Intensity measurement procedures in IEEE Standards C57.12.90 and C57.12.91.

This working group will start this project after the next Subcommittee meeting in New Orleans since most of the participants presently busy working on the Transformer Siting Guide.

There being no additional business, our meeting adjourned at 12:10 PM.

Jeevan Puri

Chairman

7.2 Bushings - F. E. Elliott, Chair

7.2.1. Introduction and Membership

Chairman, Fred Elliott opened the meeting at 10:55 AM and welcomed the members and guests. The meeting was attended by 14 members and 11 guests.

7.2.2. Chairman's Remarks

Mr. Elliott reported the following:

Next IEEE Transformer Committee meeting will be at the T & D Conference location in New Orleans. Information can be obtained on the Internet.

7.2.3. Approval of Minutes of April 28, 1998 Meeting Held in Little Rock, AR

The minutes were approved as written.

7.2.4. Working Group / Task Force Reports

7.2.4.1. WG on Performance Characteristics and Dimensions for Outdoor

Apparatus Bushings (PC57.19.01)

Chairman, P. Singh reported that his WG met on November 9, 1998 at 9:30 AM with 17 members and 21 guests present. Four guests requested membership to the WG.

He reported the following:

1. Approval of April 27, 1998 Minutes of the Meeting Held in Little Rock, ARK

The minutes were approved as written.

2. PC57.19.01 Draft 6 Transformer Committee Ballot Results

Since the ballot closing date was December 1, 1998, only partial results were available at this meeting. The results as of November 5, 1998 indicated the following:

Sent	Returned	Affirmative	Negative	Abstentions
91	34	31(97%)	1	2

3. Discussion on Comments Received on PC57.19.01 Draft 6

The WG members discussed the comments and agreed to the following changes:

3a. Table 1, Electrical Insulation Characteristics

- A negative comment was received from John Rossetti expressing concerns about eliminating some voltage ratings. He suggested that bushing ratings included in Draft 6 should be mechanically interchangeable with the existing ratings that Draft 6 proposes to replace.

The WG has discussed this issue before and then again at this meeting and decided once again to maintain the present voltage classes. It was pointed out that ratings in the proposed standard are supported by most of the members in the WG, SC and the last transformer committee ballot. The criteria for the selection of voltage classes in this table is based upon feedback from the EEI survey and Doble members. The feedback indicated an overwhelming desire to reduce the number of voltage ratings so that in the long run, the end users do not have to keep too many bushings in their inventory. It was indicated by some of the end users that the inventory costs are so high that they could buy a new bushing every few years. In order to explain the selection process, a WG paper was attached to Draft 6 to educate and explain to the members/end users, the approach, WG has taken for the revision of this standard and describe the resulting benefits. The members present at the meeting expressed a strong desire to maintain the voltage classes as per Draft 6

- Based upon some comments on metric units, the WG decided to specify creepage distance in mm instead of cm in columns 4 and 5. With this change, all the dimensions in this standard will be millimeters.

3b. Table 2, Dimensions for Bushings Through 69 kV

A comment from Richard Musil indicated that the foot note (*) in tables 2 & 3 concerning draw lead application is confusing and may be misleading. The WG discussed this at length and agreed to replace the existing notes with a proposal submitted by P. Singh as follows:

“For draw lead application, the continuous current rating of the bushing is limited to rating stated on the bushing nameplate. ”

3c. Table 3, Dimensions for Bushings above 69 kV

The footnote (*) concerning draw lead will be revised as per note for table 2 in 4b above.

3d. Table 4, Cantilever Design Test Requirements

The test force columns in this table will be rearranged to show metric units as primary

3e. Table 5, Partial Discharge limits

A comment from Subhash Tuli suggested that we should use the wording “pico-coulombs” in place of “pico-coulombs or micro-volts”. This subject has been discussed in earlier meetings. The reason for this is that some customers ask for test data in micro-volts. The WG therefore decided not to make any changes. Also, the WG decided to maintain the word “corona” for background and external discharges.

3f. Editorial Comments

The rest of the comments were editorial in nature and will be appropriately addressed.

4. Next Step

Final results of the transformer committee ballot on Draft 6 and full comments will be discussed at the next spring meeting in New Orleans, LA.

5. Adjournment

The meeting was adjourned at 10:45 AM after one session. The other two sessions were yielded to Keith Ellis for the WG PC57.19.00 meeting.

7.2.4.2. Task Force on Draw-Lead Bushings

Chairman Russ Nordman reported that his eighth TF meeting was held at 2:50 PM on November 9, 1998 with 11 members and 12 guests present. Two guests requested for membership to the TF. He reported the following:

1. Minutes from the previous meeting

These were approved as written.

2. Information on Draw leads

- Methods of calculating thermal performance of drawleads were proposed and discussed.
- A hottest spot temperature calculation method was received from Dr. Frost . Investigation and comparison to other methods has not been completed.
- Test verses calculations information by Chungduck Ko was presented and discussed. Preliminary data suggests that it may be difficult to install a large draw-lead conductor in bushings and meet rated current. More information will be presented at the next meeting.
- It was suggested that a temperature limit of 120 C is considered reasonable for drawlead operation with paper insulation.
- The disagreement between bushing manufacturers and users regarding responsibility of draw-lead design still exists. Also, manufacturers are reluctant to share proprietary information. These issues must be resolved to complete comprehensive guidelines.
- It was proposed that cable size information from the transformer manufacturers survey be reviewed and see if we can come up with suitable sizes for the draw-lead ratings. The bushing manufacturers can then review these sizes and comment on their suitability.

3. Adjournment

Meeting was adjourned at 4:05 PM

7.2.4.3. Revision of C57.19.00

Chairman Keith Ellis reported that his first WG meeting was held at 10:55 AM on November 9, 1998 with 36 guests present. Twenty one guests requested for membership to the WG. He reported the following:

1. PC57.19.00

- Work on this WG began in the Bushing Subcommittee and Draft 3 had been sent to members of the bushing subcommittee
- Discussion on the comments to this survey was the first order of business for the WG. Progress was made discussing the comments and will continue at the spring meeting.

2. Adjournment

The meeting was adjourned at 2:35 PM

7.2.5. Technical Advisor to IEC/SC36A

Russ Nordman has accepted the assignment of TA as well as head of U.S. Delegation to the IEC Subcommittee 36A. He attended his first meeting on October 17, 1998 in Houston, Texas and reported the following:

- Lars Johansson is the new chair of the subcommittee. The Secy. Mr. Giorio Villa may be retiring after 27 years on the bushing subcommittee.
- Brazil has requested for membership to the subcommittee. National Committee to decide.
- All documentation is now required to be in electronic format. Word documents 6 or 7 are acceptable.
- A proposal has been issued to start work on a new standard for DC bushings.
- CENELEC Chair, Allen Pinet will be resigning. They are looking for a new Chair. WG4 is preparing a new standard dealing with dimensions for bushings above 36 kV.
- Transformer

7.2.6. New Business

- Bert Hughes made a comment on FOW bushing test problems during transformer testing. He made his comment during a discussion on the FOW test that is expected to be a part of the bushing standard as a special test. His suggestion was that FOW test be done before the bushings leave the factory especially when this test is specified for the transformer.
- A question was raised about the guidelines on draw-lead insulation. It was suggested that this information be covered in the TF on drawleads.

7.0 Reports of Technical Subcommittees (cont'd)

- A comment was made about the need for guidelines on Iso Phase Busduct applications. It was pointed out that some guidelines are included in C57.19.100.

These comments will be discussed at the next meeting and members were asked to send information/comments to Fred Elliott.

7.2.7. Adjournment

The meeting was adjourned at 12:10 PM

Minutes By: Pritpal Singh, Secretary

Bushing Subcommittee

7.3 Dielectric Test Subcommittee - L. B. Wagenaar, Chair

The Dielectric Test Subcommittee (DTSC) met on November 10, 1998, at 9:30 a.m., in Leon, Guanajuato, Mexico with 34 members and 46 guests present. Fifteen of the guests requested membership on the subcommittee. The minutes of the last meeting held in Little Rock were approved as written.

7.3.1 Chair's Remarks

The Chair reviewed some of the highlights of the Administrative Subcommittee held on November 8, 1998. (See Section 4.0 of the Transformer Committee Meeting minutes for details.)

- The next Transformers Committee Meetings will be held on Tuesday, April 13 - Thursday, April 15, 1998 during the IEEE PES T&D Conference in New Orleans. The meeting will begin on Tuesday PM and will continue through Thursday PM. There will be no fee specifically for the the Transformers Committee as this will be included with the registration fee for the T&D Conference. No fees will be involved for anyone taking part only in the Transformers Committee meetings.
- Some confusion exists on the information required by IEEE on re-circulation ballots. It was emphasized that any changes made to a document due to comments made in a ballot, as well as the basis of any unresolved negative votes, must be included in re-circulation ballots. This procedure gives the rest of the balloting pool a chance to pass judgement on the changes in the document and the validity of the negative votes.
- Ed Adophson, a member of the DTSC, passed away recently.

7.3.2 Working Group on Partial Discharge Tests in Transformers - J. W. Harley, Chair

The meeting was held in two time slots on November 9 with 58 members and guests. Minutes of the previous meeting, held on April 27, 1998 in Little Rock, were approved as written.

The ballot on PAR C57.127, Trial Use Guide for the Detection of Acoustic Emissions from Partial Discharges in Oil-Immersed Power Transformers, closed on June 19, 1998. Consensus was reached with 79 % return of ballots and 93 % approval rate. There were a number of editorial and technical comments. These improvements have been incorporated into the guide, and four negative votes remain. There is a good possibility of resolving two of these. However, the other two negative voters believe the guide should not be issued until all of the changes now being developed by the working group for the "Location" portion can be included. The working group decided to proceed with the "Detection" portion of the document at this time, and to proceed work on the "Location" portion for inclusion in the next revision of C57.127.

The first session was spent reviewing changes to the detection portion of the guide. The latest revision of the guide will be sent to the Working Group members before the New Orleans meeting.

In the second session, Tord Bengtsson ABB Corporate Research, Vasteros, Sweden, presented information on the detection, verification and location of partial discharges (PD) in power transformers using acoustic emission techniques. Tord discussed the frequency at which acoustic emissions occur and their inverse relationship to the magnitude of the PD from other signals occurring in the same frequency range, characteristics of materials in which the signals are propagated and how these materials affect the signal. He also explained the theory and operation of the three-transducer detector which he has designed and patented.

Dr. Hem Shertukde of the University of Hartford will discuss his experience with locating partial discharges with acoustics at the New Orleans meeting.

7.3.3 Working Group on Low Frequency Tests - Mark Perkins, Chair

The working group met on November 9 with 5 members and 15 guests present. Minutes of the previous meeting were approved.

The chair reported that changes to the induced test procedures in C57.12.90 have been forwarded to Subhash Tuli for inclusion in the next revision. These changes include the elimination of RIV limits and inclusion of apparent charge limits with a guarantee of 500 pC maximum level and a delta of 150 pC during the one-hour test.

Draft 1 of C57.113 revision was distributed to the working group, and plans for balloting this document were discussed. Comments from members of the working group were solicited before January 1, 1999, and the recommended practice document will be submitted to the IEEE for balloting after that date.

The working group discussed the need to begin the next revision of C57.113 and incorporation of digital PD measuring systems, which is expected to be the monitoring choice of the future. The working group will coordinate with IEC 270 working group on this revision.

The working group then discussed the need for changes in temperature correction factors for power factor of power and distribution transformers. Data from ABB, Smit and GE Prolec were distributed, and a summary of the data was presented. The data show considerable difference between power and distribution transformers. These differences are believed to be due to moisture content in the cellulose insulation. Additional data was requested, and several members volunteered to obtain results of power factor measured at different temperatures. It was also decided to use the average oil temperature for correction of power factor as the base temperature.

The final order of business was to discuss the need for a subcommittee survey of all the proposed changes to low frequency and transient tests in C57.12.90. It was decided that the following changes would be submitted to the chair of the Dielectric Subcommittee for such a survey:

1. Tests for repaired or rebuilt transformers
2. Tests on transformers with series or multiple connections
3. Test levels for 800 kV transformers.

7.3.4 Working Group on Revision of Transient Dielectric Tests - Bertrand Poulin, Chair

The working group met on November 9 with 14 members and guests present.

The first topic of discussion was the revision of C57.98, Guide for Transformer Impulse Tests. Subhash Tuli reported that the document had passed the reaffirmation ballot with 100 % approval rate. The question was then asked, "Has the PAR been submitted for this project"? The chair will clarify this following the meeting. Note: It was found after the meeting that a reaffirmed document does not need a PAR.

The remainder of the meeting was devoted to discuss comments and proposals from Pierre Riffon of Hydro-Quebec concerning that section of C57.12.90 dealing with impulse testing. Since Mr. Riffon could not attend the meeting, the proposals were presented by Raymond Lortie of IREQ.

The first proposal concerns the procedure for full wave lightning impulse tests. Clause 10.3.1.1 b) of the present standard states that when impulsing low-impedance windings, shorter tailed waves can be used provided that the capacitance of the impulse generator is equal to or greater than 0.011 μF . Mr. Riffon thinks that this is too loose in that it allows a manufacturer to use a shorter wave without trying to improve or optimize his test circuit. His proposal is to add the following wording to the standard:

The impedance of some windings may be so low that the desired time to 50 % voltage point on the tail of the wave can not be obtained with available equipment. In such cases, shorter waves may be used provided that:

1. The optimum impulse generator connection is used (use of parallel stages, largest available capacitance);
2. The available energy from the impulse generator with the actual test connection and charging voltage is 37.5 kJ."

Mr. Riffon's goal is to encourage manufacturers to obtain the best waveshape possible with available equipment when impulsing low impedance windings. Loren Wagenaar of AEP has already addressed this issue with a proposal to increase the amplitude of the impulse crest when the minimum required time to half value can not be achieved. Dr. Gustav Preininger of Austria indicated that he has already mathematically demonstrated that increasing the amplitude of an impulse will overstress other insulation parts of a transformer. The audience agreed but indicated that this is an important consideration and the standard must be changed. It was felt by those present that the former criterion is reasonable but the idea of requiring a minimum energy or capacitance for the test circuit would not accomplish much, and perhaps the idea of imposing an increase in voltage level with a cap should be revitalized.

Mr. Riffon's second proposal concerns clause 10.3.1.3 for the chopped wave test. The present wording allows an overswing of the opposite polarity to be limited to 30 % with the use of resistors in the chopping circuit. The presence of resistors in the circuit slows down the transition during chopping and reduces the severity of the test. Although Mr. Riffon agrees with

the concept of limiting the underswing to 30 %, he proposes to impose a limit to the transition time during the chopping to 0.31 μs when resistors are used. Those present agreed to this concept with the exception that 0.5 μs should be the duration limit instead of 0.31 μs .

Mr. Riffon's third proposal addresses switching impulse testing. Manufacturers sometimes can not achieve the minimum time to zero, mainly because they use resistors to load non-impulsed terminals which draw excessive energy from the generator. Although Mr. Riffon's proposal was not accepted, those present agreed with the idea that a manufacturer must do its best to achieve the required waveshape.

New wordings will be developed for all three of Mr. Riffon's proposals and circulated among members of the working group and subcommittee for comment

7.3.5 Status Reports

7.3.5.1 C57.138, Recommended Practice for Routine Impulse Test for Distribution Transformers

John Rossetti reported via a note to the chair that he had received a final copy of the document from IEEE Standards. The publication is listed as IEEE Std. C57.138-1998.

7.3.5.2 Working Groups on Continuous Revision of IEEE Stds. C57.12.00 and C57.12.90

The re-circulation ballot of C57.12.00, Standard General Requirements for Liquid Immersed Transformers, has been passed by the balloting group. The re-circulation ballot for C57.12.90, Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers, was sent out but stopped because it did not comply with the requirements (mentioned in 7.3.1).

7.3.6 Liaison Reports

7.3.6.1 Insulation Coordination - John Crouse

The Insulation Coordination Working Group has been balloted the revision of P1312, Standards for Insulation Coordination - Part 2, Application Guide. The standard has been approved by the balloting group and sent to the IEEE Standards Board.

7.3.6.2 Surge Protective Devices - Bob Degeneff

Bob Degeneff and the chair have reviewed the minutes of the September 29, 1997 meeting with representatives of the IEEE Surge Protective Devices (SPD) Committee Working Group 3.4.8 (Attachment 1). Their response, dated September 23, 1998 and shown in Attachment 2, repeats the IEEE Transformers Committee position given during this meeting. The main point of conflict is that the SPD curve shows an abrupt change starting at about 8 μs , whereas the TC curve is continuous at this point. The September, 1998 letter explains the reasons for recommending the TC curve. We have not yet received a response from SPD.

7.3.6.3 IEC TC14/WG24 - Loren Wagenaar

Loren has attended one TC14 meeting and two WG24 meetings since the last meeting of the subcommittee. One of the primary concerns of the TC14 meeting, held in October, was the latest version of the IEC 76-3 revision; almost a day was spent reviewing some 145 comments to this document. This revision is now to the point where it will be sent out one more time to receive essentially only editorial comments.

Both WG24 meetings dealt with the revision of IEC 722, Guide to the Lightning and Switching Impulse Testing of Power Transformers and Reactors. The main task of the working group is to incorporate more information about digital transient recorders. There seem to be two issues of discussion: The first issue involves how the instrument handles the data. The instrument manufacturers seem to have used mathematical smoothing techniques which, in the most extreme examples cited, can indicate a magnitude of 10 % higher than actual. Since there are already so many instruments which use this method in the industry, the guide will give some warning of this. The second issue involves the minimum sampling frequency. Some representatives recommend 100 MHz in order to capture the voltage wave fronts and current oscillations, whereas others think that 60 MHz is sufficient. This issue seems to be related to the first issue, and much of the existing instrumentation uses 60 MHz. Copies of the trip reports to the working group meetings are available to any interested parties.

7.3.6.4 CIGRE/IEC/PSIM Work on Waveforms and Test Data Generator (TDG) Program - Ernst Hanique/Bertrand Poulin

This item is related to the concern expressed above for the data smoothing techniques for digital transient recording instruments. As Mr. Hanique explained at the previous meeting, the TDG program was originally developed with 16 fixed standard wave shapes but no transformer wave shapes. IEC is presently developing software, in Windows 95, to generate waveforms to determine that the measuring system is acceptable. Ernst requests that non-standard waveshapes (for transformers) be sent to him so that the data could be used to check out the system being developed. The data which is submitted should be the raw, unsmoothed data, in accordance with IEC 1083 and IEEE 1122, which states that the user must have access to the raw data without processing.

A meeting is planned in New Orleans for manufacturers and any other interested parties on the subject of the TDG waveshapes. The chair will attempt to set the meeting up for the morning of Monday, April 12. The meeting will cover the method, input and use of the TDG.

7.3.7 Old Business

7.3.7.1 Tables in ANSI/IEEE C57.12.00

Based on work already done on C57.12.01 for dry type transformers and his recent work in IEC TC14, Phil Hopkinson believes that while C57.12.00 and C57.12.01 are more consistent in defining the ratio of induced test voltage to system voltage than IEC 76-3, the latter document is less confusing than the ANSI/IEEE documents in matching test voltages to system voltages. Attachment 3 was handed out to those present, and several tables currently in ANSI/IEEE

C57.12.00 were reviewed. Tables 3, 4, 6 and 8 contain only a limited amount of useful information, some of it redundant and some of it no longer necessary, whereas Tables 5 and 7 are less confusing and are good tables in general. Phil proposed three new tables, found in Attachment 3, which formulate the test values in a more consistent manner and show them in a more straightforward format.

Considerable discussion ensued concerning the direction to take next on this subject. Discussion points included the following:

- There is a considerable amount of history involved with these tables and their notes, and we must carefully decide what is still important and what is no longer necessary.
- Originally, lightning impulse test levels tended to dictate the test levels for the low frequency tests. The teachings of the Kaufman/Meador paper are the basis of the long term tests, and this started to change the tendency to separate the low frequency and transient test levels.
- The tables should be streamlined but we need to make sure that we do not lose anything meaningful. Emeritus members of this committee should be consulted.
- Since the tables concern both low frequency and transient tests, any task force set up should report to the subcommittee, rather than to one of the working groups.

It was decided to set up a task force reporting directly to the DTSC. Phil Hopkinson agreed to be the chair of this new task force, which will meet for the first time at the next meeting.

7.3.7.2 Activities to Revise IEEE 4

It was pointed out at the last meeting that the DTSC has not reviewed IEEE Std. 4 - 1995. Art Molden and Bertrand Poulin were asked to review the old and new documents and report at this meeting. In the mean time, Jin Sim has generated or found a list of changes, and these have been sent on the Art and Bertrand.

Bertrand Poulin also reported that IEEE 4 is being revised again. He could not attend the meeting, but will try to attend the next one.

7.4 Distribution Transformers – K.S. Hanus, Chair

7.4.1 Chair's Remarks & Announcements

The meeting convened at 2:30 PM in Room C with the introduction of the members and guests and signing of the attendance roster. There were 13 members and 16 guests in attendance.

Minutes of the meeting in Little Rock were approved with no changes.

The chairman covered key points of the ADCOM meeting from the prior Sunday afternoon. See Clause 4.0 for details.

New Working Group Co-Chair:

John Rossetti – Distribution Substation Transformers

7.4.2 Working Group Reports

7.4.2.1 Distribution Substation Transformers

The working group met with 9 members and 7 guests. The meeting focused on two items, which were the name of the document and the scope of document.

The discussion during the meeting covered a wide range of thoughts as to what type of transformers should be included in this standard. The working group finalized on the following as the scope of the document:

- 112.5 kVA thru 10 mVA three phase, 667 thru 6667 kVA single phase
- primary 4.16Y/2.4 kV thru 69 kV (350 kV BIL)
- secondary 208Y/120 thru 34.5 kV (200 kV BIL)

7.0 Reports of Technical Subcommittees (cont'd)

- single stage cooling
- station type or unit substation
- cover and wall mounted bushings
- No LTC's
- Power Class 1

The working group also discussed the need for a table which would cover the acceptable ranges of kVA and voltage ratios to keep someone from building a 10 mVA unit with 69kV high voltage rating and a 208Y/120 volt secondary.

Units of a padmount design will not be included in this document but will be included in the .34 padmount document.

The co-chairs will submit a PAR before the next meeting.

7.4.2.2 C57.15 Voltage Regulators

The working group met with 9 members and 7 guests.

The working group met to discuss the results of recent ballot. The ballot results were 86 ballots sent out, 65 returned with 4 abstentions, 58 affirmative and 3 negative votes.

The working group discussed the 3 negative votes. The negatives were partially resolved and mainly related to deviations from the existing C57.12.00 & C57.12.90 standards plus several editorial items. The co-chairs will continue to resolve the negatives and go for a re-circulation ballot if need be.

7.4.2.3 C57.12.20 Polemount Transformers

The working group convened with 8 members and 11 guests.

Alan Wilks informed the working group the recently mailed out complimentary copy of C57.12.20 contained many errors and an errata sheet has been issued. Carlos Gaytan was thanked for reviewing the document and finding the various errors, which resulted in the errata sheet. The content of that errata sheet was reviewed.

In old business the working group discussed the issue of the type C hanger brackets and the adapter plates shown in the annex. Ken Hanus stated he had determined the safety factor of 5 was adequate and a motion was made to drop the type C bracket and require a type B on the units currently designated to have a type C. The B bracket would have to meet the requirements of paragraph 6.2.4. The motion passed and then another motion was made to drop the two footnotes in paragraph 6.2.4 as they are now longer valid and it was decided they are not needed. The motion passed. With these two motions the issue of the type C hangers is resolved. The addition of wind loading requirements was also discussed but it was decided this was not needed. Ken Hanus will rework the annex wording to indicate the annex provides for adapter plates for existing transformers with type C hangers.

Another item of old business discussed was the issue of specifying surge arrester mounting boss locations. After discussion it was determined the most common spacing is 6" from the top with 2 ½" spacing for 21 kV arresters and below and 6" from the top with 9 ¼" spacing for 27 kV arresters. Both SiC, MOV porcelain and MOV polymer units will need to be considered along with spacings for sidewall primary bushings when developing any standard. Any standard will also need to include mounting boss size and thread depth.

7.4.2.4 P1388 Electronic Data Transmittal

The meeting convened with 5 members and 7 guests. New co-chair Jerry Smith reviewed the minutes of the last two meeting to bring the working group up to date. The current PAR had expired and a new one has been submitted and will be considered at the December standards board meeting.

The recently mailed out draft 4 was discussed and the remaining details to be resolved were discussed. Items discussed included:

- Primary and secondary voltage field widths as related to how voltage descriptions for units with multiple winding voltages would fit into the field widths. It was decided abbreviate descriptions if space does not permit the voltage description to filled in exactly as shown on the nameplate.
- Several editorial changes were pointed out and changes were made.

- The valid cooling classes were reduced from four to two classes. The two classes dropped referred to power class transformers.

It was noted that throughout the document various terms were used to describe users and producers. It was decided to use “User” and “Producer” in the document.

The co-chair will incorporate these changes into draft 5 and will mail it to the working group for review before the end of the year. If possible, comments will be resolved before New Orleans and the document will be sent out for IEEE ballot next year.

7.4.2.5 Coating Integrity Documents (.28, .29, .31 & .32)

.28 Padmount Enclosures- Document is out for re-ballot due to one negative. The negative relates to the dimension of the probe tip, either a 0.100” or 0.065” dimension.

.29 Padmount Enclosures-Coastal Environments – Same report as for .28.

.31 Polemount – Nothing to report at this time.

.32 Submersibles – The document has been updated and is currently out for working group ballot.

7.4.3 Old Business

Ken Hanus covered the status of the .33 document as relates to actions taken at the last ANSI meeting. The current document has been modified to include NEMA TP-1 and will be sent out to working group members for review. After that review the document will be sent out for IEEE ballot in January 99.

7.4.4 New Business

John Borst noted the upcoming hearing on January 6, 1999 in Washington DC concerning DOE's advance notification of energy efficiency test procedures.

Leon Plaster brought up the issue about the lack of good guidelines covering the conversion of English to metric values. The only two documents known to address the issue is one by IEEE and Canadian standard Z234.1-89. Ken Hanus has the assignment to develop a guide for the working groups to use. This will promote consistency among the documents.

Tom Prevost mentioned the C57.12.26 document is slated for administrative withdrawal by the standards board if no further action is requested. C57.12.34 will be supercede .26 and therefore a two year extension will give C57.12.34 enough time to be approved and replace .26.

7.4.5 Working group assignments

The current assignments are as follows:

Dist. Subst.	Leon Plaster/John Rossetti
.20	Glenn Andersen / Alan Wilks
.21	Ali Ghafourian
.22	Ken Hanus
.23	Al Traut/Roger Lee
.25	John Lazar / Ali Ghafourian
.26	Ken Hanus
P1388	David Rolling/Jerry Smith
.35	Ed Smith
.33	Tom Pekarek/Don Duckett
.34	Clyde Pearson/Ron Stahara
57.15	Tom Diamantis/Craig Colopy

The meeting adjourned at 3:15 PM.

7.5 Dry-Type Transformers - W. F. Patterson, Chair

7.5.1 Chair Remarks and Announcements

The Dry Type Transformer Subcommittee met at 10:55 AM on November 10, 1998 with 20 members and 6 guests present. Introductions were made and the attendance roster was circulated. Minutes from the November 18, 1997 meeting were reviewed and approved. Announcements were held until after the working group reports were given.

7.5.2 Working Group Reports

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

7.5.2.1 WG Thermal Evaluation C57.12.56/60 and Flammability	R. Provost
7.5.2.2 Dry Type General Requirements	A. Jonnatti
7.5.2.3 TF Dry Type Smoothing Reactors IEEE 1277	R. Dudley
7.5.2.4 WG Dry Type Loading Guide C57.96	M. Haas
7.5.2.5 WG Dry Type Test Code C57.12.91	D. Barnard
7.5.2.6 WG Dry Type Hot Spot Differentials	P. Payne

7.5.2.1 Working Group on Dry-Type Thermal Evaluation - C57.12.56/60, and Flammability

Chair: Mr. Richard Provost

There was no meeting of this working group at the meeting due to Chairman Provost being unable to attend. SC Chairman Patterson made several announcements regarding the status of the working group:

Rick Marek circulated a letter for Chairman Provost detailing the status of the two documents:

C57.12.60 has been published and WG members should receive a copy from the IEEE.

C57.12.56 has been re-affirmed.

Chairman Provost has stated that the next order of business for the working group will be the consideration of several issues:

The use of partial discharge testing as end-point criteria for thermal evaluation.

The inclusion of additional models in the standards.

The merger of C57.12.56 and C57.12.60 into one document.

7.5.2.2 Working Group on Dry-Type General Requirements – C57.12.01

Chair: Mr. Anthony Jonnatti

Secretary: Mr. John Sullivan

The working group met in the city of Leon, Guanajuato, Mexico on November 9, 1998. Twelve members and twelve guests attended the meeting. Six guests requested membership. Chairman Anthony Jonnatti opened the meeting at 2:50 PM. After introductions, the minutes for the Spring meeting at Little Rock, Arkansas were approved.

Mr. Jonnatti announced that the new C57.12.01 standard would be printed in December. He reminded the working group that the revised standard included changes to noise levels and hottest spot modifications.

Chairman Jonnatti briefly reviewed the comments returned during the last balloting process.

A discussion about adding definitions for sound pressure and sound power to the standard took place. Wesley Patterson stated that the purpose of using sound pressure was because the human ear responds to pressure. The sound level requirements in the standard are to satisfy noise complaints by individuals. Jeewan Puri proposed using sound power as a way to demonstrate compliance.

The discussion to include transformers 600 volts and below was continued at this meeting. The task force of Gene Morehart and Wes Schwartz reviewed the issue and recommended that transformers 600 volts and below be included in C57.12.01.

The discussion then turned to potential conflict with NEMA concerning ST-20. Wesley Patterson recommended that a referral to ST-20 be included in C57.12.01. Phil Hopkinson recommended adding ST-20 to C57.12.01. Phil volunteered to explore this concept with NEMA.

Chairman Jonnatti next enumerated issues for revision to C57.12.01 – 1998. He also expressed the goal to identify all issues for revision by the Spring 1999 meeting in New Orleans. He plans to resolve those issues by the Fall 1999 meeting. The following were identified by Chairman Jonnatti:

Page 1, Scope If transformers below 601 volts are to be included the scope must be changed and a decision with respect to specialty, testing and welding transformers must be made.

Page 3, Paragraph 4 – Service Conditions. Minimum ambient temperature stated in 4.1.2.2 is – 25° C.

Page 4, 4.2.5 (18) – Unusual Service Conditions. Add a statement on parallel operation.

Page 6, Table 2B. Review test system accuracy requirements for temperature of +/- 2.0 C.

Page 6, revised table 3A eliminates old tables 3A and 3B. There are also two IEC harmonization issues:

IEC calls for negative impulse.

1. IEC does not call for a chopped wave test.

Page 10, Partial Discharge. Recommendations have been made to increase the test level from 110% to 125%.

Page 9, Paragraph 5.10.4. The word “Taps” is new.

Page 13, Paragraph 6.2. Review paragraph on tank or enclosure finish.

Page 16, Have a discussion on final temperatures during short circuit.

Page 18, Change the test order referred to in footnote 1 to table 7.

Two additional items were discussed.

1. Should flame retardency be addressed for harmonization? IEC includes tests for flame retardation.
2. Should reference to seismic zones be included onto C57.12.01?

Chairman Jonnatti recognized Roger Wicks of DuPont and Chuck Johnson of ABB as well as the entire working group for their contributions to the working group.

Being no further new business, the meeting was adjourned at 5:08 PM.

7.5.2.3 Working Group on Dry-Type Reactors - C57.16

Chair: Mr. Richard Dudley

On Nov. 9, '98 the Dry Type Reactor W.G. met from 8:00 a.m. – 9:15 a.m. and from 9:30 a.m. – 10:45 a.m. in Meeting Room C of the Fiesta Americana Hotel in Leon, Mexico. There were 4 members and 2 guests present. The following are the highlights.

1. The attendance list was circulated.
2. The minutes of Little Rock meeting were approved.
3. Draft 8 will be produced in sufficient time prior to the New Orleans meeting to allow for a survey ballot of the HVDC Converter Transformers & SMR S.C., the Performance Characteristics S.C. and possibly the Power Transformers S.C.
4. L.E. Juhlin volunteered to provide missing drawings for D8; specifically those related to oil immersed SMRs.
5. Klaus Papp's rewrite of ANNEX D on S.C. testing was distributed. It will be included in D8.
6. The current D7 was discussed. Editorial and clarification changes were made during the meeting and will provide a starting point for D8. The following are the highlights of discussions on D7.
 - (i) In Annex D, Section D.3, "spiraling effect" will be added as a critical stress for oil immersed SMRs.
 - (ii) Very few oil immersed SMRs of low power rating have been manufactured. Therefore power transformers on which S.C. tests have been performed can be used as comparators for S.C. calculations. In the case of dry type air core SMRs, S.C. tests on other reactor types can also be used for comparison purposes. The validity of such comparisons must be justified.

- (iii) References to AC LA standards will be eliminated as they are not applicable.
- (iv) Construction details for dry type air core smoothing reactors will be included in Section 7. Items to be included are lifting, mounting (leveling or levelness of foundation; including a tolerance), grounding practice, ancillary equipment (sound shields), terminals (loads, corona protection, connection practice) and magnetic clearances.
- (v) ANNEX C will remain.
- (vi) The letter “E” will continue to be used for voltage.
- (vii) ANNEX’s B, C and D will be labeled informative annexes.
- (viii) ANNEX A; content?
- (ix) It was agreed that the calculation method for determining harmonic losses (Section 12.3.5.2.3) is inaccurate. Pierre Riffon demonstrated that harmonic losses were off by a factor of 3 vs measurement. Therefore the harmonic losses for oil immersed SMRs will be determined by measurement as for dry type air core SMRs. Section 12.3.5.2.1 will be modified accordingly.
- (x) A number of modifications were made re the “DC Voltage Withstand Test”. It was more appropriately renamed the DC Pollution Test; to be carried out on the bushings of oil immersed SMRs and the support insulators of dry type air core SMRs.
- (xi) The “Vibration Test” for oil immersed SMRs was eliminated as being not applicable. Due to the high DC current loading vibration is not an issue.
- (xii) In Section 11.4.1 which covers the “AC Applied Voltage Test with PD Measurement” the CIGRE reference paper (2) will be referred to re the rationale for the test.
- (xiii) Digital impulse test systems are readily available today and therefore the “modified turn to turn” test is no longer necessary. This test will be eliminated but a digital impulse test system **MUST** be used. References to cathode ray oscillogrammes will obviously have to be eliminated. The impulse test sequence will also be modified to reflect the elimination of the “modified turn to turn” test.
- (xiv) Section B.3 will be modified to include a comment on the type of and content of pollution.
- (xv) Should the recommendations re ambient temperature in IEC 111, “Guide On General Conditions” be utilized in D8? An average 24 hour ambient of 35°C is recommended vs the 30°C currently used in IEEE standards. Three low temperature classes are defined; -25°C, -40°C, -50°C.

The meeting adjourned at 10:45 a.m. The Chairman agreed to produce D8 for a survey ballot prior to the New Orleans meeting.

7.5.2.4 Working Group on Dry-Type Loading Guide - C57.96

Chair: Mr. Michael Haas

The working group met at 9:30 AM in Room A of the Fiesta Americana Hotel in Leon, Mexico with 5 members and 9 guests present.

After the introductions, the minutes of the Little Rock, AR meeting were approved as written.

The chairman reported that all of the changes that were submitted in the survey of the Working Group and the Dry Type Sub-Committee were incorporated in a new draft and the draft was submitted to IEEE for balloting. The invitation to ballot closed on 11/5/98 and the draft was expected to be sent out to the ballot pool for comments within the next two weeks.

There being no further business, the meeting was adjourned.

7.5.2.5 Working Group on Dry-Type Test Code - C57.12.91

Chair: Mr. Dave Barnard

Secretary: Mr. Tim Lewis

The working group met at 8:00 AM, November 9, 1998 in the Diamante Room of the Fiesta Americana Hotel, Leon, Mexico. There were 10 members and 10 guests. Six of the guests requested membership.

Introductions were made and the minutes of the Little Rock, AR meeting were approved as written.

OLD BUSINESS: The group was reminded of the need to incorporate test procedures for making hottest spot measurements once the working group on that subject has completed its work.

NEW BUSINESS:

1. The chair asked for a volunteer to compare C57.12.90 with C57.12.91 for the purpose of bringing before the working group items in the liquid filled standard which should be considered for inclusion in this standard. Don Kline stated that he has made this comparison and will report on his findings at the next meeting.
2. Loss Measurements. Oscars Petersons, NIST, reported that the DOE is to publish on November 10, 1998 a notice of proposed rulemaking and a public hearing on test procedures for distribution transformers, with regard to the work on a possible DOE energy conservation standard for distribution transformers. The notice will be posted on the WEB on November 10, 1998 and printed in the Federal Register on November 12, 1998. The public hearing will be held on January 6, 1999 in Washington DC.
3. The direction of this working group will continue to be the creation of a test code that is technically correct and user friendly.
4. Don Kline offered to bring a comparison between TP2 and C57.12.91 to the next meeting.

7.0 Reports of Technical Subcommittees (cont'd)

5. Chuck Johnson offered to provide the chairman suggested wording to add to the standards next revision which will clarify the location for attaching leads to a transformer when making loss measurements.
6. Phil Hopkinson stated that reference to the Partial Discharge guide needs to be added to the next revision of this standard. The chair will look into adding this reference.
7. The chair asked Wes Patterson for guidance as to the reaffirmation or revision of this standard before it automatically expires in the year 2000. Revisions must be sent out for ballot by the next meeting, if any or a request for reaffirmation should be submitted.

There being no further new business the meeting adjourned at 9:10 AM.

7.5.2.6 Working Group on Dry-Type Hot Spot Differentials

Chair: Ms. Paulette Payne

The Working Group met at 8:00am in Room G of the Fiesta America Hotel with twelve (12) members and eleven (11) guests. The membership of the Working Group is fifteen (15). The minutes of the April 28, 1998 meeting were approved as written.

The Chair gave results of Draft 2.1 balloting:

- 45 ballots sent
- 34 ballots received (75% return)
- 25 approved
- 7 approved with comments
- 2 abstentions.

Working Group discussion focused on substantive comments of balloters, as all editorial comments will be incorporated into the next Draft.

R. W. Simpson: *Clause 3. Definitions – Including “Temperature rise” seems redundant (and could be confusing) since you already have “average winding temperature rise” and “maximum winding temperature rise” defined.*

Resolution: The Working Group voted unanimously to retain the definition of temperature rise, as it is a common terminology in use.

Klaus Papp: *Clause 4.1 Temperature Sensors - “Thermometers” are not listed as an applicable temperature measurement device. In section 4.2.3 “Attachment of Temperature Sensors” thermometers are mentioned. I suggest including thermometers in the list of applicable*

temperature measurement devices in 4.1. If however there is a specific reason to exclude thermometers from this list, then the reason should be addressed.

Resolution: From the discussion, it was agreed that thermometers are not applicable; all references to thermometers will be removed from the document.

Wes Schwartz: *Clause 5.2 Effects of Winding Hottest Spot Temperature Rise – add to the listing:*

f. Coil configuration (round, rectangular)

g. Core effects, losses/magnetic effects.

Resolution: The Working Group unanimously agreed to include the items as noted above.

Rick Marek, Michael Hass, Klaus Papp, and Lars-Erik Juhlin: *Equations 1 and 2 calculation of hottest spot temperature rise – The symbol $\Theta c'$ used in equations 1 and 2 on page 14 differ from the symbol $\Theta' c$ defined thereafter.*

Resolution: The symbol as defined after the equations will be corrected to $\Theta c'$.

Rick Marek: *This document is a “Guide” and as such should not use the word “shall” in accordance with the IEEE Style Manual (pages attached).*

Resolution: The text will be revised as required in accordance with the IEEE Style Manual.

5.3 Transformer Model – The word “must” used in the second paragraph should not be used. Reference to IEEE Style Manual is attached.

Resolution: The text will be revised as required in accordance with the IEEE Style Manual.

5.3.1.3 – References to epoxy thickness are missing. The following is suggested:

e. Large thickness of epoxy such as the tap area.

Resolution: The Working Group unanimously agreed to add the item to the listing.

Linden Pierce: *Annex A Bibliography – Remove notes 1, 2,3 and the note after A15. The reason is that some of the papers pertain to both analysis and testing, etc. for example A15. Let’s simply let the user obtain any reference he wishes or all and determine the applicability.*

Resolution: **The text will be removed from the Annex as recommended.**

Annex B Figure 1 – Remove Figure 1 or replace with a figure more representative of actual test data. My data and others submitted to the Working Group indicates that the temperature profile is steeper than that shown. Unless the plot can be substantiated with test data it should be removed since it may not be possible to get agreement within the Working Group or when it is balloted by IEEE.

Resolution: **The Working Group unanimously agreed to remove the figure from Annex B since the curve could vary based upon winding configuration and dimensions.**

The Chair noted receipt of editorial comments from the IEEE Editor, and addressed the more substantive comments during the meeting:

Italics in equations: The use of Italics in equations should be limited to the variables. Numbers should not be italicized.

Resolution: **Numbers in Italics of equations 2 and 3 will be corrected.**

Annex B Table: The table in [B] 4.1 has insufficiently clear column headings. Please explain them, either in the text or in the table itself. (What does "Thermometer" refer to? What is "T/C"? "Stickers"? "Infra red"?)

Resolution: **The Chair will revise the text to provide clarity.**

These were all the comments received from the ballot survey.

Jewan Puri expressed concern over convincing certified agencies that requirements are met stating that the calculation method provides substantial information, but the measurement technique is not as clear. He recommended more detail be included on (1) winding types, (2) hot spot locations and (3) how models correlate and what are the differences between models. Jewan also recommended guidance as to what defines equivalence of model (thermal duplicate).

Chuck Johnson stated we have defined five unique methods of testing based on gathered body of discrete data giving a pass/fail criteria. Wes Patterson stated that numerous winding configurations exist, there is a need to be generic, not exclusive of any winding configurations of future. Richard Dudley expressed concern of making the Guide rigid; Dhuru Patel concurred that detailing requires precision. Linden Pierce remarked that the Guide reflects the state-of-the-art. Deemed by the membership impractical to detail windings, the recommendation is to add discussion to the Introduction and that the definition of thermal duplicate be considered for future revision of the Guide as it would take considerable time to develop.

Chuck Johnson stated that proving the model could take 300 thermocouples for defining the hottest spot temperature location. For any units in the design family, thermocouples can be placed at the predicted hottest spot locations based upon design model test data. Jewan Puri stated that there is a need to share experiences on where hot spots are, and what a thermal duplicate is.

Resolution: Linden Pierce recommended and the Working Group unamously agreed that if the term thermal duplicate is not used in the Guide, the definition in clause 3 should be removed. Linden Pierce and Jewan Puri will provide an addition to the Introduction concerning issues for future direction of Working Group efforts to maintain the published document state-of-the-art.

There were no other comments from the floor. The Chair stated that she would revise the document and submit it for a balloting pool vote. Being no further business, the meeting adjourned at 9:15am.

7.5.3 Announcements and New Business

After the working group reports, the following announcements were made by the Chair:

The chair discussed issues raised at the ADCOM meeting:

Regarding negative votes on ballots; when the recirculated ballot is sent to the ballot pool, the comments that accompanied the negative ballot and the resolution of the negative ballot should be sent along with the recirculated ballot. Phil Hopkinson will

supply the chair with a copy of a document use by the IEC to address this issue. PAR forms will now be posted on the Internet at standards.ieee.org. The form should be downloaded from the Internet, completed, and submitted to Tom Prevost who will submit the PAR to the IEEE.

The Standards Association member number is the same as the IEEE member number. Fees for the Standards Association now appear on the IEEE membership renewal and should be paid to insure members can vote on the standards.

The Spring 1999 meeting will be held in New Orleans, Louisiana and will coincide with the T&D show. The meetings will be held on Tuesday through Thursday instead of Monday through Wednesday. It was recommended that reservations be submitted early due to the expected large number of attendees at the T&D show. Reservations should be made on the Internet at www.99ieeet-d.org. The meetings will be held at the convention center.

The chair then reviewed the status of all standards maintained by the subcommittee. The status of these documents can be found in the main committee minutes.

Phil Hopkinson discussed an inrush study on step-up transformers he had performed that indicated that very high currents are present in this application. A discussion ensued on the possibility of presenting a paper at the next transformers meeting. The subcommittee voted to have the chair to try to arrange time during the second session of the subcommittee meeting for the presentation

Being no further new business, the meeting was adjourned at 11:50 AM.

7.6 HVDC Converter Transformers & Smoothing Reactors S. C. - Richard Dudley, Chair

The HVDC Converter Transformers and Smoothing Reactors S.C. met in the Diamanti Room of the Fiesta Americana Hotel in Leon, Mexico on Nov. 9, '98 from 2:50 p.m. to 4:10 p.m. There were 5 members and 2 guests present. The following were the highlights.

1. The minutes of the meeting in Little Rock were approved.
2. The attendance list was circulated and is attached.
3. The Chairman reviewed the status of the converter transformer standard. Reballoting resulted in 3 negatives and 10 approved with comments. RFD stated that he would work to resolve the negative ballots and would assess the 10 approved with comments. The objective is to have C57.129 approved early in 1999. An extension to the PAR is required.
4. Pierre Riffon briefed the S.C. on the highlights of a meeting of IEC TC14 held in Houston Texas, Oct. 19-21, '98. They are as follows:
 - (i) Pierre Riffon submitted comments on the IEC draft converter transformers standard. Harmonization with the IEEE document was the objective. All Pierre's comments were accepted.
 - (ii) The IEC converter transformer standard is at the committee draft for voting stage. This is the last opportunity to make substantive comments. The next stage will be final draft version international standard. The total anticipated time to a final published document is 2½ to 3½ years.
 - (iii) IEC are planning an application guide for converter transformers. A first draft will be available in 1999. Estimated time to complete this project is 5 years.
 - (iv) IEC will establish a W.G. to review IEC-289, Reactors. Pierre Riffon suggested at the meeting of TC14 that 289 be subdivided based on reactor type. If this were done a separate sub document could be developed for HVDC SMRs. Participation on this W.G. of individuals who will represent IEEE's point of view re requirements and test code for HVDC SMRs is very important. This will facilitate the harmonization process.
 - (v) As an example of how difficult harmonization can be Pierre mentioned that the IEEE DC bushings standard (IEEE C57.12.03-1996) be referenced in the IEC converter transformer standard as there is no similar IEC document. His proposal met with resistance and was not accepted.
5. D7 of the IEEE SMR standard was reviewed. Discussions were a continuation of those conducted during the meeting of the Dry Type Reactor W.G. The following are the highlights.

- (i) IEC 111, Guide For General Conditions was reviewed re its possible application to IEEE P1277; specifically the ambient temperature guidelines. S.C. consensus was that the ambient temperature guidelines must be first accepted for inclusion in C57.12.00; e.g. 24 hour average of 35°C and –25°C, -40°C and –50°C low ambient temperature classes. It should be noted that ambient temperature is the temperature of the cooling air.
- (ii) The “a.c. power test” presented in Section 12.11 can be carried out at any frequency between 50 Hz and 1000 Hz.
- (iii) Pg. 22; retesting of “old” SMRs should be at impulse test levels 10% above the LA protection level.
- (iv) For the polarity reversal test the last reversal is to be held for 45 minutes with p.d. levels being documented for the first 30 minutes and monitoring only during the last 15 minutes.
- (v) The Chairman agreed to produce D8 for a survey ballot of the HVDC Converter Transformer and SMR S.C., the Performance Characteristics S.C. and possibly the Power Transformer S.C. prior to the next Transformers Committee meeting in New Orleans.

The meeting adjourned at 4:15 p.m.

Richard F. Dudley

7.7 Instrument Transformers - J. E. Smith, Chair

7.7.1 Chair's remarks & Announcements:

The subcommittee met on Nov. 10, 1998 with 3 members and 4 guests present.

- The meeting was chaired by R. McTaggart because J. Smith was unable to attend.
- A report on the Administrative SC meeting was presented
- The minutes of the April 27, 1998 meeting were approved as written.

7.7.2 Working Group Reports:

7.7.2.1 WG C57.13.5 - Working Group on Test Requirements for High Voltage Instrument Transformers 115 kV and above – Pierre Riffon

The WG had two sessions. It met on November 9 and 10, 1998. Five members and eight guests attended the meetings. The meeting was chaired by Mr. P. Riffon since Mr. J. Ma was not able to attend the meeting.

The minutes of the Little Rock meeting were approved.

The last draft (Ed. 15.10.1998) on Trial-Use Guide of Test Requirements for Instrument Transformers Rated 115 kV System Voltage and Above was discussed. The decisions made during the Little Rock meeting has been reviewed together with the associated changes made into the draft. This meeting also focused on routine and type tests procedures and flowcharts.

A) The decisions made for routine tests were:

- Figures 1 and 2 were accepted as presented. It has been pointed out that the winding resistance measurement should be moved before the performance characteristic tests;

- The reduced impulse test level should be changed to 50% to 70 % in order to give more freedom to the laboratory. This change shall also be applied for type tests (impulse and switching);

- Only two levels should be specified for the capacitance and dissipation factor tests, the first one being the 10 kV level and the second level being the maximum rated voltage;

- The maximum partial discharge level (10 pC) should be added in clause 5.7;

- Clause 2.1.6 should be more detailed in order to include all test possibilities (between windings and between windings and tank);

- The height of the metallic structure used during tests has been discussed. It was a general consensus that this matter should be put in a section dealing with "General Test Conditions". Participants did agree that the height of the structure used during tests shall be equal to or lower than the structure used in service. Moreover, the height of the structure used during tests shall be reported in the test report;

- The Applied Voltage Test and Partial Discharge Tests on the Primary Winding (clause 5.7) has been discussed. All participants did agree that the duration of partial discharge extinction voltage should be limited to 30 seconds. If the partial discharge level after the 30 seconds period is higher than the maximum allowable level, the test may be prolonged to a maximum time of 10 minutes. If after 10 minutes, the partial discharge level is still higher than the maximum allowable limit, the unit is considered to have failed the test.

B) The decisions made for type tests were:

- Figures 3 and 4 have to be modified in the same way as described for Figures 1 and 2 (winding resistance measurements to be done before "Performance characteristics tests"). Moreover, a note should be added beside the Temperature Rise Test and Short-circuit Withstand Tests. This

note should say that these tests can be performed at any time if the routine test sequence is to be performed after each individual type test;

- Measurement of the secondary transferred voltage during impulse tests has to be deleted since the impulse tests have to be performed with the secondary windings shorted and grounded;

- The chopped wave tests with a chopping time of 1,5 μ s should be deleted because this test is considered less severe than the one with a chopping time of 3 μ s;

- The duration of the Applied Voltage Withstand Test and Partial Discharge Tests has been extensively discussed. L. Wagenaar from AEP suggested to apply the extinction voltage level for one hour as it is prescribed for bushings. After discussion, the majority of participants was in favor to keep it to a 10 minutes duration. The success criteria should be applied only at the end of this 10 minutes period. In addition, the value recorded after 30 seconds shall be reported in the test report;

- Table 8 has been reviewed and the same levels than those given in Table 5 should be given. No criteria should be given for the water content after type tests.

C) General concern

- The scope should also address the reasons for which this document has been written (e.g. reference to the EPRI study). The scope shall also indicate that this guide is giving more stringent requirements regarding testing performance than the actual C57.13.

- It was a consensus that this document should, few years after its first publication, be a part of C57.13. It is meaningless to keep two classes of HV instrument transformers. The cost increase due to a more severe testing procedure will not be too significant.

Members did agree to revise (editorial and technical) the last draft and give their comments to Joe Ma before the end of January 1999. The revision has been split in the following way:

7.0 Reports of Technical Subcommittees (cont'd)

- Sections 1 and 2 by Mr. Tom Nelson;
- Sections 3 and 4 by Mr. R. McTaggart and Mr. P. Zhao;
- Section 5 by Mr. V. Khalin;
- Sections 6 and 7 by Mr. A. Jonnatti;
- Section 8 by Mr. L. Wagenaar.

Mr. P. Riffon and Mr. J. Ma will work on the description of the Temperature Rise Test and on the Short Circuit Withstand Test procedures as well on the Special Tests which are still missing or not described fully. These additions will be included in the next draft. Then, the WG will have a quite complete document after the next meeting in New Orleans. After the next meeting, the document is expected to be ready for a survey ballot within the subcommittee.

7.7.2.2 Working Group on C57.13 Revision - Tom Nelson

The working group met on Nov. 10, 1998 with 5 members and 3 guests present. A 2 year extension on this PAR has been requested, since the present one expires this year. Tom Provost reported that he had not heard back from IEEE on this, but that he felt the extension would be granted. A draft copy of the standard will be circulated before the next meeting.

7.7.2.3 WG C57.13.6 – Working Group on Instrument Transformers for use with Electronic Meters and Relays – Ross McTaggart

The working group met on Nov. 10, with 4 members and 5 guests present. It was chaired by R. McTaggart because C. Ten Haagen was unable to attend.

The minutes of the previous meeting were approved as written.

The latest revision of C57.13.6 was reviewed and received the following comments:

- In Table 2, footnote 2 is to be added

7.0 Reports of Technical Subcommittees (cont'd)

- There was some opposition to the 0.15% accuracy requirement @ 5% I_{rated} in Table 1 – it was proposed to change it to 0.3% if C. Ten Haagen agrees.
- Clauses explaining how to use the standard are to be added
- Clarification is needed regarding the applicable range of burdens – ie does the .15% class apply also to the C57.13 burdens? If so, they should be repeated in C57.13.6
- It was agreed that we should not try to incorporate this in the next C57.13
- Before balloting, R. McTaggart will solicit comments from AEP, Hydro Quebec and Ontario Hydro

Draft standards for low-power Instrument Transformers from the PSRC and IEC TC 38 WG27 were distributed for information. These documents are geared more to non-conventional IT's for relaying applications, whereas in this WG we are dealing with high accuracy metering applications. Both documents incorporate voltage outputs from current transducers. It was agreed that this was beyond the scope of this WG. The possibility of setting up another WG will be discussed at the next Subcommittee meeting.

7.8 Insulating Fluids - F.J. Gryzkiewicz, Chair

The Insulating Fluids Subcommittee and its Working Groups met concurrently in Leon, Mexico on Monday and Tuesday, November 9 and 10, 1998. In attendance were 20 members and 51 guests.

The Subcommittee minutes of the April 27 and 28, 1998 meeting in Little Rock, Arkansas were approved as submitted.

7.8.1 Current Subcommittee Projects

7.8.1.1 C57.130 - Trial Use Guide for the Use of Dissolved Gas Analysis During Factory Thermal Tests for the Evaluation of Oil Immersed Transformers and Reactors - Frank Heinrichs, Chair

A Recirculation Ballot was conducted on Draft 13 prior to the meeting in Leon. Ten negative ballots were received. All negative ballots resulting from Draft 12 of this document have been resolved. Draft 13 of this document has been sent to IEEE Headquarters for a Recirculation Ballot.

7.8.1.2 P1258 - Trial Use Guide for the Interpretation of Gases Generated in Silicone-Immersed Transformers - Jim Goudie, Chair

Draft 9 of this document has been sent to IEEE Headquarters for a Recirculation Ballot. The results of this ballot will be known prior to the next meeting in New Orleans.

7.8.1.3 C57.106-1991 - IEEE Guide for Acceptance and Maintenance of Insulating Oil in Equipment - Joe Kelly, Chair

The Working Group met on Monday, November 9. Draft 1 of this document was thoroughly reviewed. Numerous changes were recommended. Draft 2 will be sent to Working Group members prior to the next meeting in New Orleans.

During the Working Group meeting, it was suggested that load tap changer oil be included in the revised Guide. Bernhard Kurth, Reinhausen, Mfg. Will prepare the section dealing with topic and send it to the Working Group Chair for inclusion in Draft 2. The Working Group Chair discussed the subject of load tap changer oil with Bill Henning, the Working Group Chair for Load Tap Changer Performance. It was agreed that the Insulating Fluids Subcommittee would

write this section and forward it to the Load Tap Changer Performance Working Group for review.

WG members at this time are Joe Kelly, Frank Gryszkiewicz, Gene Kallaur, Fredi Jakob, Patrick McShane, Harold Moore, T. V. Oommen, George Reitter, J. A. Thompson, Charlie Raymond, Peter Balma, John Lackey and Bob Turcotte. Bob Turcotte has volunteered to do the electronic editing of the Guide.

7.8.1.4 C57.104-1991 - IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers - Frank Heinrichs, Chair

The Working Group met on Tuesday, November 10. The Working Group Chair, Frank Heinrichs was unable to attend these meetings. Draft 1, Part 1, was reviewed at the last meeting in Little Rock. Draft 1, Part 2, was reviewed at our meeting on Tuesday. The comments received will be incorporated into Draft 2 which will be sent to Working Group members prior to the next meeting in New Orleans.

Bob Turcotte of Hartford Steam Boiler Inspection & Insurance Company will contact IEEE Headquarters to obtain the electronic file for this document as now published. This will make future editing changes easier.

7.8.1.5 C57.139 - Dissolved Gas Analysis in Load Tap Changers - Rick Youngblood, Chair

The Working Group met on Tuesday, November 10 and reviewed Draft 1 of this document. Comments received will be incorporated into Draft 2, which will be sent to Working Group members prior to the next meeting in New Orleans.

The Working Group Chair, Rick Youngblood, currently has DGA data on approximately 11,000 load tap changers. Several guests at the meeting felt that more data was needed to incorporate threshold values for DGA which will be included in the Guide. Rick has more data to add to his database and requested that, others who have data forward the data to him.

7.8.1.6 C57.121-1989 - Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers

This document has been approved the IEEE Standards Board and will soon go to print.

7.8.2 Other Business:

At the Administrative Subcommittee Meeting on Sunday, November 8, the Insulating Fluids Chair was informed that two documents, which are under the jurisdiction of the Subcommittee, had reached their five-year life and would be withdrawn by the Standards Committee at their next meeting in December. These documents are:

A. IEEE Standard 637 - IEEE Guide for the Reclamation of Insulating Oil and Criteria for its Use

The Subcommittee felt that this was still a very useful Guide and voted to submit this document for a Reaffirmation Ballot.

B. IEEE Standard 799 - IEEE Guide for Handling and Disposal of Transformer Grade Insulating Liquids Containing PCBs

The Subcommittee felt that this Guide no longer contains state-of-the art information. In addition, it was pointed out that Federal and State regulations govern the handling and disposal of PCBs. In view of the foregoing, the Subcommittee voted to request withdrawal of this Guide.

7.9 Insulation Life - L. W. Pierce, Chair

The Insulation Life Subcommittee met Nov. 10, 1998 at Leon, Mexico with 25 members and 33 guests in attendance. The minutes of the April 28, 1998 meeting in Little, Rock were approved as written.

7.9.1 Announcements by Chair

1. A panel session on transformer thermal modeling will be held at the 1999 IEEE T&D Conference. A "Call for Papers" which appeared in the Power Engineering Review resulted in 4 papers.
2. A new Working Group will be formed to update the 1995 Loading Guide, C57.91. EPRI reports on the investigation of Bubble Evolution were supplied to the Chair by Dr. T. V. Oommen for revision of that section. Other possible issues to be addressed include a) adding insulation life curves and clarifying that section, b) incorporating a variable ambient into the Clause 7 equations, c) adding a simplified version of the Annex G equations, d) adding voltage regulators previously covered in C57.95-1984 to the scope, and e) correct errors.

7.9.2 New Business

The major activity of the meeting included discussion of 8 proposals for revisions of C57.12.00 and C57.12.90 which resulted from the most recent ballots of those documents. These were mailed to the members prior to the meeting. Those not in attendance were permitted to mail a ballot prior to the meeting.

Proposals 1 and 2 to remove the "(When Specified)" and "*" notes from C57.12.90/D5 were considered by the Working Group for that document prior to the Insulation Life Subcommittee meeting.

Proposal No. 3: C57.12.90/D5 Clause 15 item c) 6) Thermal Performance Data. Add "item vii) winding resistances corrected to reference temperature for the thermal test tap position" was approved by a vote of 23 to 2.

Proposal No. 4: C57.12.90/D5 Clause 15 item c) 6) vi) Thermal Performance Data. Replace "maximum" with "each". The revised item reads, "Calculated winding hottest spot temperature rise over ambient for each rating". This was approved by a vote of 26 to 3.

Proposal No. 5: C57.12.00/D4 Clause 5.11.1.3 Rise of Metallic Parts Other than Windings, Change first sentence in this clause as follows: "Metallic parts in contact with current-carrying conductor insulation shall not attain a temperature rise in excess of 80 °C." There was a lengthy discussion. This proposal was deferred for further study.

Proposal No. 6: C57.12.00/D4 Clause 5.11.1.3 Rise of Metallic Parts Other than Windings. Change second sentence to read, "The temperature rise of other metallic parts, including the tank, shall not exceed 100 °C at maximum rated load. After lengthy discussion this proposal was deferred for further study.

Proposal No. 7: C57.12.00/D4 Table 19. Change Tolerance on temperature from ± 1 °C to ± 2 °C. This was deferred for further study.

Proposal No. 8: C57.12.00/D4. Figure 4. Dimensions of Thermometer Well. Change to show metric dimensions being predominant over English dimensions. It was decided to let the IEEE editor follow current IEEE metric practice.

7.9.3 Status Report on C57.119

Bob Grubb reported on PC 57.119, "Recommended Practice for Performing Temperature Rise Tests on Oil-Immersed Power Transformers at Loads Beyond Nameplate Ratings". This document has been successfully balloted. Bob is working on editorial changes and preparing the documentation for submittal to the IEEE Standards Board.

Summaries of the reports of the Working Groups and Task Forces were not given due to time but are included in the minutes as follows:

7.9.4 Task Force on Hottest Spot Temperature Rise Determination - Don Platts, Chair

The Working group met on Monday, Nov. 9, 1998 with 23 members and 27 guests in attendance.

The PAR application for a "Guide for Determination of Maximum Winding Temperature Rise in Liquid Filled Transformers" was approved by IEEE and assigned the number P1538. A draft 2.0 was revised by Linden Pierce to address negative comments from the previous draft 1.0. A new clause 6.0 addresses a calculation method for winding hottest spot temperature using thermal test data and prior experience with thermal modeling or tests with direct measurement. Each of the three respondents who had returned negatives during the survey of draft 1 indicated that the changes satisfied their concerns, and they could now vote to approve.

The Chair asked for comments on the latest draft. None of the meeting attendees had comments. Draft 2.0 will be sent to IEEE for formation of a balloting pool and ballot.

The other item on the agenda was to review the comments returned during the ballot of C57.12.00 that pertain to items under the scope of the Subcommittee and Working Group. Each of the 6 comments relating to Clause 5.11, "Temperature Rise and Loading Conditions" were reviewed as follows:

1. A request was made to place definitions of "rated secondary voltage", and "rated Current" into the definitions clause. The consensus was that if these terms are defined in C57.12.80, then no change is required. D. Platts will investigate.
2. A proposal to change the reporting requirements for the hottest spot temperature was offered as a way to resolve J. Corkran's negative ballot was withdrawn. D. Platts will contact him to determine if he wants the Working Group to pursue it.
3. Loren Wagenaar submitted a negative and requested that the hot spot rise over average winding rise be limited to no more than 15 °C, so that users could predict overloading capabilities before ordering a transformer. This request was also submitted during Working Group surveys and was rejected. Some designs utilize a lower average winding rise and higher hot spot rise to achieve an optimum design. Lin Pierce pointed out that this would be a drastic change from the present standard, and would severely constrain manufacturers. The Working Group agreed to keep the present requirements and wording.

4. Len Stensland made a comment that 5.11.1.1 appears to be inconsistent with the Forward. He will be contacted for clarification.

5. Suggested editorial changes to wording were rejected.

6. Al Traut submitted a negative with a request that the methods for determining the hot spot be amended to add a fourth option of; "Adding 15 °C to the average winding temperature rise for distribution transformers 500 kVA and below with a secondary voltage of 600 volts or less".

He does not believe that the present requirements enhance the applications of distribution transformers, which are purchased as commodities.

The Chair reiterated the objective to define a method of proving compliance with the hottest spot requirement, not necessarily to enhance the application of the units. Steve Snyder offered supporting comments, stating that the hottest spot rise over average rise in these units does not approach 15 °C. This would be a conservative and cost effective alternative for the manufacturer who couldn't or did not choose to do a detailed analysis.

Mike Barnes noted that similar statements had been discussed at each of the prior meetings, and requested a vote of the Working Group to reject this request. The vote was 29 to 1 to reject.

Additional comments. Subhash Tuli noted that as written each manufacturer will have a wide range of values to use as an H factor for his designs. He suggested that we could develop a list of design criteria for the appropriate H factors. It was decided that this could lead to a very complicated project and there were no volunteers to undertake such a project. Bob Grubb stated that he is working on a technical paper that addresses this topic, but it will be some time before it is complete.

7.9.5 Working Group on Thermal Duplicate - Barry Beaster, Chair

The Working Group met on Monday November 9, 1998 with six members and eighteen guests attending. Rich Hollingsworth of Howard Industries and Chris Simmons of ABB, South Boston were added to the membership.

The meeting was devoted to developing the framework for a new guide document, which was entitled, "Guide for the Definition of Thermal Duplicate Liquid-Immersed Distribution, Power, and Regulating Transformers. The PAR has been approved and assigned the number P1524. Bob Grubb stated that the original work was not intended to define criteria for Design Tests, but rather to set guidelines for power transformers in deciding whether a thermal tests was to be performed. This raised the issue whether distribution transformers should be removed from the scope of the guide. After the meeting this was discussed with Linden Pierce, Chair of the Insulation Life Subcommittee and he stated it should include distribution transformers.

Mark Perkins raised an issue regarding the application of the new Guide on the Hottest Spot Temperature Rise Determination and its effect on using earlier designed units as thermal duplicates. The discussion concluded that there would be sufficient test data on the measured variables to still use the original design and the determination of the hot spot rise on the new unit would have to follow the new guide on hottest spot temperature rise.

The issue of presenting the document as a Guide, Trial Use Guide, or as a Recommended Practice was raised. Several in attendance believed it should be either a Standard or Recommended Practice, while others believed it should be left as a Guide. A vote of the members attending were tied at three each. The issue was reviewed with the Insulation Life Chair who stated it should be a Guide as stated on the approved PAR.

Volunteers David Aho, Chuck Simmons, and Robert Grubb agreed to write drafts for the new document. David Aho and Barry Beaster will provide example calculations to be included in the Annex.

7.9.6 Task Force on Winding Temperature Indicators - V. S. N. Sankar, Chair, M. F. Barnes, Secretary

Mike Barnes conducted the meeting for V. S. N. Sankar who could not attend. The Task Force met on Monday Nov. 9, 1998 with 3 members and 19 guests in attendance. One new member was added.

The focus of the meeting was to determine the direction of the Task Force. The unanimous decision was that the objective of the Task Force will be to prepare a technical paper which will define the winding temperature behavior of the transformer. The paper will present the "problems" of winding temperature indicators along with supporting calculations and/or experimental data. It will not pose solutions, as some of the solutions may not yet exist.

The scope of the paper will initially cover all transformer sizes and cooling modes for which winding temperature indicators are utilized, even though the original problem posed before the task force was for specific situations with certain types of large transformers, under heavy overload conditions. The scope can be narrowed later, if covering all the possible varieties makes the task too complex.

The Task Force will not prepare a guide or a standard, as it was decided that the first step is to define the problem, and a technical paper is the best forum to accomplish that. It was pointed out by Jin Sim that the latest approved revision of C57.12.10 paragraph 9.1.6 contains a statement regarding the use of WTI's in overload situations.

The objective for the April '99 meeting will be to have a detailed outline for the technical paper ready for review. This outline will have gone through extensive preparation and discussion, and will not be a first draft. Ideally the Task Force will also have some initial text. A small group was chosen to do this, headed by Barry Ward. The group consists of V. S. Sankar, Jin Sim, Sam Hall, Mike Barnes, Phil McLure, and Bob DeVecchio. Linden Pierce and Bipen Patel have volunteered to review and critique the material. The group will collect and document data, information and experiences from other users and manufacturers as well as their own.

7.9.7 Working Group on Revision of Temperature Test Code (Section 11 of C57.12.90) - George Henry, Chair

The Working Group met on Monday November 9, 1998 with six members and eighteen guests attending. Linden Pierce presided for George Henry who could not attend. Draft 6 of Revision of C57.12.00 Section 11 was mailed to the Working Group members prior to the meeting. Draft 6 contained many revisions to address comments from previous surveys. A review and discussion of the document indicated that the Clause 11.2.2 on Hot-Resistance measurements needed additional

work. The document will be revised again and mailed to the Working Group prior to the April 1999 meeting.

7.9.8 Ballot Review Committee on IEEE PC57.12.100, "IEEE Standard Test Procedure for Thermal Evaluation of Liquid-Immersed Distribution and Power Transformers".

Draft 5 dated Feb. 26, 1998 was balloted by IEEE with the following results.

145 people in ballot group, 119 voted for a 82 % return.

110 Affirmative votes, 3 abstention votes, and 6 negative votes for 94 % affirmative.

A ballot review committee (BRC) formed in accordance with Annex B of the IEEE Standards Companion met Nov. 9, 1998 at the IEEE Transformers Committee meetings in Leon, Mexico to review the negative ballots. The members of the committee were as follows:

Linden W. Pierce, Consultant, Chair

Ron Barker, Virginia Power

John Borst, ABB T&D Company

Bob Grub Waukesha Electric Systems

Don Lowe, Howard Industries

Steven Snyder, Kuhlman Electric Corp.

There were also 16 guests in attendance and they were permitted to participate in the discussions.

Proposed rebuttals and resolutions of the six negative ballots were prepared by Linden Pierce and mailed to the committee prior to the meeting for review. The action of the committee in regard to the negative ballots is summarized as follows:

1. G. Preininger, Consultant, Graz, Austria

Mr. Preininger submitted comments stating that he did not believe the document was applicable to power transformers. The ballot review committee determined that the comments attached to his negative ballot were not valid. The negative ballot did not suggest a resolution. The objection that the test procedure is not valid is not supported by the opinions of others in the balloting pool. 110 of 116 balloters voted affirmative. The 110 balloters consisted of manufacturers, users, and general interest. The vote of the producers was unanimous in that 41 of 41 voted affirmative. The validity of the test procedure is based on industry experience which is documented in the references given in Annex B.

The document is a standard test procedure to follow if a thermal evaluation program is undertaken. It is not mandatory that all transformer manufacturers conduct a thermal evaluation test program on their products. It is not one of the standards listed in C57.12.00-1993, "IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers". The standard may become mandatory only when required by a duly constituted legal authority, or when specified in a contractual relationship.

2. Lars-Erik Juhlin, ABB Power Systems AB, Ludvika, Sweden

Mr. Juhlin suggested that the following two sentences be deleted from Clause 11:

"For these reasons, caution should be exercised in applying the results of thermal evaluation tests to designs other than those actually tested. In particular, when it is intended that an evaluation apply to a number of different transformer ratings, the test samples preferable should be of the rating in which the design stresses are the highest".

The ballot review committee determined that these two sentences are valid for power transformer models and will be retained in the final draft.

3. Joe D. Watson, Florida Power & Light, Juno Beach, FL

Mr. Watson voted negative and submitted two comments. He attended the meeting and participated in the discussion of his comments.

Comment Number 1: The comment stated that the end point dielectric test level for power transformers should be 100 % of the design level instead of the 65 % stated in the document.

The rebuttal was as follows: The correct value for end point dielectric tests is a subject of debate and it is very difficult to arrive at the correct value. At one extreme are those who believe that useful life ended only when the transformer was unable to carry rated load at rated voltage. At the other extreme are those who believe that transformers which could not sustain the standard tests given to new transformers were unfit for further use, since they believe that the probability of failure on abnormal currents or voltage would then be high. The consensus was that the end point test level should be 65 % of design level because that represented the maximum value used for insulation tests in the field. Since such tests presumably are intended to insure serviceability of the apparatus, the 65 % should be adequate for end point tests. This issue was reviewed at the March 30, 1992 meeting of the Working Group at which time the 65 % end point test level was adopted for power transformers.

Although the comment has some validity an increase in the value would not be consistent with past experience in conducting thermal evaluation tests. The ballot review committee thought that if the value were increased than more negative ballots would result and thus reduce consensus. This negative was the only negative relative to this issue of the 116 ballots returned.

The ballot review committee determined that no changes were required to the main document as a result of this technical comment. A paragraph incorporating the rebuttal comments will however be included in the Introduction. The Introduction is not considered part of the document.

Comment Number 2: This stated that Figure 1 was incorrect. Figure 1 was reviewed with Mr. Watson and he agreed that it was correct.

Mr. Watson agreed that his negative was resolved and would submit an E-mail acknowledgement.

4. Roger Wicks, Dupont, Wilmington, DE

Mr. Wicks submitted 14 comments of which 12 were editorial. Comments no. 1 and 9 were technical and the basis of the negative ballot. The ballot review committee determined that changes were required as a result of his technical comments.

Comment No. 1. This pointed out a discrepancy in the definition of "maximum hottest conductor temperature (MHCT)" in two different documents. The MHCT-10 phrase was developed by the P1276 Working Group. The C57.100/D5 in Annex A.4 Uses MHCT to mean "Maximum hottest conductor temperature". In C57.100/D5 it was intended that the MHCT would be 110 °C for the current cellulose systems. This was based on an 80 °C hottest spot rise plus the 30 °C ambient. This is reflected in Figures 1 and A1 and equations 1 and A2 which show the stated life of 180000 hours and 65000 hours at 110 °C for the models and sealed tube aging tests as listed in the document. There has been no change from previous drafts 3 and 4 of the document. IEEE 1276 however defines MHCT to be 10 degrees higher (or 120 °C) than the MHCT (110 °C) used in C57.100/D5 because it was defined in that document as based on the 40 °C maximum ambient. Thus there is a discrepancy between the definition of MHCT in the two documents.

Resolution: The ballot review committee adopted the following resolution. The term "maximum hottest conductor temperature", (MCHT) will be replaced with "Rated hottest spot temperature". No changes to IEEE 1276 will then be required.

Comment no. 9. Mr. Wick's suggested resolution was accepted. The sentence in Annex A2 which states, "A minimum moisture content of 0.25% and a maximum of 0.50% by weight of cellulose insulation is required as measured by the Karl Fischer method." will be changed to, "A minimum moisture content of 0.25% and a maximum of 0.50 % by weight of solid insulation is required as measured by the Karl Fischer method".

5. Richard L. Provost, Dupont, Wilmington, DE

Comment No. 1 and 2. Draft 5 omitted Informative Annex B in Draft 4. Mr. Provost's comments 1 and 2 stated that the Working Group should meet to consider this prior to the ballot. The ballot resolution committee rejected this resolution. As noted in the minutes of the 1996 meeting the remaining question to be resolved was to get EPRI approval to use the text and pictures in Annex B. Annex B was an Informative Annex. It was not possible to obtain EPRI approval or to obtain the pictures or figures. This accounts in part for the delay in balloting of the document. Larry Lowdermilk, Working Group Chairman discussed this issue with Linden Pierce, Chairman of the Insulation Life Subcommittee. Since Annex B was an Informative Annex the only practical solution appeared to be omit the EPRI material from Annex B. References were given in a revised Annex B which should allow the user to obtain information on prior test programs and models. Except for omitting the EPRI material from Informative Annex B, there were no substantive changes from the previous Draft 4 approved by the Working Group and the Insulation Life Subcommittee. Only editorial changes were made in Draft 5 to conform to the IEEE Style Guide, improve the appearance, and improve the legibility of the figures. The decision to omit the EPRI material and proceed to ballot draft 5 was considered to be within the discretionary authority of the Working Group and Subcommittee Chairs.

Comment No. 3. This comment stated that a definition of "hottest spot temperature at rated load" was not in C57.12.00-1993. This referred to the definition of rated load and the sentence will be changed by inserting a comma to clarify the sentence.

Comment 4. This comment stated that the A constant in Clause 1.2 and Equation A2 should be the same since the insulation material in both cases was cellulose. The rebuttal is as follows: Equation 1 is for full size distribution transformers or power transformer models. Life testing experience has

shown that a life of 180,000 hours can be expected at 110 °C. This is reflected in Equation 1 and Figure 1. Equation A2 and Figure A1 are for sealed tube aging tests of cellulose paper. The end point criteria is 50 % tensile strength. A characteristic of the paper tested under these conditions is that the life at 110 °C is 65000 hours. It should be noted that both equation 1 and equation A2 contain the constant 15000 which is a characteristic of cellulose. The different constants of 27.064 and 28.082 are used to account for the different life expectancy, i. e. 180,000 hours and 65,000 hours. The constants are different because the equations describe two different test methods on two different test specimens with different end point criteria and different life expectancies at 110 °C.

Comment 5. Comment 5 was editorial stating that temperature rise should use the symbol "K" instead of "C". Although this may be technically correct this is not the practice in IEEE standards prepared by the Transformers Committee. The use of the letter "K" instead of "C" for temperature rise we will follow the practice to be used in C57.12.00 and C57.12.90 which will be submitted to the Standards Board in 1999.

Comment 6. This comment was accepted.

The title of Clause 12 will be changed from "Degree of Polymerization test" to "Other Tests". The following language will be added after the existing paragraph.

"The Degree of Polymerization (DP) measurement, while applicable to cellulose insulation materials, is not necessarily applicable to other polymeric materials, such as polymeric enamels or aramid papers. For materials not cellulosic in composition there may be other tests which have more relevant correlation to the aging process. Although there are no proven tests which have been correlated with thermal aging and tensile strength reduction, several techniques are available which would be more relevant than DP for synthetic polymers. Possible suggestions would be measurement of "average molecular weight" or "molecular weight distribution", or other comparisons such as results obtained from Differential Scanning Calorimeter (DSC) or Thermal Gravimetric Analysis (TGA)."

6. Robert Whearty, Dupont, Marlton, NJ

Mr. Whearty suggested the ballot be withdrawn and the Working Group convened to discuss his comments. The ballot review committee determined that this is not in accordance with IEEE Standards Procedures. This would only delay the standards making process and give greater significance to the comments of one balloter. If this practice were extended to all ballots on all standards then no documents would ever issue.

Mr. Whearty submitted 5 comments. These were similar to those by Roger Wicks and Richard Provost, also of Dupont. The rebuttals and resolutions of the comments are described as follows:

Comment 1 and 5. Rebuttal. Similar comments and same response as Comment 1 and 2 by Richard L. Provost.

Comment Nos. 2 and 3. Rebuttal. Similar comments and same response as Comment 4 by Richard L. Provost.

Comment 4. Comment similar and resolution same as for comment No. 1 by Roger Wicks.

Respectfully Submitted by:

Linden W. Pierce

Insulation Life Subcommittee Chair

7.10 Performance Characteristics - D. J. Fallon, Chair

7.10.1 Introduction/Attendance

The Performance Characteristics Subcommittee (PCS) met at 8:00 a.m. on Tuesday, November 10, with 31 members and 21 guests in attendance.

7.10.2 Approval of Meeting Minutes

The minutes of the April 28, 1998, PCS Meeting in Little Rock, Arkansas, were approved as written.

7.10.3 Chairman's Remarks

7.10.3.1 Administrative Subcommittee Notes

Several items from the discussions held at the November 8, 1998, Administrative Subcommittee meeting were highlighted as follows:

1. The next Transformers Committee meeting will be held in New Orleans, LA, in conjunction with the T&D Conference. Committee Meetings will be held from Monday, April 12 through Thursday, April 15, 1998.
2. Concern was expressed for the need for more attendance and participation by end users in order to better balance the ratio of manufacturers to users.
3. Volume 1 of the GSU Failure Survey, including the responses to the question form, will be published shortly by IEEE. Volume 2, containing data and information supplied in addition to the form responses, will not be published at this time due to continuing discussion over concerns with legal ramifications.
4. The recent Recirculation Ballot of C57.12.90(D5) has been declared invalid, due to procedural errors. A new Recirculation Ballot, complete with the negative ballots, resolutions, and rebuttals, will be carried out as soon as all the required documentation is assembled.
5. The C57.109 Guide for Transformer Through Fault Current Duration will expire shortly. Bipin Patel, who led the effort when that document was approved, suggested proceeding for reaffirmation. Jin Sim suggested some review of C57.109 in relation to the recently published (or nearing publication) C37.91 Guide for Protective Relay Applications in Power Transformers. Ron Barker has agreed to coordinate the reaffirmation effort. PCS members with thoughts on issues in C57.109 that might require review and/or modification should contact Ron.
6. A standards interpretation request related to temperature rise tests and loss determination was reviewed and responded to this summer. The request and response are included at the end of the PCS minutes. The Chairman has received verbal word that the questioner is seeking further clarification, and a written request has been received subsequent to the meeting.

7.10.3.2 Membership

New Members: Chris Wickersham (CCW & Associates) was added to the roster.

7.10.4 Agenda Changes

None

7.10.5 Working Group Reports

7.10.5.1 Revisions to C57.12.90 - Pierre Feghali (Subhash Tuli reporting)

Subhash Tuli and Don Platts served as Co-Chairs in the absence of Pierre Feghali, and the WG met at 9:30 a.m. on Monday, November 9, 1998 with 11 members and 32 guests in attendance.

Mr. Tuli reviewed the ballot results for C57.12.90. There were seven (7) negatives and many comments with the affirmative ballots. Six of the negative ballots were resolved or withdrawn. One ballot remained negative. The document was recirculated, but due to a procedural error (while the error was unintentional, the documentation did not include sufficient disclosure and discussion on the negatives) that recirculation ballot was declared invalid.

The WG spent the meeting discussing means of resolving Linden Pierce's negative ballot. Mr. Pierce explained the two separate issues involved in his objections to Clause 15 (c) 6, part of the "certified test data" in the thermal performance data:

- In the newly revised wording "Thermal Performance Data (when specified)*", the phrase "(when specified)" would require users, even when certified test data is required, to further indicate that thermal test data be supplied on the certified test report. This would apply to all classes of transformers.
- In addition, the "*" in the above wording is used to indicate that thermal test data for distribution transformers will only be supplied "when specified" by the user. Mr. Pierce felt that this note was inappropriate, particularly for the larger sizes of distribution transformers, where he felt thermal test data would be routinely needed by users.

Mr. Pierce asked that the WG address these two issues separately. The first item was taken care of quickly, with WG members voting 9 - 0 to remove the phrase "(when specified)" from Clause 15 (c) 6. Discussion on the second issue was a bit more involved.

Mr. Pierce noted that while distribution transformers are typically considered to range in capacity from 50 to 500kVA, ANSI/IEEE documents include discussion of three phase pad mount transformers and secondary unit substation transformers as distribution transformers, and these can range in capacity up to 2500kVA, or even 5000kVA. Any user who wanted to evaluate harmonic loading impact or loading

capability beyond nameplate for these larger “distribution” transformers would require and expect thermal performance test data in the certified test report. Mr. Pierce proposed as a compromise that the note state that thermal test data is not required for transformers up to 500kVA.

The WG then discussed the options of 500kVA and 2500kVA as an appropriate limit. Items raised in this discussion included:

- C57.12.00, Table 17 provides test requirements for units less than, or greater than, 500kVA.
- The product standard for distribution transformers, C57.12.26, has an upper limit of 2500kVA.
- Distribution transformers covered under the Draft document for electronic test data transmission should not have an added requirement for thermal data.

The WG next developed a proposal to replace the single asterisk “*”, with the note that test items identified by the “*” would not be required for distribution transformers 500kVA and smaller. Discussion continued on the appropriateness of the two proposed kVA limits, with no clear resolution, and a vote was requested on Mr. Pierce’s proposal, including the note that thermal test data is not required for transformers up to 500kVA.

After additional discussion, the WG members voted 8 to 2 against accepting this proposal. Mr. Pierce requested that the minutes reflect the WG members’ votes. Messrs. Fallon and Matthews voted for Mr. Pierce’s proposal, and Messrs. Corkran, Sim, Cash, Wickersham, Khalim, Antweiler, Sampat, and Tuli voted against.

Jin Sim proposed another vote with 2500kVA as the limit. This proposal passed 8 to 2 (Messrs. Corkran, Sim, Cash, Wickersham, Khalim, Antweiler, Sampat, and Tuli voting for the proposal, and Messrs. Fallon and Matthews voting against).

Mr. Pierce then raised a question of whether thermal performance data falls under the responsibility of the Performance Characteristics Subcommittee (PCS) or the Insulation Life Subcommittee (ILS), suggesting further that the ILS will review this item before the next revision of C57.12.90.

The two items approved at this meeting will be included in the next recirculation of C57.12.90 (D5), to be sent out to the Balloting pool shortly.

There being no further time for discussion of and new business items, the meeting was adjourned at 10:45 a.m.

7.10.5.2 57.133 Guide for Short Circuit Testing - Nigel McQuin (Don Fallon reporting)

The Working Group did not meet in Guanajuato. The Chairman forwarded a report that this document had been submitted to IEEE for ballot in March. Due to possible difficulties at IEEE that ballot has not yet taken place. The Chairman is re-submitting the ballot request to IEEE, in the expectation that the Ballot will proceed shortly. Jin Sim noted that there had been no survey document sent out prior to Ballot, as this

document is essentially identical to the Annex from C57.12.90. PCS Chair Don Fallon requested members to consider in the ballot process that the S.C. Test Guide will go out of publication shortly if this Ballot is not approved, as the Annex has been removed from the revision of C57.12.90. If concerns for the Ballot on C57.133 can be expressed as comments to an approved ballot, then this needed document will stay in print and any comments will be reviewed by the WG for future revision.

7.10.5.3 Revision of C57.110 - R. P. (Rick) Marek

The Working Group for the revision of the IEEE Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal load Currents met at 8:00 A.M., November 9th, 1998 in the Turquesa room at the Fiesta Americana Hotel in Leon, Guanajuato, Mexico. There were 8 members and 3 guests present. After introductions, the Chairman reviewed the report submitted for the spring 1998 meeting.

The Chairman informed the working Group that the revised document, PC57.110/draft 7, was approved by the IEEE-SA Standards Board on July 2, 1998. Also, on August 19, 1998, the Transformers Committee rejected the appeal by Jerry Frank. The IEEE Editorial Staff indicated that the document was scheduled for publication by the end of October. However, as of November 4, the editing was not yet complete and no new date was set.

The Chairman then requested volunteers to assist in the editing review, if help was needed. Chuck Simmons and Dudley Galloway offered to assist. There was no further old business.

For new business, the Chairman introduced the topic of the future status of the Working Group. He also suggested that, since the revision involved many changes and additions, the document should be used for a year or two before any revision is considered. This would allow time for general application, which would hopefully provide some feed back. The Working Group agreed. The Chairman noted that in the next revision, some harmonizing with C57.18.10 was necessary, concerning the variable subscripts. Don Kline commented that IEEE 519 was being revised now and that in the future, all three documents should be harmonized.

There being no further new business, the meeting adjourned at 8:15 A.M.

7.10.5.4 Loss Tolerance and Measurement - Ramsis Girgis

The WG on loss tolerances and measurement met at 4:15 p.m. on Monday, November 9, 1998, with 7 members and 18 guests attending.

The meeting was to start with a report on the activities of the TF on “low Power Factor power measurement.” The Chairman of the TF could not attend the TF meeting. The Chairman of this WG used the opportunity to discuss with TF members issues with the Guide on “No-Load and Load Loss measurement.”

In the WG meeting, a number of suggested improvements to the Guide were discussed and decisions were made on which to implement, as is, not implement, or

implement with modification. The improvements enhance the accuracy and completeness of the Guide. Two of the more important improvements made are removing the less accurate, seldom used NLL test circuits of Figures 18 and 19 and providing a more generic description of advanced voltage and current transducers as well as calibration techniques.

Another item discussed in the meeting was the new loss tolerance criteria which replaced the tolerance table in section 9.3 of C57.12.00. The Chairman explained the statistical basis for the change and the difference between an acceptance criteria and guaranteed levels given for economic loss evaluation purposes.

The plan now is to produce draft #A of the Guide for PCS review before the next meeting in New Orleans.

The meeting was adjourned at 5:30 p.m.

7.10.5.5 Semi-Conductor Rectifier Transformers C57.18.10 - S. P. (Sheldon) Kennedy

(Don Fallon reporting)

The Working Group did not meet in Guanajuato. The Chairman forwarded a report that this document, Standard Practices and Requirements for Semi-Conductor Rectifier Power Transformers, had been approved by IEEE earlier this year and is expected to be published shortly. The Chairman will communicate with WG members to solicit discussion at the next meeting on review of any open items. If there is no immediate need for further review, this WG may disband until review is appropriate after the document has been in use for one or two years.

7.10.5.6 Revisions to C57.12.00 - Donald W. Platts

The Working Group met on Monday, Nov. 9, at 1:20 PM. We had 6 members and 26 guests who signed in as attending.

The minutes of the prior meeting were not distributed directly to members, and no approval was requested.

We reviewed the status of the ballot of C57.12.00. Draft #3 produced 17 negatives and many comments. Draft #4 addressed many of those. It was re-circulated and received a 90% approval.

We reviewed the purpose of the WG. It is to address PCS issues in C57.12.00, on a continuous basis, as items are brought up.

The WG began the process of reviewing and addressing the comments submitted by 38 balloters responding to Draft #4. Those were prescreened to include issues for PCS. To accomplish this, the Chair asked those attending to split into 4 groups and each was given several of the comments to review.

Before the April meeting, the Chair will coordinate the reviews done by members and guests. Those that fall under the scope of other Subcommittees will be forwarded.

The items that have been addressed will be documented. The remaining items will be prioritized and a listing sent to WG members as the agenda for our next meeting.

The meeting was adjourned at 2:55.

7.10.5.7 Switching Transient Induced by Transf./Breaker Interaction - Bob Degeneff (Secretary Peter Balma reporting)

The Working Group on Switching Transients Induced by Transformer/Breaker Interaction was called to order at 4:25 PM on Monday November 9, 1998. There were 16 members and 17 Guests present. Introductions were made, and the minutes of the April 27, 1998, meeting in Little Rock were accepted without comment.

After presentation of the agenda for the meeting, discussion began with a brief review of the goals for the working group which are to:

- Identify the problem and key relationships
- Provide guidance/education
- Discuss mitigation methods
- Provide Examples

One suggestion was to utilize as much information as possible from the C37 series of standards, in particular ANSI/IEEE C57.010 was highlighted. Various members of the group also indicated the value of several IEC standards. As a result of the importance of the breaker to this problem, Bob Degeneff indicated that Dr. Allan Greenwood a leading expert and author in this area has agreed to assist in the development of this guide.

The discussion continued with an in depth review of the latest version of the table of contents suggested for this guide.

Table of Contents

- I. Overview
- II. Scope / Applicability / Limitations
- III. System Configurations of Concern
- IV. Transformer Characteristics
- V. Supply Characteristics
- VI. Load Characteristics
- VII. Circuit Breaker Characteristics
- VIII. System Voltage Response
- IX. Mitigation Methods

- X. Annexes
 - A. Numerical Examples
 - B. Bibliography
 - C. Tutorial

Each item in the Table of Contents was discussed, and some additional thoughts on this problem and the guide considered the following:

- A generic circuit illustrating the problem was reviewed. It would be the basis for system configurations of concern. It was suggested that several circuits would be needed and that both ANSI and IEC standards should be reviewed for input.
- Autotransformers may require special consideration due to their lower capacitances.
- All styles of breakers will have to be considered i.e., vacuum, gas, air, etc.
- Loading of a transformer has a significant effect on interactions and will require definition. Unloaded transformers have the highest risk for dangerous interactions, and high power factor loaded units the least.
- Chopping, particularly that of a vacuum breaker, needs to be analyzed.
- Is there a simple external test that could be made on a transformer to determine frequencies of concern? If such a test was possible interactions could be avoided with proper design.
- As a part of system voltage response, all aspects of an arrester application must be considered to determine if any level of protection will be provided. Frequently an arrester will provide little or no protection for a breaker/transformer switching interaction.
- Capacitors and resistor networks provide an effective tool to minimize the impact of interactions.

Documentation for submittal of a PAR has been obtained, and based on the discussions at this meeting will be submitted in the next several weeks.

All members and guests were asked to submit examples of transformer failures due to breaker/ transformer switching transients, or any reference material that will assist the working group.

The group concluded its activities with an excellent presentation made by Phil Hopkinson. The topic was Mitigating Techniques to Minimize Switching Surge Problems.

After the presentation, a request for any New Business for the working group was made and since there were not any additional items the meeting adjourned at 5:55 PM.

7.10.6 Project Reports

7.10.6.1 Survey of GSU Transformer Failures - H. F. Light

As noted earlier, Volume 1 of this Survey will be published by IEEE shortly.

7.10.6.2 Reaffirmation of C57.125, Failure Analysis Guide - Don Cash

The recirculation ballot of the C57.125 “Guide for Failure Investigation, Documentation, and Analysis for Power Transformers and Shunt Reactors” was successful but the document was administratively withdrawn due to some missing paperwork. A complete package was submitted to the Standards Board on July 29, 1998, and the document was reaffirmed by the IEEE-SA Standards Board on September 16, 1998.

7.10.6.3 Reaffirmation of C57.117, Guide for Reporting Failure Data - Don Cash

The reaffirmation ballot for the C57.117 “Guide for Reporting Failure Data for Power Transformers and Shunt Reactors on Electric Utility Power Systems” had the following results:

- 115 Eligible voters / 102 ballots returned
- 101 Affirmative / 1 Abstention (88% returned, with 100% Affirmative)

The required package of documentation was submitted on July 29, 1998, and the document was reaffirmed by the IEEE-SA Standards Board on September 16, 1998.

7.10.7 Old Business

There was no status report on the reaffirmation of the C57.116 Guide for Transformers Directly Connected to Generators.

7.10.8 New Business

Jin Sim reported that the IEEE 519 Harmonics Guide is being revised at present, and suggested that liaison with PCS, particularly with the C57.110 and C57.18.10 WG's, is appropriate. The Chair will forward this information on to the WG Chairs for review.

There were no other items of new business.

7.10.9 Next Meeting

The next meeting will be held on April 14, 1999, in New Orleans, LA.

The meeting adjourned at 8:55 a.m.

Respectfully submitted,

7.0 Reports of Technical Subcommittees (cont'd)

Donald J. Fallon, PCS Chair

7.11 Power Transformers Subcommittee - E.G. Hager, Jr., Chair

The Power Transformers Subcommittee was called to order at 8:05 AM, Tuesday with 9 members and 16 guests in attendance. Seven guests requested membership in the Subcommittee.

The Minutes from the Little Rock meeting were approved without any changes.

Reports from the various Working Group chairmen were presented as follows:

1. Bill Henning, Chairman of the Working Group on Load Tap Changer Performance, reported that the Working Group met on Monday, November 9th, 1998 at 10:55 AM. There were 18 members and 11 guests in attendance. The Minutes of the previous meeting were approved.

Draft 1.1 of the "IEEE Guide for the Application of Load Tap Changers" was discussed. Dr. Dieter Dohnal pointed out that a Working Group is currently reissuing IEC-60214 (Requirements for On-Load Tap Changers) and plans to reissue IEC-60542 (Application Guide for On-Load Tap Changers). Dr. Dohnal suggested that since our Guide is initially based on IEC-542, we should wait to see what revisions are made to IEC-60542. Craig Colopy also noted that the IEC Working Group is adding reactance-type LTC's and de-energized tap changers to its scope and offered to provide this Working Group with copies of the IEC Working Group's Minutes.

Jim Harlow suggested that there is information related to reactance type LTC's that should be added to our Guide and suggested a Working Group survey be utilized to bring out those comments. The Working Group approved this suggestion.

In Addition, Harry Gianakouros indicated an interest in information on the application of series transformers, and Sam Mehta discussed the need for information on contact life determination.

The Guide will, most likely, reference two other documents currently under development by the Transformers Committee, C57.106, "IEEE Guide for Acceptance

and Maintenance of Insulating Oil in Equipment” and C57.139, “Dissolved Gas Analysis in Load Tap Changers.”

2. Rick Young, Chairman of the Working Group on Diagnostic Field Testing and Monitoring of Liquid Filled Power Transformers, Regulators and Reactors reported that the Working Group met on Monday, November 9th, 1998 with 42 members and guests in attendance.

The concept of Life Extension or Life Management was introduced with discussions on the work being done within CIGRE WG12.18 and the IEEE/PES Substations Committee. The subjects were further discussed in Subcommittee, and during the later report by Rowland James, with respect to the appropriate home for this Guide or Standard.

Jim Harlow’s Task Force for On-Line Monitoring Communications had met earlier on the same day with 28 members and guests in attendance. He reported that the Generic Objects Models for Substation and Feeder Equipment (GOMSFE) portion of the Utility Communication Architecture (UCA) system was scheduled to have its first major release in January, 1999. The Task Force made a final review of its identified transformer parameters which can be monitored. These will be submitted for the January release which effectively completes the Task Force’s assignment. The Task Force has thus been disbanded, but Mr. Harlow will continue to monitor the progress of the GOMSFE document and the Working Group will modify the transformer parameters as required. The Chairman thanked the Task Force and especially its Chairman for their efforts.

The Task Force developing a Guide for On-Line monitoring met as part of the Working Group meeting. Chairman Donald Chu was not in attendance so the Secretary, Andre Lux, conducted the session. The Working Group Chairman will submit a PAR for this Guide after determining whether the scope should include instrument transformers and addressing coordination issues. Most of the discussion concerned the outline for the recently completed Draft 2, and the soliciting of volunteers to work on the various sections. The Task Force will meet prior to the New Orleans Transformer Committee meeting to make more effective progress on this Guide.

3. Tom Lundquist reported for Edgar Trummer, that the Working Group on the “IEEE Guide for the Application, Specification and Testing of Phase Shifting Transformers” convened at 3:00 PM on November 9th, 1998 with 30 members in attendance. The Minutes from the Little Rock meeting were approved.

The Chairman reported that all Task Groups had completed and returned their work assignments from the previous meeting, but a complete Draft was not distributed to the members before the meeting. All revised sections were available at the meeting, however, and the complete Draft, incorporating the approved previous comments will be distributed for review and Working Group ballot by January 1, 1999. The closing date for the returned comments and/or negative ballots will be February 15, 1999.

Comments from the Working Group indicated a numbering problem with the revised Section 6 and those errors will be corrected in the next Draft.

All returned ballots will be prepared for discussion at the New Orleans meeting. Everett Hager also requested Tom Prevost to ensure that the protective portions of the Guide will conform with the System Protection Group's Guide for PST protection.

4. Don Cash reported that both C57.125, the "Guide for Failure Investigation, Documentation and Analysis for Power Transformers and Shunt Reactors" and C57.117, the "Guide for Reporting Failure Data for Power Transformers and Shunt Reactors on Electric Utility Power Systems" had been successfully reconfirmed. The complete package for both Guides was submitted to the IEEE Standards Board on July 29th, 1998 and reaffirmed by the IEEE-SA Standards Board on September 16th, 1998.

5. Rowland James and the PT Subcommittee discussed the need for a Working Group or Task Force to develop and document transformer life extension methods for power transformers. The discussions focused on the work currently being done under CIGRE Working Group 12.18 and the IEEE/PES Substations Subcommittee. It was also noted that Condition Assessment was a key issue, closely related with Life Extension and Diagnostic Testing and Monitoring. The Subcommittee agreed that this work should begin and reside under this Subcommittee, but that it may be better to develop a Task Force as Liaisons to the other Groups. Mr. Brian Sparling volunteered to serve as Liaison to the Substations Subcommittee's Group. After the meeting, however, the Subcommittee Chairman discussed the issue with Mr. Tom Prevost, who recommended that the Power Transformer Subcommittee should form a Working Group and produce a Guide which the other groups should reference in their own documents. Those working on the subject will interface with the other groups, regardless of the final resolution.

Everett Hager informed the Subcommittee of a paper by Bob Stewart, and others, on transformer retrofitting, a subject that this Subcommittee may want to expand upon.

The Subcommittee Secretary, using e-mail or regular mail, will distribute the paper to the Subcommittee members and guests. The formation of a new “West Coast” Working Group was also discussed to address issues relatively unique to that area such as seismic and HVDC. The issue was not resolved and will continue to be under consideration.

Rick Young also discussed the formation of a new Working Group under the Distribution Transformers Subcommittee on “Small Power Transformers.” It was the consensus of the Subcommittee that this work should reside under the Power Transformers Subcommittee and the Chairman will pursue the subject.

The meeting adjourned on schedule at 9:15 AM.

Minutes prepared by Joe Watson, PT Subcommittee Secretary.

7.12 Underground Transformers and Network Protectors - P. E. Orehek

7.12.1 Introduction/Attendance

The Underground Transformers and Network Protectors Subcommittee met at 9:30 a.m. on November 10, 1998, with nine members and five guests present.

7.12.2 Approval of Minutes

The minutes of the April, 1998 meeting in Little Rock, Arkansas were approved as submitted.

7.12.3 Membership

No changes in membership were made and it remains at 14.

7.12.4 Chairman's Remarks

Administrative Subcommittee Notes

- A. The next Transformer Committee meeting will be held in New Orleans, Louisiana during the IEEE T&D Exposition from April 12-14, 1999.

- B. The Working Group Award for 1998 was for C57.110 "Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents."

- C. The revision of the Transformer Committee Organization and Procedures Manual has been approved.

- D. ANSI Standard C57.12.90 will be recirculated again for approval.

- E. The PAR form has been revised again and must be obtained from the IEEE web site.

7.12.5 Working Group Reports

7.12.5.1 Three-Phase Underground-Type Transformers (C57.12.24) C.G. Niemann - Chairman

The working Group met on Monday, November 9, 1998 at 10:55 a.m. with seven members and nine guests in attendance.

The minutes of the meeting on April 27, 1998 in Little Rock, Arkansas were approved as submitted.

Draft 2 of the revised standard was reviewed and the following changes were made:

- Paragraphs on Impedance and General Tests will be reworded to agree with the other Standards developed by the Subcommittee.
- The paragraph on Liquid Preservation will be eliminated since most of the information is in another paragraph and the remaining part does not add anything to the standard.
- All tables and graphs located at the end of the standard will now be inserted in the text where they are referred to.
- Hole spacing on secondary terminals and ground pads will be changed from 44 to 44.5 mm.
- The revised Standard is expected to be ready for balloting after the next meeting.

There being no additional new or old business, the meeting was adjourned at 2:40 p.m.

7.12.5.2 Liquid Filled Secondary Network Transformers (C57.12.40) R. L. Plaster - Chairman

The Working Group met on Monday, November 9, 1998 at 9:30 a.m. and 2:55 p.m. for two sessions with 10 members and six guests in attendance.

The minutes of the April 27, 1998 meeting in Little Rock, Arkansas were approved as submitted.

Tom Greely of Seattle City Light and Larry Dix of Quality Switch became new members of the WG.

Draft 4 of the revised standard was reviewed and the following changes were made:

- The paragraphs on Impedance and Lifting Provisions will be reworded to agree with the other standards developed by the Subcommittee.
- Magnetic level indicators and the combination drain and bottom filter valves are located on the primary switch compartment and the tank. The paragraph for each will be worded such that they will be the same in each section.
- The clevis hole used for lifting will be increased from one to one and one-half inches.
- In Table 5, the “24-kV switches” will be changed to “25-kV switches.”
- In Table 9, the voltage ranges will be changed to read “15-kV Class and Below,” “25-kV Class,” and “35-kV class.” A sketch will be added to clarify the dimensions given.

There being no additional business, the meetings were adjourned at 10:45 a.m. and 4:05 p.m., respectively.

7.12.5.3 Secondary Network Protectors (C57.12.44) D.H. Mulkey - Chairman

The Working Group met at 8:00 a.m. on Monday, November 9, 1998 with six members and three guests present.

The minutes of the April 27, 1998 meeting in Little Rock, Arkansas were approved as submitted.

Only two activities were required to complete the review of the revised standard. The proposed revisions for the electrical testing were accepted and the fuse data in Annex B was completed.

One new change was a “microprocessor-based” relay was incorporated into the definitions and Annex F.

The Working Group approved the revised Standard. The chairman will request IEEE to form a Balloting Group.

There being no additional business, the meeting was adjourned at 8:53 a.m.

7.12.5.4 Ventilated Dry-Type Network Transformers (C57.12.57) A. L. Robinson - Chairman

The Working Group met on Monday, November 9, 1998 at 1:20 p.m. with five members and two guests present.

The minutes of the April 27, 1998 meeting in Little Rock, Arkansas were approved as submitted.

Review of the entire text of Draft 7 of the revised standard was completed. Common terminology from the other standards developed by the Subcommittee will be used in several sections.

Clause 5.8.2 "Lifting Provisions" will be rewritten.

Clause 6.3, "Ventilating Opening," will be compared to other dry-type transformer standards and either rewritten or deleted.

It is expected that review of the drawings and tables will be completed at the next meeting and the standard will then be ready for balloting.

There being no additional new or old business, the meeting adjourned at 2:35 p.m.

7.12.6 Other Business

The members discussed at length conversion of units in the standards to the metric system. Some items that the Subcommittee is trying to resolve are the following:

1. Is there a standard convention available for converting to metric?

2. What isn't to be converted, if anything?
3. Can "cm" be used?
4. How will the same values be used in all standards for common items; i.e., the four, six and eight hole spades used for secondary neutrals and ground pads?
5. What guidelines are other Working Groups using?

7.12.7 Future Meetings

The location and dates for future meetings are as follows:

April 12-15, 1999	New Orleans, Louisiana
November 7-10, 1999	Monterey, Mexico
April 2-5, 2000	Nashville, Tennessee
October 15-18, 2000	Niagara Falls, Ontario, Canada
Spring, 2001	Amsterdam, The Netherlands
Fall, 2001	Open
Spring, 2002	Vancouver, British Columbia, Canada

The Subcommittee meeting adjourned at 10:30 a.m.

8.0 Reports of Liaison Representatives

8.1 EPRI - S. R. Lindgren

Memorandum

November 6, 1998

TO: Mr. Jin Sim
Secretary, IEEE Transformers Committee
Waukesha Electric Systems
P.O. Box 268
2701 Highway 117 South
Goldsboro, NC27530

FROM: Stan Lindgren, Manager, Power Transformers

SUBJECT: **EPRI LIAISON REPORT**

The following report is for inclusion in your minutes for the November 11, 1998 meeting in Guanajuato, Mexico.

1. Static Electrification in Power Transformers:

- ii This is the suspected failure mechanism in over 36 core form and shell form FOA transformers worldwide. Recent failures involve 15 year or older transformers worldwide that had just been reprocessed following maintenance work. Failure typically occurs during the first startup or light loading period.
- ii Work has focused on the effects of temperature and moisture transients. Phase I of a comprehensive test program was completed on a 333 MVA single phase 500 kV autotransformer that was fully instrumented to monitor static electrification effects during a series of experiments. A broad range of partial discharge activity was produced. A Phase II second round of tests was completed in October, 1996. A broad range of static electrification activity was again produced. Tests and monitoring results are being evaluated. The

8.0 Reports of Liaison Representatives (cont'd)

transformer was disassembled and inspected. Evidence of static electrification discharges was found at both the bottom and at the top of the unit.

- ï Results of the field tests are being reflected in a quarter-scale flow-model experiment that will simulate the 500 kV transformer under laboratory conditions and controls. The model of the major insulation structure and simulated windings has been completed and experiments are nearing completion.
- ï A symposium, *Transformer Reliability: Management of Static Electrification in Power Transformers*, will be held May 19-21, 1999, in Monterey, California.

2. Moisture Dynamics:

- ï Very rapid load changes can cause bubble formation under some conditions and reduce low frequency and impulse dielectric strength by 40%. This has been demonstrated in models with rapid/high overload.
- ï Additional work has recently been completed to experimentally study moisture dynamics associated with rapid overloads and cool-down cycles plus detect inception of partial discharges caused by bubble evolution. Moisture moves away from the hot conductor fast and returns very slowly after cool-down. Distribution of moisture in the solid insulation was found to be very uneven and time to dissolve free water is very long. Phase II is nearing completion to study the correlation between moisture-in-oil with moisture-in-paper for a range of conditions and temperature cycles using winding models with moisture contents ranging from 0.5% to 7.0% in paper and pressboard. Phase III starting 1/99 will broaden the experimental work plus field trials of the algorithm starting on core-form transformers.

3. High Voltage Instrument Transformers & Bushings

EPRI sponsored a workshop 9/90 to provide a forum to compare and categorize failure information, failure modes and potential mitigation measures. This was an outgrowth of the Transformers Committee roundtable in Washington, DC, 4/88. Proceedings, TR 100205, are published. A Project was completed to study fast disconnect switching transient effects on HVCTs. Mathematical modeling was checked experimentally through laboratory tests and switching tests in a 500 kV substation with very high speed instrumentation. Effects of switching resistors during disconnect switching has been studied and found to reduce bus transients and stresses by up to 80%. A final report is published, TR-104961.

A new project is in process to monitor a large number of HVCTs and bushings in laboratories and in service, including on-line tan delta, partial discharge and other available monitoring methods. Units are being tested to failure to evaluate failure modes, sensitivity of monitoring and to develop "end-of-life" criteria for interpretation of field monitoring data.

4. Thermal Models for Real-Time Loading

8.0 Reports of Liaison Representatives (cont'd)

This project involves all transmission components including power transformers regarding software development and a field test involving two substations on a utility system. The field test has been completed. A final report is published, TR-105421. An IEEE paper, 94 SM 473-9 PWRD, was presented at the IEEE/PES 1994 Summer Meeting in San Francisco. A second paper, "Field Application of a Dynamic Thermal Circuit Rating Method", was presented at the IEEE/PES 1996 Winter Meeting in Baltimore.

5. On-Line Transformer Condition Assessment ñ Green / Yellow / Red

This project is a continuation of earlier EPRI efforts to develop an on-line low cost gas analyzer that were abandoned because of baseline drift of the sensors. A key gas analyzer uses metal-insulated-semiconductor (MIS) sensors to monitor individual ppm for hydrogen, acetylene, ethylene and carbon monoxide. A field demonstration program involved 40 prototypes, starting October 1993. was completed in 1996. Technical problems have delayed commercial production until 1999. An alternative 9-gas analyzer for nitrogen-blanketed transformers has been developed and is being Beta tested at this time. This will be followed by a version suitable for conservator type transformers.

Experimental work is in process to identify the dynamic behavior of gases and other byproducts associated with loading and internal problems. Early results show that gases are developed in the form of tiny bubbles that *are not* quickly absorbed into the oil, including gases with high solubility. Knowledge developed will be used in the development of fuzzy logic expert system modules that can reside in MMW / IM&D software platforms, being developed by EPRI, to provide Green-Yellow-Red indication of transformer operating condition.

6. Power Transformer Remaining Life Prediction & Extension

i Furaldehydes in Transformer Oil

A project is in process to develop a correlation between furaldehydes in oil samples with degree of polymerization (DP) found in paper insulation samples taken from a significant number of transformers in service. Additional laboratory experimental work is in process to identify trace chemicals that are an early indication of insulation degradation that can be sensed with on-line monitoring.

ii Vibration & Frequency Response Analysis (FRA)

A project is in process to develop a correlation between existing winding conditions and vibration & FRA tests before and after internal inspection and re-clamping of the same transformers. The objective is to develop noninvasive field test methods and criteria that can be used to predict winding condition in the broad variety of existing power transformers without entering the transformer. Over 40 transformers have had the initial FRA and internal inspection, and over 20 have had the follow-up FRA test.

7. Transformer Expert System

Objective of this project is to capture the knowledge of transformer experts and make it usable in an off-line software tool for evaluation of transformer design questions, condition assessment, problem diagnosis, and

8.0 Reports of Liaison Representatives (cont'd)

identification of maintenance needs. Beta testing has been completed and some modifications are in process. Commercialization is expected in early 1999. Expansion to add LTC will follow.

8. Guidelines for Life Extension of Substations

These guidelines, now published in Final Report TR-105070 dated April 1995, include a large section on transformer inspection, condition assessment, testing, and maintenance practices. An updated version is in process.

9. Maintenance-Free LTC

Work is in process to identify and categorize specific LTC problems, causes and populations involved; evaluate existing mitigation measures; and identify R&D needed to achieve substantial reduction in LTC maintenance requirements. A workshop was held November, 1996 in Tampa, FL. to provide a forum for discussion of LTC problems / maintenance / and ways to improve reliability and reduce maintenance. Proceedings are published in TR-108398 dated June 1997. EPRI projects are underway to improve understanding of contact coking, oil filtration effectiveness and monitoring concepts.

10. High Temperature Superconducting Transformer

EPRI will provide funding and technical support for Phase II of the DOE Superconductivity Partnership Initiative (SPI) to design, fabricate, and operate a 5/10 MVA prototype high temperature superconducting transformer.

cc: J. W. Matthews, Chairman, IEEE/PES Transformers Committee
Dr. Robert Schainker

8.2 SCC4 - P. A. Payne

No Report.

8.3 TC 14 TAG - P. J. Hopkinson

8.3.1 APPROVAL OF PREVIOUS MINUTES

The minutes for the meeting held April 17, 1998, were approved as submitted.

8.3.2 MEMBERSHIP

Members reviewed the TAG roster and made such changes and corrections as needed. It was noted that Mr Subash Tuli's name was missing from the list. The TA reviewed the manning of the IEC TC 14 Working Groups and the documents for which each has responsibility. It was noted that phase shifter and distribution transformers will be addressed in future TC 14 documents. It was also noted that in WG 21 expert coverage of HV converter issues remains not as strong because of the unavailability of the principal expert for travel.

It was noted that the TA will include John Faller, Secretary TC14, and J. Foldi, (ABB – and TA Canada) as well as Julio Rodriguez (ANCE and TA Mexico) on the TAG mailing list to keep them abreast of issues of interest to the US.

8.3.3 OLD BUSINESS

The Technical Advisor engaged in a brief discussion of IEC procedures and TAG organization to address current and future issues in TC 14, noting that the organization of the TAG is intended to include as many of the US experts on the various issues covered by TC 14. Part of that strategy includes calling on the resources of IEEE to present the US positions on such matters. There was a brief discussion on the resolution of technical differences in the IEC.

Members reviewed a number of technical issues in TC 14

8.3.3.1 **Tapchangers.** These issues are addressed in WG 26. The US objective is to add reactance tapchanging to resistance on-load tapchangers as well as add off-circuit tapchanger requirements. Some of the issues that must be addressed are the definition of loading requirements, type tests and definition of routine tests. A new functional life test is being proposed as a design test for off-circuit tapchangers to address the issue of contact oxidation and coking.

8.3.3.2. Insulation levels, dielectric tests. These issues are addressed in WG 24. The US TA objective is to reach agreement on test requirements dealing with short- and long-duration tests and address inconsistencies in the dielectric tables. It was noted that the Europeans prefer using the short-duration test, though the TA indicated there wasn't a need for both tests to exist. The TA noted that proposals relating to the inconsistencies in the dielectric tables have been offered for discussion at the IEEE meetings. The acceptance of those proposals may fortify US presentations in TC 14 on the matter.

Loren Wagenaar, US expert to WG 24, briefly reported on the discussions at the last meeting of the WG.

TC 14 agreed to circulate the document to national committees as an FDIS (Final Draft International Standard).

8.3.3.3 Short Circuit. These issues are addressed in WG 23. The US TA objective is to define type and routine tests. Among the issues under consideration in the WG are acceptability of calculations and the definition of calculation methods.

It was pointed out that in C57 12.00, below 46 kV 4300 mVA of available fault current should be used and it is estimated that the US document is inaccurate in that the fault current seen does not reach that which is expected at 4300 mVA. L. Wagenaar indicated that calculations he has performed raised questions about how the C57 table was developed.

It was noted that the French and Italians were seeking the acceptance of tests rather than calculations as the means for verification of short circuit. A task force has been established in CIGRE, to which R. Delvecchio has been named a member, to develop a calculation methodology. It was noted that in France, not all equipment is routinely tested prior to shipment; the customer usually designates which transformers will be tested. It was suggested that the French chief delegate appeared to represent EDF rather than the total French Industry.

TC 14 agreed to circulate the document to national committees as an FDIS.

8.3.3.4 Audible Sound. These issues are addressed in WG 25. The US TA objective is to seek agreement on sound measurement techniques. Among the issues being addressed are noise intensity versus sound pressure, microphone placement, minimum clearance to walls and sound tables. J. Puri briefly reviewed the key items under discussion.

TC 14 agreed to circulate the draft to national committees as a CDV (Committee Draft for Voting).

8.3.3.5 **Converter Transformers.** These issues are addressed In WG 21. The US TA objective is to define a HVDC application guide. Among the issues under consideration are acceptability of momentary Pd on polarity reversals and RMS vs fundamental power ratings. An important additional issue is a viable US participation.

It has been suggested that the document include both rms and fundamental values and let experience determine the better.

TC 14 agreed to circulate the document to national committees as a CD (Committee Draft)

8.3.3.6 **Phase Shifter and Distribution Transformers.** These projects are yet to be defined or their scopes established. The TA noted that these are opportunities for the US to define both the contents of the documents and nature of international discussions. The distribution transformers documents will likely be in two parts: dry and liquid.

8.3.4 NEW BUSINESS

8.3.4.1 DUES to the USNC

The TA briefly described the background to the decision to institute a dues base for voting members of US Technical Advisory Groups, noting that the base cause was the evaporation of financial support from companies paying dues to ANSI.

The TA proposed that each company agree to support one voting representative to the TAG and that other members remain as observers (non-voting). The TAG Administrator advised members that a questionnaire would be circulated shortly to determine TAG member status that will likely be the basis for the next dues billings from ANSI. He requested that members respond promptly to the correspondence.

8.3.4.2 Coordination on IEC Matters

The TAG Administrator briefly outlined the matrix developed for the NEMA members which is intended to identify IEC TC having an impact on each others' standards and to provide a mechanism for coordination of US comments on IEC documents. The matrix identified key product technical committees in the IEC and the ancillary committees that write

8.0 Reports of Liaison Representatives (cont'd)

standards which impact them. This information will be used to monitor each TCs document development process in order to identify matters of interest and need of comment. Any comments developed would be introduced through liaison with appropriate US TAGs.

8.3.5 TIME AND PLACE OF NEXT MEETING

Members agreed to meet during the IEEE Transformer Committee meeting in New Orleans in April 1999. Time and date will be determined later and announced.

8.3.6 ADJOURNMENT

There being no additional business, the meeting was adjourned at 3:40 PM.

Reported by

John A. Gauthier

TAG Administrator

10 November 1998

9.0 Old Business

The revised draft of the Transformers Committee O & P Manual was approved and mailed out to all on the committee invitation list.

10.0 New Business

Phil Hopkinson raised the issue of Inrush Current for Ventilated and Cast Coil Dry Type and Liquid Filled units up to 10 MVA. Phil submitted his company's internal document for review by the general membership. See attachment 6. He plans to make a presentation on the subject during our Fall 1999 meeting.

11.0 Adjournment

The meeting was adjourned at 11:22 AM.

Respectfully submitted,
H. Jin Sim, Secretary

Attachment 5

GROUPS	Kan. Apr. 95	Boston Nov. 95	Sanf Apr.96	Burl Oct.96	Graz Jul.97	St.Louis Nov.97	Little R Apr. 98	Leon, Nov. 98	MAX	AVG
Committee Registration: Members and Guests	286	272	301	287	164	282	267	262	301	265
Spouses	45	51	64	67	91	32	34	49	91	54
Luncheon	158	165	167	148	108	147	156	262	262	164
SC ADMINISTRATIVE	22	20	21	19	17	19	16	19	22	19
SC AUDIBLE NOISE AND VIBRATION	18	26	34	23	9	22	32	23	34	23
SC BUSHINGS	35	32	32	29	32	23	32	25	35	30
WG Revision C57.19.00								36	36	36
TF Draw Lead Bushings	18	25		17		21	23	23	25	21
WG DC Applications of Bushings	21	19	19						21	20
WG Revision C57.19.01	32	30	30	28	26	24	33	38	38	30
SC DIELECTRIC TESTS	99	71	88	91	58	71	81	80	99	80
WG Low Frequency Tests	40	39	50	49	40	31	42	20	50	39
WG Revision of Transient Dielectric Tests								20	20	20
WG Rev. Dielectric Tests on Distr. Transf.	15	14	16	13		14	21		21	16
TF Rev. Distr. Impulse Guide	19	18	16	13					19	17
WG Partial Discharge Tests		27	35	44	37	43	51	58	58	42
SC DISTRIBUTION TRANSFORMERS	48	44	37	45	11	37	49	29	49	38
WG Distribution Substation Transformers								16	16	16
WG Overhead Type Distr. Transfs. C57.12.20	30	30		23			39	19	39	28
WG Single-Phase Submersible C57.12.23	30	23					41		41	31
WG Single-Phase Deadfront Padmount C57.12.25	30	29		28		35	41		41	33
WG Bar Coding	35	29				25	40		40	32
WG Loss Evaluation	40	47				55	48		55	48
WG Electronic Data Transmittal	35	33				20		12	35	25
WG Combination of C57.12.22 and .26	30	28							30	29
WG Step-Voltage and Induction Regs C57.15	40	33				26		16	40	29
SC DRY-TYPE TRANSFORMERS	45	37		33	21	32	22	26	45	31
WG Test Code C57.91		27		18		20	23	20	27	22
WG Dry-Type Reactors	13	10	14	8	8	7	9	6	14	9
WG Dry-Type Reactors - HVDC Smoothing	6	7	5	6	12		9		12	8
WG Dry-Type Thermal Eval. and Flammability	20	21		27	15	24			27	21
WG Dry-Type General Requirements C57.12.01	36	27	20	27	5	30	28	24	36	25
WG Insulation Req. for Specialty Transf.	10	9	11	17		6			17	11
WG Cast Coil Loading Guide	24	21	19	18	19	21	18		24	20
WG Hot Spot Differentials	38	28	34	32		27	33	23	38	31
SC HVDC CONVERTER TRANF. & REACTORS	13		11	9	8	6	6	7	13	9

Attachment 5

GROUPS	Kan. Apr. 95	Boston Nov. 95	Sanf Apr.96	Burl Oct.96	Graz Jul.97	St.Louis Nov.97	Little R Apr. 98	Leon, Nov. 98	MAX	AVG
SC INSTRUMENT TRANSFORMERS	13	18		26	9	10	13	7	26	14
WG Test Req Instr Transf >115 kVA	30	22	16		7	13	20	13	30	17
WG C57.13.6 Instr Transf for Electronic Meters & Relays								9	9	9
WG Revision of C57.13	13	20	20		9	10	17	8	20	14
SC INSULATING FLUIDS	61	58	68	69	33	71	84	71	84	64
SC INSULATION LIFE	49	57	65	60	18	55	73	58	73	54
WG Thermal Eval. of Distr. and Power Transf.			32						32	32
WG Thermal Tests	34	21	33	32	19		18		34	26
WG Revision of Temperature Test Code	22	19	37					24	37	26
WG Thermal Duplicate		26	20	37		30	34	24	37	29
TF Hottest Spot Temp. Rise	44	52	51	40		56	67	50	67	51
TF Winding Temperature Indicators	50	46	48	41	25	26	32	22	50	36
SC PERFORMANCE CHARACTERISTICS	88	99	106	108	49	74	77	52	108	82
WG Loss Tolerance and Measurement	36	34	37	30	27	18	27	25	37	29
WG PCS Rev. C57.12.00	38	29		46	23	19	36	32	46	32
WG PCS Rev. C57.12.90 Part I	15	23	34	49		21	33	43	49	31
WG PCS Rev. Short circuit Testing		5			29	19			29	18
WG Revision C57.110	39	40	34	42	22	39		11	42	32
WG Semi-Conductor Rectifier Transformers	29	33	28	26	18	19	13		33	24
WG Switching Transients					30	22	31	33	33	29
SC POWER TRANSFORMERS							26	25	26	26
WG LTC Performance Requirements						34	31	29	34	31
WG Diagnostic Field Testing & Monitoring		64	89	94	70	66	83	42	94	73
TF On-line Monitor Communication					27	28	28	28	28	28
WG West Coast	26		9	12	15	13			26	15
WG Phase Shifting Transformers	15	18	36	38	31	26	43	30	43	30
SC STANDARDS	17	14	24	19	9		11	4	24	14
WG Continuous Revision C57.12.00	15	15					8		15	13
WG Continuous Revision C57.12.90	15	15					8		15	13
SC UNDERGRND. TRANF. & NETWK. PROTCS.	15	12	12	13	6	13	11	14	15	12
WG Three-Phase Underground Transfs.	10	13	10	12	5	13	14	16	16	12
WG Liquid-Filled Sec. Network Transfs.	15	15	12	13	6	16	16	16	16	14
WG Secondary Network Protectors	13	13	11	13	5	16	12	9	16	12
WG Dry-Type Network Transfs.	6	9					5	7	9	7

INRUSH CURRENTS FOR MEDIUM VOLTAGE TRANSFORMERS

Rev 6, January 12, 1999 PJ Hopkinson

Over-current protection for medium-voltage transformers requires coordination with the natural inrush characteristics of the transformer. Eermal Curd from Lexington recently requested a review of inrush current calculations to update practices dating back to 1983. This analysis examines several types of medium voltage transformers and displays relevant data for both circuit breaker and fuse coordination. **In revision 6, the 15 kV Class 150C rise Power Dry Transformers of both 60 kV BIL (Standard) and 95 kV BIL (Optional) are added to see if there are any similarities to either the 80 degree rise or to the 5 kV Class 150 degree rise Power Dry transformers. You will see that they are much closer to the 5 kV Class 150C Rise than to the 80 C Rise. This is because the higher current densities associated with higher temperature rise give higher resistance and increased damping .**

Transformers:

1. Power Cast
2. Uni-Cast
3. Power Dry
4. Liquid-Filled

Displayed Data:

1. Peak 1st half cycle inrush current as a multiple of rated symmetrical rms line current for the worst phase, in XN.
2. RMS value of 1st half cycle inrush line current in XN. This value will be useful in determining coordination with instantaneous breaker trips and with current limiting fuses, as all coordination curves are shown in rms units. It is calculated by dividing the peak 1st half cycle inrush current by the square root of 2. Note that this is not a heating equivalent current but simply 70% of the peak current.
3. RMS equivalent value of 1st full cycle inrush line current in XN. It is derived from the square root of the $1/T * I^2 t$ integration.
4. RMS equivalent value of inrush line current for the 1st 6 cycles of integration of $1/T * I^2 t$, in XN. This corresponds to the equivalent current for 0.1 seconds.

Assumptions:

Attachment 6

1. Non loss-evaluated transformers, where no arbitrary limits are placed on core induction and on current densities. High core induction produces the worst case saturation and worst first half cycle inrush. However, very low current densities and winding losses result in the longest transient settling time associated with very low damping.
2. Power ratings for the simulation were approximately 2000 kVA. Inrush is generally worse on lower kVA ratings, especially 500kVA and below. In parametric terms, inrush current increases as kVA to the $\frac{3}{4}$ power, but in practical terms, larger kVA ratings actually are nearly linear with kVA due to increased space factor. Hence, power ratings higher than 1000kVA have nearly constant inrush (multiples of rated current) because of naturally opposing elements. However volts/turn has a major impact. Large windings with high volt/turn and large air and/or oil gaps are worst cases. Interestingly, high BIL copper primary windings, especially 34.5 kV, are the worst case.
3. Delta-connected primary winding for Part I. The calculated line currents are not substantially different for Wye-connected windings connected to a 3-wire source.
4. Worst A-phase peak remnant flux, switched on at a positive-going voltage zero on the H1 terminal. For this case, current is highest on the H2 terminal, prompted by saturation of both the A-phase and B-phases of the core. B saturates less than A, but currents at H2 reinforce in spite of a 60 degree displacement. This results in an effective line current on H2 that exceeds that of the A-phase winding by 25.6%. Note, that this worst case amplitude does not occur for either of the other lines, when successively energized at their highest remnant flux state.
5. The transient decay curve is calculated using both the plus 20-degrees C as well as the minus 40-degrees C a-c resistances of the winding and 3% of the core watts equivalent resistance. Oshkosh engineering had seen a good correlation with greater than 3% core watts in some Cedar-Rapids testing of low-voltage transformers, but higher concentrations in these calculations appeared to make the decay overly-aggressive. High temperature rise designs (i.e. 150C), generally have considerably higher winding resistance than low rise (80C) designs. Winding resistance has a major impact on the transient response, especially the 0.1 second point.
6. Grounded Wye high voltage winding connected to a 4-wire source for Part II. This connection does not get used very often but results in 50% higher inrush currents than the 3-wire source.
7. Part III is similar to Part II except the low voltage winding is Grounded-Wye and connected to a 4-wire source.
8. Part IV is like Part I except the low voltage winding is Delta or Wye and connected to a 3-wire source.

Summary Of Calculations:**RMS Equivalent Currents (XN)****Part I High Voltage Delta Connected Winding or Wye Winding to 3-Wire Source**

Transformer Type	Peak Inrush (XN)	1 st Half Cycle		1 st Cycle		0.1 Seconds			
		20C	-40C	20C	-40C	20C	-40C	20C	-40C
Power Cast	80 Rise>1000kVA	23.9	24.1	16.9	17.1	13.4	13.6	9.6	10.0
34.5kV-200kV BIL-Cu		28.4	28.7	20.1	20.3	15.7	15.9	11.1	11.6
Power Cast	80 Rise< 750 kVA	25.4	25.8	18.0	18.3	14.4	14.6	10.3	11.1
Uni-Cast	100 Rise>1000kVA	23.0	23.3	16.3	16.4	13.0	13.2	9.2	9.6
Uni-Cast	100 Rise< 750 kVA	24.5	25.0	17.4	17.6	14.0	14.2	10.5	10.7
Pwr Dry 15KV	80 Rise>1000kVA	22.3	22.6	15.7	16.0	12.6	12.8	8.7	9.1
Pwr Dry 15KV150	Rise>1000kVA	19.1	19.4	13.5	13.8	10.8	11.0	7.0	7.4
Pwr Dry 95BIL150	Rise>1000kVA	18.3	18.6	13.0	13.2	10.3	10.5	7.1	7.5
Pwr Dry 5KV	150 Rise>1000kVA	22.4	22.8	15.8	16.1	12.5	12.8	7.9	8.5
Pwr Dry 15kV	80 Rise< 750 kVA	23.8	24.3	16.8	17.2	13.6	13.8	9.0	10.2
Pwr Dry 15kV150	Rise< 750 kVA	21.5	22.1	15.2	15.6	12.0	12.4	7.7	8.4
Pwr Dry 95BIL150	Rise< 750 kVA	19.7	20.1	13.9	14.2	10.8	11.1	7.2	7.9
Pwr Dry 5KV	150 Rise<750kVA	18.7	19.3	13.2	13.7	10.4	10.8	6.2	6.9
Liquid-Filled	65 Rise>1000kVA	18.2	18.5	12.8	13.1	10.3	10.6	6.9	7.4
High BIL-CU-	low winding loss	18.6	18.9	13.2	13.3	10.7	10.8	7.7	8.1
Liquid-Filled	65 Rise< 750 kVA	23.3	23.8	16.5	16.8	13.2	13.5	9.0	9.7

Part II High Voltage Grounded Wye Winding Connected to 4-Wire Source**RMS Equivalent Currents (XN)**

Transformer Type	Peak Inrush (XN)	1 st Half Cycle 1 st Cycle 0.1 Seconds							
		20C	-40C	20C	-40C	20C	-40C	20C	-40C
Power Cast 80 Rise>1000kVA		32.9	33.3	23.3	23.5	18.5	18.8	13.2	13.8
34.5kV-200kV BIL-Cu		39.2	39.6	27.7	28.0	21.7	22.0	15.3	16.0
Power Cast 80 Rise< 750 kVA		35.1	35.6	24.8	25.2	19.8	20.2	14.2	15.3
Uni-Cast 100 Rise>1000kVA		31.7	32.1	22.4	22.7	17.9	18.2	12.6	13.3
Uni-Cast 100 Rise< 750 kVA		33.9	34.4	23.9	24.4	19.2	19.6	13.8	14.8
Pwr Dry 15kV 80 Rise>1000kVA		30.7	31.1	21.7	22.0	17.4	17.7	11.9	12.6
Pwr Dry 15kV150 Rise>1000kVA		26.4	26.8	18.6	19.0	14.9	15.2	9.6	10.3
Pwr Dry 95BIL150Rise>1000kVA		25.3	25.7	17.9	18.1	14.2	14.4	9.7	10.3
Pwr Dry 5KV 150 Rise>1000kVA		30.9	31.5	21.8	22.3	17.3	17.7	10.9	11.7
Pwr Dry 15kV 80 Rise< 750 kVA		32.9	33.4	23.2	23.7	18.7	19.1	13.0	14.1
Pwr Dry 15kV150 Rise< 750 kVA		29.7	30.4	21.0	21.5	16.6	17.1	10.6	11.6
Pwr Dry 95BIL150 Rise< 750 kVA		27.1	27.7	19.1	19.6	14.9	15.3	10.0	10.9
Pwr Dry 5KV 150 Rise<750kVA		25.8	26.6	18.3	18.8	14.3	14.9	8.5	9.5
Liquid-Filled 65 Rise>1000kVA		25.0	25.5	17.7	18.0	14.3	14.6	9.5	10.1
High BIL-CU- low winding loss		27.1	27.5	19.2	19.5	15.4	15.6	10.4	11.0
Liquid-Filled 65 Rise< 750 kVA		32.2	32.8	22.7	23.2	18.2	18.6	12.4	13.4

Part III Low Voltage Grounded Wye Winding Connected to 4-Wire Source**RMS Equivalent Currents (XN)**

Transformer Type	Peak Inrush (XN)	1 st Half Cycle		1 st Cycle		0.1 Seconds			
		20C	-40C	20C	-40C	20C	-40C	20C	-40C
Power Cast	80 Rise>1000kVA	53.1	53.9	37.6	38.1	29.6	30.2	18.9	20.0
	34.5kV-200kV BIL-Cu	68.3	68.9	48.3	48.7	37.6	38.1	25.4	26.3
Power Cast	80 Rise< 750 kVA	58.1	59.4	41.1	42.0	32.4	33.4	20.5	22.5
Uni-Cast	100 Rise>1000kVA	47.2	48.2	33.4	34.1	26.3	26.7	16.0	17.1
Uni-Cast	100 Rise< 750 kVA	52.2	53.7	36.9	38.0	29.1	29.9	17.6	19.6
Power Dry	80 Rise>1000kVA	62.6	63.2	44.2	44.7	35.2	35.7	22.5	23.4
Power Dry	80 Rise< 750 kVA	67.6	68.7	47.7	48.6	38.0	38.9	24.1	25.9
Liquid-Filled	65 Rise>1000kVA	40.6	41.5	28.7	29.3	22.9	23.5	14.0	15.0
	High BIL CU Primary, CU LV	44.6	45.5	31.5	32.2	25.0	25.6	14.8	15.9
Liquid-Filled	65 Rise< 750 kVA	55.6	56.8	39.3	40.2	31.3	32.1	20.3	22.0

Part IV Low Voltage Delta Connected Winding or Wye Winding Connected to 3-Wire Source**RMS Equivalent Currents (XN)**

Transformer Type	Peak Inrush (XN)	1 st Half Cycle		1 st Cycle		0.1 Seconds			
		20C	-40C	20C	-40C	20C	-40C	20C	-40C
Power Cast	80 Rise>1000kVA	38.6	39.2	27.3	27.7	21.5	21.9	13.7	14.5
	34.5kV-200kV BIL-Cu	49.5	50.0	35.0	35.3	27.3	27.6	18.4	19.1
Power Cast	80 Rise< 750 kVA	42.1	43.1	29.8	30.5	23.5	24.2	14.9	16.3
Uni-Cast	100 Rise>1000kVA	34.3	35.0	24.6	25.2	19.1	19.4	11.6	12.4
Uni-Cast	100 Rise< 750 kVA	37.8	38.9	27.1	28.0	21.1	21.7	12.8	14.2
Power Dry	80 Rise>1000kVA	45.5	45.9	32.1	32.5	25.6	26.0	16.3	17.0
Power Dry	80 Rise< 750 kVA	49.0	46.8	34.6	35.3	27.6	28.3	18.5	19.8
Liquid-Filled	65 Rise>1000kVA	29.6	30.3	20.9	21.3	16.7	17.1	10.2	10.9
	High BIL CU Primary, CU LV	32.3	33.0	22.8	23.3	18.1	18.6	10.8	11.5
Liquid-Filled	65 Rise< 750 kVA	40.4	41.2	28.5	29.1	22.7	23.3	14.7	16.0

Discussion Of Results:

The calculated values for these transformer types appear to be logical with respect to the algorithms from which they are derived. The fundamental expression that paces the calculation is as follows:

$$I_{\text{peak}} = 6.45 \cdot 1000 \cdot h \cdot A_c \cdot (B_r + 2B_m - B_s) / (3.2 \cdot n \cdot A_w \cdot K) \quad (1)$$

- Where:
- h is the coil electrical height in inches
 - A_c is the core area in square inches
 - A_w is the mean area of the exciting winding
 - N is the number of turns of conductor in the exciting winding
 - B_r is the core remnance in kilogauss
 - B_m is the nominal peak operating core induction in kilogauss
 - B_s is the core saturation density in kilogauss
 - K is a correction factor for coil geometries, typically around 0.5.

The primary factors that produced differences in the transformer types are as follows:

1. Power Cast are the largest transformers with big air gaps between core and inside winding. They tend to operate at high volts/turn, and have the largest cores. These factors make the high voltage winding have the highest inrush, but the large air gap under the low voltage winding reduces its inrush when used as a step-up transformer.
2. Uni-Cast has a similar high voltage winding to Power Cast, but is assumed to have a 10 kV low voltage BIL rating, giving it a glove fit low voltage winding that more tightly hugs the core. Generally they operate at lower volts/turn than Power Cast and have lower inrush currents
3. Power Dry with a 10 kV low voltage BIL has a glove fit low voltage winding similar to Unicast, but it also has smaller coil ducts than either Uni-Cast or Power Cast. Power Dry can operate at higher temperature rise and may have smaller cores. This transformer was 80 degrees rise, which required low current density and low winding resistance. The high voltage winding was not substantially different in size from the Power Cast, which gave it similar inrush results. However, the low voltage winding was both a glove fit to the core and it had low winding resistance. This resulted in very high inrush currents for the step-up connection, with source connected to the low voltage winding.

4. Liquid-Filled transformers are considerably smaller than either of the other types, because they do not require as large cooling ducts or dielectric insulating barriers. They operate at much lower volts/turn, and have considerably higher air core inductances. They always have lower inrush currents than the dry or cast windings.

Through-Fault Short Circuit Coordination Considerations:

1. All Liquid-Filled transformers are governed by the standard specifications in ANSI C57.12.00 as a fundamental rule. Short circuit requirements are specified in section 7.
2. All dry type transformers, including cast resin are governed by the requirements in ANSI C57.12.01. It is generally true that Power Cast transformers are able to meet the requirements of section 7 of C57.12.00, but there is no industry requirement for this.

Recommendations:

1. The Inrush program has been written by Jayant Patwardhan of Oshkosh and modified by Phil Hopkinson Of Monroe to develop a simulated line current. The net line current is not calculated directly but requires several steps to achieve a net value. This process could be handled more efficiently by reprogramming the excel spreadsheet calculator. Jayant is fully familiar with the necessary reprogramming requirements and is encouraged to reissue the model with this valuable addition.
2. Source and line impedance has not been included in this calculation, but can have a significant impact in reducing inrush currents. If desired, the reprogramming necessary to allow for this provision is minor and could be easily added.
3. Grounded Wye 4-wire source connections have the potential to produce extremely high inrush currents. For such applications, resistance grounding is encouraged to minimize the inrush concerns, effectively reducing them to the 3-wire source conditions.
4. Individual cases are easily run and may differ from these generalized calculations.
5. Copies of the calculation program should be maintained at each transformer design center.

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