8.5 Performance Characteristics Subcommittee – Ramsis Girgis, Chairman; Stephen Antosz, Secretary

8.5.1 Introduction / Attendance

The Performance Characteristics Subcommittee (PCS) met on Wednesday, October 17, 2007 with 66 members and 46 guests in attendance. 9 of those guests requested membership in PCS. See last page of these minutes for attendance summary.

8.5.2 Approval of Meeting Minutes

The minutes of the last meeting in Dallas, TX were approved as written.

8.5.3 Chairman's Remarks

8.5.3.1 Administrative Subcommittee Notes

- Next Transformer Committee meeting dates and locations are as follows:
  1 Spring 2008, March 16 – 20: Westin Hotel, Charlotte, NC
  2 Fall 2008, October 5-9: Sheraton Hotel, Porto,Portugal
  3 Spring 2009, April 19 – 23, Southern US location
  4 Fall 2009, October 18 – 22, TBD
- IEEE PES Meeting: July 20 – 24, 2008, Pittsburgh, PA. Submission of papers for this meeting is November 1 – 30, 2007.
- IEEE T&D Conference & Exposition: April 20 – 25, 2008, Chicago, IL. There will be 7 transformer papers presented there.
- The issue of dual – logo status of an IEEE and IEC Standard has hit a snag. Since there are many other IEEE documents referenced in an IEEE Standard, these other documents also become a required part of the Standard. There are then possibly additional deeper references in the referenced document. A partial solution is to use only references necessary to implement the Standard in the normative body of the document, and all others go to the Bibliography which is informative only. This problem will be a significant ongoing hurdle to overcome related to dual – logo status of all future documents.
- Those, who are active in the SC & WGs and are still not members of the transformer Standards Committee, are encouraged to apply for membership.

8.5.4 Working Group (WG) and Task Force (TF) Reports

8.5.4.1 PCS WG on Test Code C57.12.90 – Mark Perkins, Chairman; Kirk Robbins, Secretary

This WG met in Minneapolis on October 15, 2007 at 9:30 A.M. There were 85 in attendance, 31 members and 54 guests, of which 5 requested membership

Announcements

The patent slides were shown and the chair asked if anyone had any patent issues relating to this standard. Being none, this discussion was closed.

The minutes from the last meeting were then reviewed and approved as written.

Gerry Rosselli, secretary of the working group, will no longer be able to attend the meetings and will no longer be able to be secretary to the WG. Mark asked for

volunteers for a new secretary. Kirk Robbins, from Exelon Energy, is selected to be the new Secretary of the WG.

Task Force Reports

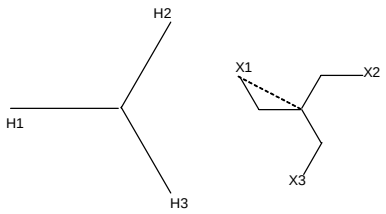
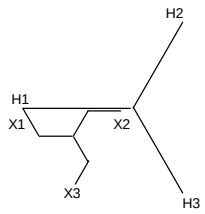
1. Gerry Rosselli reported on the issue of Zero Sequence Test for Interconnected winding Transformers where 2 transformers exhibited negative values. The problem resulted from the voltage measurement, so a new definition of Eav was formulated to correct this problem "E*av* = average of three phase measured applied voltages on the HV side divided by the transformer turns - ratio". With this correction, the negative values no longer exist and the new calculation provides similar values to the original manufacturer's data. Gerry presented a table of cases that demonstrated the accuracy of the method after this change. It was also discussed that this new method could, in addition, be applied to other transformers without interconnected windings, but that it takes longer to perform the measurement than the current method. A statement to describe this will be added to the text of section 5.5 of C57.12.90. Another statement will be added to qualify the accuracy of the method. The WG agreed to forward the proposed new text for section 5.5 to be included in the upcoming revision of C57.12.90 for the next ballot of this Standard.

2. The TF on short-circuit testing, section 12 of C57.12.90 and PC57.133 Guide to Short-Circuit testing, met at 8:00 a.m. on Monday. Marcel Fortin, TF chair could not attend the WG meeting so Mark and Ramsis reported on behalf of Marcel. The chairman stated that the present Guide mainly included the Low Voltage Impulse method that was historically used for diagnostics in short circuit testing. He also stated that recently the TF agreed to drop the LVI method since it is no longer being used and there are new more effective methods used presently for this purpose, such as FRA and DGA. The question was raised whether a separate S.C. test Guide is necessary. The rest of the information, which was originally part of the S.C. test Guide, could be added to the short circuit testing section of C57.12.90. The chairman requested that WG members review Revision D4 of section 12 of C57.12.90, which was sent to the WG members before this meeting. He requested a response with comments sent to him by November 15, 2007. Also, the Chairman will shortly send members of the WG a document that describes the following:

    i. Content of the present S.C. Guide
    ii. Why it would not be necessary to have a separate Guide
    iii. Proposed sections of the present Guide that he would add to the new revision of section 12 of C57.12.90.

    Members of the WG will be requested to send their comments on the need for a separate S.C. test Guide by January 15, 2008. A new draft of section 12 of C57.12.90 will then be ready for review by members of the TF well before the next Standards meeting in March 2008.

After the meeting, Subhash Tuli mentioned that there was an additional diagram needed in Figure 7- Transformer lead markings and phasor diagrams. The Wye-ZigZag diagram is not listed in the table, and needs to be included. The diagram is shown here:

Y - ZIG ZAG			
ANGULAR DISPLASEMENT 30 DEGREES			*CONNECT* H1 *TO* X1 *MEASURE* H3-X2, H3-X3, H1-H3, H2-X2, H2-X3 *VOLTAGE RELATIONS* (1) H3-X2 = H3-X3 (2) H3-X2 < H1-H3 (3) H2-X2 < H2-X3 (4) H2-X2 < H1-X3

New Business

The WG chairman presented a new topic; revision to section 6 “Polarity and Phase Relation”. This section is nearly 7 pages in the Standard, and much of the information is outdated and no longer being used and there are some inaccuracies. The WG then went over this section of the standard. There are some inconsistencies in figures 4 and 5 for the polarity marks and the definition of Subtractive and Additive polarity.

The Chairman presented an assortment of different transformer nameplates to show the information used as reference for the polarity test. In general, there is a lot of variability in the way nameplate drawings are shown, and the drawings do not necessarily represent the actual winding configuration. As a result, when the polarity test is performed, what is actually done is measuring the terminal polarity and comparing this with the nameplate information. Examples were shown of transformers from different manufacturers that had various combinations of windings with additive and subtractive polarity. Some nameplates include polarity marks and others do not. The chairman then asked members of the WG if they agreed that it was necessary to update section 6, and the consensus was that it is.

8.5.4.2 PCS WG on General Requirements C57.12.00 - Steve Snyder, Chairman; Enrique Betancourt, Secretary

The WG met on Monday, October 15, at 3:15 PM. There were **28** members and **50** guests present. The following two guests requested membership, leaving the WG membership at **71** members :

Jim Zhang Arizona Public Service
Ibrahim Shteyh ABB, Inc. (South Boston)

Following introductions, minutes of the March 12, 2007, Dallas meeting, were approved as submitted. Working group members were then asked about any applicable patents pertaining to our work. No patents were disclosed by anyone.

Old Business:

The chairman presented a new version of **Table 21 - Draft 6A** - (Routine, design, and other tests for liquid-immersed transformers) that incorporates all the previous changes agreed to by this WG. Hard copies were distributed, including a list of changes included since Draft 3 (balloted April 2003), and two more options, **Drafts 6B and 6C**, for possible formats of Table 21.

On sight of draft 6A of Table 21, the WG made reference to some items that still required discussion before considering the table formats.

Resistance Measurements
The WG agreed (33 in favor, none opposed) to remove the status of this test as "Other" for Distribution Transformers, and remove the sentence in the note mentioning the range of 500 kVA and below. The new note will read "For distribution transformers rated 2500 kVA and smaller, this is a Design test. Greater than 2500 kVA is a Routine test".

In response to further questions of how a Distribution Transformer is defined, the chairman remarked that now Std. C57.12.36 defines Distribution Transformers up to 10 MVA, three – phase.

Single Phase Excitation Tests
A discussion ensued about whether this test falls under PCS or Dielectric Tests, and there was no clear determination. In consideration of the considerable expertise assembled at this meeting, the topic was discussed with the understanding that the Dielectric Tests Subcommittee could override these decisions if it is subsequently determined the topic is better handled in that forum. This will be addressed in the Dielectric Tests Subcommittee meeting on Wednesday.

The comment on this test shown in Draft 6A will be changed to imply that only one winding of each phase should be tested, as it presently is worded in the published standard. After a lively discussion, the group also recommended (37 in favor, 2 opposed), to change the status of this test as "Routine Test" for Class I and Class II Power Transformers. (Further consideration for this test will be taken up in WG C57.12.90. Subhash Tuli volunteered to prepare a paragraph on the subject).

Dong Kim raised the question if Winding Insulation Resistance and Core Insulation Resistance should be "routine tests" for Class I power transformers. Loren Wagenaar will take those subjects within the Dielectric Tests SC.

Dennis Marlow pointed out that Draft 6 of Table 21 was missing Impedance and Load Loss tests. This editorial mistake will be corrected taking the text from previous Draft 5.

As regarding the format of Table 21, the Group agreed that Draft 6A of Table 21 is the most preferred. This version is landscaped with comments in the last column, and will hopefully facilitate application for future users of the document.

Subhash Tuli requested clarification that the sequence of tests listed in Table 21 does not imply the recommended test sequence. The chairman explained that explanatory text will be added to Section 8 of C57.12.00 to address that matter.

Other suggestions included: (Mark Perkins) Categorization of tests in terms of Performance, Dielectric and Mechanical; (Ramsis Girgis) Reduce the comments in Table 21 to the ones necessary to specify what tests and to what types of transformers. The chairman will address those items in the future, after the existing table structure gains acceptance.

The chairman will soon conduct a survey of the PCS membership using the Draft 6A format with all the agreed to changes. It is desired to have this work completed before the next revision ballot of C57.12.00, anticipated next year.

8.5.4.3 WG on Loss Tolerance and Measurement - Ed teNyenhuis, Chairman; Andy Steineman, Secretary

- 4 members and 3 guests attended.

- IEEE Patent Policy - The policy was reviewed by the WG and an opportunity was provided for WG members to identify or disclose patents that the WG member believes may be essential for the use of that standard. No responses were given.

- Minutes from the Dallas Meeting held on Mar 13th, 2007 were read and approved.

- It was reported that the TF for "Guide for Low Power Factor Measurements" has been discontinued, and will only meet within PSIM.

- Frequency Conversion Factors of Transformer Performance Parameters – The status of the proposed wording for inclusion in C57.12.00 and C57.12.90 was reviewed. The status is as follows:
  - Survey is complete in this WG
  - WG reviewed results of the survey & approved all suggested changes to wording
  - Section on Frequency conversion of noise level was reviewed and finalized by Audible Sound & Vibrations SC. Immediately after this meeting, Ramsis Girgis will submit this section to the Audible Noise SC for survey.
  - This wording is planned to be balloted with the upcoming C57.12.00 and C57.12.90 ballots.

- C57.123-2002 – Guide for Transformer Loss Measurement – The status of the Guide was reviewed:
  - The following is presently being done, to be completed by end of Oct:
    - Ballot invitation (forming of ballot pool)
    - Mandatory Editorial Coordination
    - Review of text by IEEE editorial staff
  - Last step is to submit for ballot

- Ramsis Girgis proposed 2 enhancements be made to the Loss Measurement Guide:

  - Modifications to allow a Dual – Logo IEEE/IEC document. References within the Guide to IEEE Standards will need to be moved to the bibliography. The Guide was quickly reviewed during the meeting, and it was determined that there is a need to examine the feasibility of making this change.

  - The Department of Energy's Efficiency Standards for distribution transformers has been recently published. It uses terminology and methods that are not all consistent with C57.12.90. It was proposed that a section could be added to the Guide that would deal with the differences between the two documents.

It was decided that, since the balloting pool for the revised Guide is already being formed, these modifications would be considered for next version of the Guide.

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

This WG was called to order at 8:00 AM on October 16, 2007. There were 72 attendees, 23 members, and 49 guests. The minutes from the March 13, 2007 meeting in Dallas, Texas were approved, and copies of the minutes were distributed.

1. IEEE patent policy was reviewed and if there were no disclosures.
2. The old PAR for this project was withdrawn and a new PAR with joint sponsorship with the Switchgear Committee was submitted, and has been approved.
3. The joint TF that was assembled with members from the Switchgear & Transformer Committees' has been working on a new draft of the document. The new draft will be shared with both committees and then go out to ballot. Input from the Switchgear committee TF is expected within the next week, and plans are to go out to ballot this fall.
4. The structure of the latest draft of the guide has been revised based on input from the switchgear committee. The new order of the clauses in the guide will aid user's understanding of the concepts presented.
5. Phil Hopkinson made a brief presentation on his observations of situations where interaction had occurred, and expressed the point of view that both resonances and traveling waves need to be considered. The WG then had an extensive discussion of this concept with contributions from many members of the group. Salient points discussed are highlighted in the following:
    a. It is the combination of the load, cable, switching device, transformer, and the system that produce the potentially damaging interaction.
    b. It is persistence and repetition of the waveform that results in transformer damage.
    c. The guide does not discriminate between high and low frequencies. There is a whole family of natural frequencies, but the guide refers primarily to the first three to illustrate the interaction issue.
    d. Transformer failures at the line end are usually due to high dv/dt events and not resonant conditions.
6. At the end of the discussion, a decision was made to include information to explain the whole spectrum of frequencies that are in play when considering transformer, switching device and system interactions. It was also reiterated that the guide does not address high frequencies in detail; however, it was decided earlier in this project that was not going to be part of the scope of the initial version of the guide.
7. Bob Degeneff then presented the commonly used Protection / Mitigation methods to protect transformers from switching interactions. The methods include:
    a) Surge arrestors
    b) Surge capacitors
    c) Snubbers
    d) ZORC (Snubber & arrestor)
    e) Series Inductance & Shunt Capacitance

    A question was raised as to whether something can also be done with circuit breakers to mitigate this problem. Nigel McQuin referred the group to IEEE Standards C37.010, and C37.011 which provide substantial information to aid the

user in understanding breaker applications and transient recovery voltages.

There was no other new business brought before the group.

8.5.4.5 WG on Revision of C57.21- Standard Requirements, Terminology, and Test Code for Shunt Reactors over 500 KVA – Richard Dudley, Chairman

The W.G. met in the Duluth Meeting Room of the Hilton Minneapolis Hotel in Minneapolis, Minnesota on Oct. 15, 2007 from 11:00 a.m. to 12:15 p.m. There were 16 members and 17 guests present. The following are the highlights.

1. Introductions were made.
2. The minutes of the Dallas meeting were approved.
3. IEEE patent policy was reviewed and no patent issues were identified re the revision of IEEE C57.21.
4. The remainder of the meeting was devoted to discussing the comments associated with the 5 negative ballots received during the formal IEEE ballot of Draft #12 of the revision of IEEE C57.21. The following are the highlights.

(i) JEFF NELSON

- Clause 12.8: IEEE C37.109 Guide for the Protection of Shunt Reactors will be "cited" and added to the "Normative References".
- Clause 12.2: To be in line with the requirements of the NESC the pedestal height recommendation will be 8 feet 6 inches.
- Table 5: The proposal to change maximum voltages for 115 kV, 161 kV and 230 kV systems from 121 kV, 169 kV and 242 kV to 123 kV, 170 kV and 245 kV was rejected as current levels are per the current IEEE transformer standards. The proposal is based on the practice in IEEE Switchgear Committee standards.
- Clause 3.2 and 3.2.3: The title of Clause 3.2.3 will be changed to "Rated Voltage" from "Rated System Voltage"; rated voltage is now defined specifically. The statement in Clause 3.2.3 "Rated voltage is normally the voltage associated with nominal system voltages" will be deleted.
- Table 1: Table 1 and Table 2 will be modified to show no correction for altitudes $\leq$ 1000M.
- Clause 4.1.5: Example (2) will be modified to include seismic to be consistent with the latest revision of IEEE C57.12.00. Note IEEE 693-2005 is "cited" in Clause 10.10.

(ii) LOREN WAGENAAR

- Clause 10.3.4.4: The third paragraph will follow the Notes to ensure there is no confusion as to what the note contents refer to. Notes: "However, only……..".
- Clause 10.3.3.1 and 10.3.3.2: Comment that the end user must be notified at the tender stage re testing with a single phase source was accepted.
- During the discussion of LOREN WAGENAAR's comments it was noted that the clause numbering in Section 10.3.3 was in error e.g. "Turn-to-turn Overvoltage Test for Dry-Type Shunt Reactors" etc. The Chairman will correct this for the "recirculation" draft.

(iii) ALAN DARWIN

- Clause 10.6.6.4: Equation 11 is incorrect. It is correct in IEEE C57.21-1990. This version will be used. The title of Clause 10.6.6.4 will be changed to "Calculation of Sound Level at Each Microphone Position".

(iv) CARLOS PEIXOTO
- Clause 10.3.3.1.4: The request to change p.d. levels was not accepted by the W.G. Values are in line with those in IEEE transformer standards.
- Section 4.1: Clause 4.1.6 will be added covering "Environmental Conditions" and will be based on the content in Annex A Clause A.3.4. The Chairman will make this change.

(v) JIM WILSON
- Jim Wilson's comments are accepted.

(vi) The comments associated with "approved with comments" ballots are largely editorial or corrections and are accepted. They will be included in the "recirculation" draft.

The Chairman requested that W.G. members provide any input as soon as possible. The Chairman will produce Draft #13 and send to W.G. members for approval prior to "recirculation ballot". The meeting adjourned at 12:15 p.m.

8.5.4.6 WG on Revision of C57.110 – IEEE Recommended Practice for Establishing Liquid-Filled & Dry-Type Power & Distribution Transformer Capability When Supplying Non-Sinusoidal Load Currents – Rick Marek, Chair; Kent Haggerty, Co-Chair

There was no meeting this fall since a ballot on the document had just been completed. The ballot results are as follows:

Ballot Open Date: 08/28/2007 Ballot Close Date: 09/27/2007

RESPONSE RATE: This ballot has met the 75% returned ballot requirement.
85 eligible people in this ballot group:
66 affirmative votes
2 negative votes with comments
0 negative votes without comments
2 abstention votes

70 votes received = 82 % returned 3 % abstention

APPROVAL RATE: The 75% affirmation requirement is being met.

68 votes = 97% affirmative, 35 total comments

The next step will be to review the comments, resolve the negative ballots, and then re-circulate an updated version.

8.5.4.7 TF on Semi-Conductor Rectifier Transformers, C57.18.10 – Sheldon Kennedy, Chairman

The WG met on Tuesday, October 16, 2007 at 3:15 PM with 10 members and 5 guests present. Sheldon Kennedy chaired the meeting.

The IEEE disclosure statement was discussed. There were no patents pertaining to this standards work for which any members had awareness.

The minutes of the March 13, 2007 meeting in Dallas were approved.

The Chair announced that the Amendment, C57.18.10a/D2, had been put out for a survey in the Performance Characteristics Subcommittee. Only 17 votes were received out of the 126 members. Eleven approved with no comments. One approved with comments. Five abstentions were received. No negatives were received. Lacking any negative votes, the chair proceeded on with the amendment process.

The Chair sent the draft on for IEEE editorial review. That was completed and the invitation to ballot was sent out on October 7, 2007. The ballot invitation is open until November 9, 2007. The balloting process will begin after that.

The Chair reminded the WG that IEEE had published an Errata in January 2006, correcting some of the problems that occurred when the Word copy was converted to a PDF file. Also, with this Amendment, the standard cannot be reaffirmed in 2008. When it comes due it will have to go to a full revision. The Chair discussed some of the tabled topics from the reaffirmation and previous work and asked members to begin to think about things they would like to work on for the next revision. The Chair also expressed concern for all of the work that will be needed to bring this document into the new IEEE format. This standard contains many tables and formulas which will be a lot of work to convert.

8.5.4.8 WG on IEEE Standard Requirements, Terminology, and Test Procedures for Neutral Grounding Devices, PC57.32 – Steve Schappell, Chairman

In absence of the WG Chair Steven Schappell, the meeting was conducted by Peter Balma and notes were taken by Raj Ahuja.

There were 16 attendees -- 6 members and 10 guests with 1 guest Vif Radbrandf requesting membership to the WG.

Approval of minutes from the March 2007 meeting in Dallas was requested. The minutes were approved as written.

The IEEE Patent disclosure requirements were discussed and a request was made for disclosure of any patents that may be related to the work of the WG. There were no responses to the request for disclosure.

Discussion on the present Draft:
There was good discussion from the attendees and following is the summary –

1. The Resistors – Stainless steel type there is need for the justification of temperature limits and the reference documents in the standard.
2. Thermal rating of Resistors – there is need for the tolerance in resistance value at the end of thermal rating duration -- to be included in the standard.
3. Section 14.2 There was discussion on the need of reduced Insulation level at the ground end of the resistor as an option available to the users. At present the ground end has same Insulation level as the Neutral end.
4. Zigzag grounding transformers to be covered in the standard

Assignments for sections requiring review:

Members volunteered to review of following sections -

1 Definition of Sections -- Peter Balma
2 Ground fault neutralizers – Richard Dudley
3 Grounding Transformers – Donald Ayers
4 Capacitors – Peter Balma
5 Combination Devices – Sergio Panetta

New Business:

600 V class Neutral grounding resistors to be included in the standard for Distribution class transformers. At present standard covers only >= 1200 V class.

8.5.4.9 WG on the Guide for the Application and Interpretation of Frequency Response Analysis for Oil Immersed Transformers, PC57.149 –– Chairman; Charles Sweetser

WG PC57.149 met for the development of the Frequency Response Analysis (FRA) Guide in Minneapolis, MN on October 15, 2007 at 1:45 PM. There were 76 people in attendance, 21 members and 55 guests which of 11 requested membership.

The first order of business was to show five IEEE slides regarding patents.

The working group chair gave an update of draft D4.

The Working Group Chair presented a brief report on what had been done in the last six months. It was estimated that the document is over 95% complete. The latest contributions were identified and discussed.

Section 1: Scope and Application - Review complete and open to general comments.

Section 2: FRA Test Parameters - Review complete and open to general comments.

Edits to Section 3: Making a FRA Measurement

Larry Coffeen has agreed to supply the alternate connection instructions, including a purpose, description, and terminal connection table. This section will be appended to the primary recommended test connection table

Section 4: Test Records – Paulette Payne Powell and Alexander Kraetge provided recommendations regarding required and optional fields for test records. These fields will be required to save a FRA dataset. Twenty-three items are required; however, several items can be automated if test templates are applied.

Edits to Section 5, analysis and Interpretation: The discussions focused on failure modes and trace comparison strategies.

An analysis strategy regarding failure modes was proposed. 8 failure modes presented:

1. Radial “Hoop Buckling” Deformation of Winding
2. Axial Winding Elongation “Telescoping”
3. Overall- Bulk & Localized Movement
4. Core Defects
5. Contact Resistance
6. Winding Turn-to-Turn Short Circuit
7. Open Circuited Winding
8. Electrically Float Shields

The working group agreed to limit the failure modes to these 8 categories.

Three common variations (oil, residual magnetization, poor connections and grounding) will also be added to this section, but will clearly be separated, since they are not actual failure modes.

The Working Group recommended including any information describing why the FRA traces change for specific failure modes.

The proposal presented the concept of a one-page format. A one-page analysis template would be created for each failure mode, and would include a view of all applicable tests of a failure mode. The key is to not concentrate on a single test.

This format will include the following tests:

1 HV Open Circuit
2 LV Open Circuit
3 HV – LV Short Circuit

The test will be presented in both before / after and phase / phase comparison formats.

Several members offered to provide case studies; Payne Powell, Alexander Kraetge, Jin Sim, Kurt Robbins, Larry Coffeen, and Peter Werelius.

Alan Darwin volunteered to provide a short description on modeling and agreed to review and edit the appendix on FRA Theory.

The chair provided an update on the CIGRE WG A2.26. The CIGRE WG A2.26 met on October 10, 2007 in Bruges, Belgium. They published their document “MECHANICAL-CONDITION ASSESSMENT OF TRANSFORMER WINDINGS USING FREQUENCY RESPONSE ANALYSIS (FRA).”

The PC57.149 FRA WG plans to have an updated draft D5 at the next meeting.

8.5.5 Old Business

None

8.5.6 New Business

None

Attendance at this Meeting

MEMBERS

1. Raj Ahuja
2. Stephen Antosz
3. Carlo Arpino
4. Javier Arteaga
5. Barry Beaster
6. EnriqueBetancourt
7. Wallace Binder
8. Carl Bush
9. Alvaro Cancino
10. Craig Colopy
11. John Crouse
12. Alan Darwin
13. Dan de la Cruz
14. Richard Dudley
15. Fred Elliott
16. Bruce Forsythe
17. Eduardo Garcia
18. Charles Garner
19. Ramsis Girgis
20. E. Gomez-Hennig
21. Bill Griesacker
22. Myron Gruber
23. Stanley Hatch
24. Roger Hayes
25. William Henning
26. Philip Hopkinson
27. Virenda Jhonsa
28. Sheldon Kennedy
29. Vladimir Khalin
30. Alexander Kraetge
31. John Lackey
32. T. Machado Junior
33. Richard Marek
34. Dennis Marlow
35. John Matthews
36. Harold Moore
37. Martin Navarro
38. Van Nhi Hguyen
39. Gylfi Olafsson
40. Klaus Papp
41. Mark Perkins
42. Christoph Ploetner
43. Bertrand Poulin
44. Paulette Powell
45. Ryland Revelle
46. Jean-Chris Riboud
47. Pierre Riffon
48. Girolamo Rosselli
49. Marnie Roussell
50. Mahesh Sampat
51. Ewald Schweiger
52. Jin Sim
53. Steven Snyder
54. Andy Steineman
55. Craig Stiegemeier
56. Charles Sweetser
57. Juan Luis Thierry
58. Robert Thompson
59. Robert Tillman
60. George Tolbert
61. Alan Traut
62. Subhash Tuli
63. Dharam Vir
64. Loren Wagenaar
65. Jim Zhang
66. Peter Zhao

GUESTS

1. Hasse Nordman
2. Ulf Radbrandt
3. Mark Peterson
4. Rudolf Ogajanov
5. Shawn Patterson
6. Waldemar Ziomek
7. Dave Ostrander
8. Paul Mushill
9. Jennifer Yu **
10. Jeff Foley
11. Peter Werelius **
12. Mark Scarborough
13. Kirk Robbins **
14. Robert Perlichek
15. Jim McBrider
16. Dong Kim
17. Patrick Wang
18. Prem Patni
19. Shamaun Hakim
20. Dwight Parkinson**
21. Steve McGovern
22. Vinay Mehrota **
23. Bruce Fairris
24. Donald Ayers **
25. Gene Blackburn
26. Lewis Powell
27. Mathieu Sauzay
28. Sanjay Patel
29. Ryan Brady
30. Brett Todd
31. Charlie Drexler
32. David Scaquetti
33. Kipp Yule
34. Steve Jordan **
35. Eberhard Lemke
36. JaneAnnVerner**
37. Richard Tellez
38. Richard Graham**
39. Pat Pries
40. Do Gyoon Kim
41. Mike Craven
42. Randall Kyle
43. Ben Lopez
44. Wayne Johnson
45. Liu Qiuping
46. Fran Huguet

** Guests requesting Membership.