7.3 POWER TRANSFORMERS – E. G. HAGER, CHAIR

The Power Transformers Subcommittee met Wednesday afternoon, March 10th at 1:30 pm with 103 in attendance including 49 members and 54 guests. 16 of the guests requested membership in the subcommittee and will be added to the membership roster.

The minutes from the Pittsburgh meeting were approved before the various working groups and task forces reported.

7.3.1 WORKING GROUP AND TASK FORCE REPORTS

7.3.1.1 TASK FORCE FOR REVISION OF C57.17, ARC FURNACE TRANSFORMERS – Dominic Corsi, Chairman

The Chairman called the meeting to order at 8:00 am. There were 10 attendees. This was the 5th meeting of the group since the start of the Task Force project. A written handout containing the minutes of the last meeting and work input from the Task Force members was distributed for review and comment.

The first order of business was the review and approval of the minutes from the October meeting that was held in Pittsburgh, PA. The members present approved the minutes.

The Chairman reviewed the status of the Task Force and progress to date.

A review of Old Business by Section resulted in the following comments and action items:

Section 4, Ratings

- Decided to keep the "old" table for voltage ratings of 34.5kV and below
- Discussed the point of view by some members that the ratings table with respect to large furnace transformers is not flexible enough. Further review will be necessary to resolve this issue.
- Recommend changing the chart of ratings, minimum and maximum low voltage values, to Typical to acknowledge latest design and furnace requirements (ref. Tables 4-2 and 4-3 of C57.17/D1).
- Ad 46kV class to Table 4-1. In addition, a recommendation was made to use the same ratings as listed in C57.12.00 which will be taken into consideration.

Section 9, Construction

- Recommended moving the Item 9.1.3, Vector Relationship from Construction to Section 4, Ratings
- Briefly discussed the impact of metrification efforts on the Construction Section
- Reviewed the physical arrangement of Secondary Bars with the intent to relieve historical restrictions on present designs and to concentrate on electrical characteristics such as ampacity and dielectric clearances
- Contributors were requested for Section 9.4, No Load Tap Changers and Section 9.5, Load Tap Changers.

Appendix A, Dissolved Gas in Oil Analysis

- Frank D'Amico submitted a write up for this Appendix to include a Guide for the Interpretation of Gasses Generated in Electric Arc Furnace Oil-Immersed Transformers.
- Members are to review this data and to submit comments prior to the next meeting.
- The Chairman is compiling data using a comprehensive database available to him through his employer, S.D. Meyers, Inc. He will make this available as soon as he gets the results.

Appendix B, DC Arc Furnace Transformers

- Mr. Ugo Piovan has agreed to assist in writing this section.

Appendix C, Guide for Protection of Arc Furnace Transformers

- Mr. Tom Slovik submitted a calculation method for protection of a large AFT and requested input from the group on scope of inclusion

Under New Business, the Chair again solicited for participation of the members to include submission of new input and review to include comments of the latest submission of data from the group.

The meeting adjourned at 9:00 am.

7.3.1.2 WORKING GROUP FOR THE REVISION OF C57.93, INSTALLATION OF LIQUID-FILLED TRANSFORMERS - Michael Lau, Chairman

Acting Chairman: Peter M. Balma reported that the Working Group for The Installation of Liquid-filled Transformers was called to order at 9:35 AM on Monday March 8, 2004. There were 57 attendees, 28 members, 3 requesting membership, and 26 guests. The agenda for the meeting was reviewed; and minutes, material on storage guidelines, a suggested clause on shielding and a comparison of this guide versus related EPRI guidelines were distributed.

The agenda for the meeting was reviewed, and the following items were completed at this session:

- Agenda review
- Introductions
- Progress Update
- Storage Guidelines
- New Clause
- Guide Comparison
- Guide Format
- Adjournment

Progress Update: PAR was approved June 13, 2002, a revised PAR is required to include maintenance in the title, Draft 5 of Guide has been assembled, Clause 4.6 Preliminary Oil Filling was removed, Clause 4.9.3 Hot air circulation for drying will be retained, and a section on cold weather Dewpoint testing is needed.

Storage Guidelines: A new clause, Storage 4.14, has been added to Draft 5 and was reviewed in detail. Thanks to Malcolm Thaden for this contribution, which generated substantial discussion at the meeting.

Clause 4.14.1.1

- Question: What is relatively level in storing or installing a transformer, what If I have a transformer on a large slab that has a 1 or 2 inch differential. Comment: As long as sound is not an issue not a problem. Perhaps relatively level should be removed from this clause.
- Comment on that storage in oil seems to only be addressed in last paragraph of 4.14.1.1, consideration should be given to storing the transformer in oil regardless of time in storage.

Clause 4.14.1.2

- Comment from Don Chu that you need to pull a vacuum on a transformer to remove nitrogen from the transformer after storage in same, prior to entry into the transformer.
- Peter Balma indicated that rather than use the term “dry air”, maybe we should use the term “breathable dry air” throughout the document.
- Comment: Even if a transformer is stored in dry air, it needs to be purged.
- Comment: For ester-based fluids you may not want to fill with dry air. Ester based fluids WG will be contacted for input. (Patrick McShane)
- Comment: Should we reference OSHA for requirements relative to entry into a transformer?
- Comment: More users are requesting dry air. Not aware of any papers on the effect of use of dry air versus dry nitrogen storage. Should we be more specific and not allow alternatives? Based on this discussion the working group voted on whether both dry air and dry nitrogen should be described in the guides. Consensus of the group was to leave both in.
- Comment: The word “dry” should be added before “nitrogen.”
- Second to last paragraph – does this apply to both dry air and gas filled or how long stored?

Clause 4.14.1.2.1

- Change number to 0.1 – 0.3.

Clause 4.14.1.2.2

- Comment: What is preferred? Maybe the guide should indicate that the best or preferred method of storage is in oil, however, some manufacturers permit storage in dry nitrogen or air for up to 6 months or longer.

- Comment: The term “elevated pressure” should be quantified, perhaps 4-5 PSI and not beyond the pressure relief device setting. The pressure should not exceed 5 PSI.

Clause 4.14.1.2.3

- Add paragraph stating that regardless of the length of the storage period, user should consider providing power to cabinet heaters and/or placing desiccant filled bags in the cabinet.
- A suggestion was made to add a paragraph to address installation/assembly delays when the six-month storage period has been extended do to unintentional delays.
- Should guidance on whether a transformer should be fully dressed as a spare (including radiators), or just oil filled for storage, be provided?
- Comment: The proper storage environment should be considered, including oil containment, seismic restraint, grounding, etc.

A new clause, Internal Shields, was submitted and suggested by Wayne Hansen. It was indicated that the clause could be added to Clause 4.7, however, that the title should be changed to Internal Grading Shielding.

Guide Comparison: Thanks to the efforts of David Wallach, a handout, which compared C57.93 versus EPRI guidelines, was reviewed and resulted in the following comments.

- Paragraph 4.8.2 Vacuum Treatment: Utilize the existing information in IEEE standard.
- Paragraph 4.8.3.2 Vacuum Leakage test – EPRI has provided more detail. It was suggested that we use table from EPRI as it has more recent information, and to investigate as to why it is a little different.
- Paragraph 4.8.5 Vacuum filling – hold vacuum: EPRI indicates based on voltage class of transformer, should this be considered. When does vacuum time start? When you reach specified level, or when you turn on the vacuum pump. The guide will be checked to determine if this needs to be clarified.
- Group was asked to provide any additional input related to this analysis/comparison to either the working group chair or secretary.

The format of the present guide, which distinguishes between transformers rated less than 10 MVA and 69 kV, and for those rated greater than 10 MVA and 69 kV, was reviewed with the intent of resolving the final format for the guide. Should these two clauses be blended, left as separate, or have common sections pulled out up front. The working group voted to leave as is.

In the next several weeks, Draft 5 of the guide will be placed on the transformer committee website for use by the working group.

The meeting adjourned at 10:45 AM.

7.3.1.3 WORKING GROUP FOR STANDARD CONTROL CABINET DESIGNS – Joe Watson, Chairman

The new Working Group met at 11:00 am on Monday, March 8, with 28 in attendance. There were 13 members and 15 guests. None of the guests requested membership.

The minutes from the Pittsburgh meeting were approved as submitted.

The group was informed that the PAR has been approved, changing the Task Force that has discussed this issue into a Working Group. The document will be a Trial Use Standard.

Joe indicated that only one response was received for input into Draft 1 (Guide for the Layout, Design, and Construction of Control Cabinets for Power Transformers). There are four main sections that require the most work: cabinet construction, components, modular cabinet designs, and cabinets for different types of transformers.

The list of volunteers from the Pittsburgh meeting was reviewed, and additional volunteers were requested. Jane Verner agreed to help with the first two sections.

Joe discussed the wiring layouts, and suggested that the control cabinet be divided into quadrants. He suggested that several manufacturers get together to try to decide which components would go where. Steve Schappell volunteered to lead this effort. Tim Huff, Brent Hayman, and Enrique Betancourt all agreed to participate.

Discussion took place concerning placement of items in the cabinet, and the number of variations we wish to present. It was decided that we would come up with a basic layout, and allow users to review it to see how it meets their needs.

It was suggested that we compare the requirements in C57.12.10 to ensure that all required items are addressed. New electronic temperature monitors that mount outside of the cabinet were discussed. Standards for relays, breakers, etc. were discussed. It was decided that the guide would contain definitions for these items, as well as information to size them.

Joe stressed that he would like to get input for the next revision of the Draft within the next 60 days. Susan McNelly will be asked to post the current Draft on the website. The goal is to have a completed revision 2 of the Draft in time for the Fall meeting.

The meeting adjourned at 12:00 pm.

7.3.1.4 WORKING GROUP ON LOAD TAP CHANGER PERFORMANCE - William Henning, Chairman

The Working Group on LTC Performance met on Monday, March 8th with 8 members and 32 guests attending. Eight of the guests present requested membership in the Working Group.

The main discussion covered a comparison of C57.131-1995, "Requirements for Load Tap Changers," with IEC 60214-1, "Tap Changers Part 1, Performance Requirements and Tests." Each paragraph was placed in one of four categories:

- Same: The paragraph in C57.131 and the corresponding paragraph in 60214-1 are identical or convey the same meaning.
- Different: The two documents convey different meanings covering the same topic.
- 131 Only: The information is contained only in C57.131.
- 60214-1 Only: The information is contained only in 60214-1.

With the differences identified, a Working Group survey will be conducted, asking members to vote separately on each item, as to whether or not changes should be made to C57.131 for that item. In addition to a review of IEC 60214-1, the IEEE reaffirmation ballot produced a list of 14 proposed revisions to C57.131. The Working Group survey will include the 14 items from the IEEE ballot.

The Working Group survey will have a 45-day return period. During that time a first draft of an application Guide will be prepared. The source of information for this Guide will be the latest drafts of the IEC Guide 60213-2.

This Working Group has two documents that it is working on concurrently. We are unsure what numbering will be used for the two related documents, but the Working Group Chair will discuss numbering with the IEEE NESCOM administrator. Because we are working on two documents, the Working Group would like to request a second time-slot for subsequent meetings so the requirements document could be discussed at the first meeting, and the application Guide could be discussed at the second meeting.

With that, the meting adjourned at 2:45 pm.

7.3.1.5 WORKING GROUP ON C57.140 "GUIDE FOR THE EVALUATION AND RECONDITIONING OF LIQUID IMMERSED POWER TRANSFORMERS" - Rowland James, Chairman.

The Working Group met at 3:15 pm on Monday, March 10, 2004 in San Diego, CA. There were 53 members and 45 guests in attendance.

After introductions of members and guests, the chairman announced that Bill Bartley had been appointed co-Chair of the Working Group. Bill was previously vice-Chair and Secretary.

The first item on the agenda was the status of the draft. The draft is essentially complete – with just one article outstanding. The draft guide has also been completely reorganized to make it easier for the reader to find a particular subject matter.

The draft will be sent into the IEEE, in the upcoming months, for a pre-ballot editorial review.

The draft will be circulated to the working group membership by the end of the summer, for a straw ballot.

Volunteers were selected to review the major sections of the Guide.

Comments were received from the floor regarding changes to Section 4, Risk Assessment.

The meeting adjourned at 4:15 pm. The next meeting will be in the fall of 2004.

7.3.1.6 WEST COAST WORKING GROUP - Michael Lau, Chairman

The meeting was called to order by Red Hager at 08:00 am on March 9, 2004 with 21 members and guests in attendance. Two Task Forces discussed business during the Working Group meeting and both Task Forces presented reports in the Subcommittee meeting as follows:

7.3.1.6.1 TASK FORCE ON NEW GUIDE COVERING TRANSPORTATION ISSUES – Tom Lundquist, Chairman

The first item of business was the forming of a Task Force chaired by Tom Lundquist with the purpose to begin development of a Guide for large power Transformer Transportation Issues. Members were requested to joint this TF/WG for purpose of development of a scope and PAR for the next meeting in winter. The winter meeting will be used to decide upon any revision, develop a scope, and prepare a PAR.

7.3.1.6.2 TASK FORCE ON REVISION OF IEEE 62, C57.117 AND C57.125 - Wally Bender, Chairman

Red Hager introduced Wally Binder, Chair of the Task Force, who reported on the current status of the three guides being discussed.

IEEE 62 – Reaffirmation ballot is completed. Five negative ballots required recirculation of those ballots. Recirculation produced no additional negative ballots and with the promise of a revision project, four of the five withdrew their negative ballots.

- All negative ballots were regarding the use of a moisture equilibrium chart and calculation, which is part of the current C57.106. This issue is being addressed in

a Working Group under the Insulating Fluids Subcommittee. Any revision of IEEE 62 will need to wait for this issue to be resolved by the experts in the Insulating Fluids Subcommittee.

- The issue is the subject of a Tutorial Presentation Session at the San Diego Meeting on Tuesday afternoon.
- The remaining comments are editorial in nature, such as updating the Standards references.
- Final paperwork must be submitted to IEEE before reaffirmation will be complete.

C57.117 – Reaffirmation ballot is completed. The vote was 100% affirmative.

- Final paperwork must be submitted to IEEE before reaffirmation will be complete.
- Editorial comments will be needed to update the Guide.
- Originally written to make reporting of failure statistics consistent, no agency is currently tracking those statistics in a public forum. Individual companies may be using the methods internally.

C57.125 - Reaffirmation ballot is completed. The vote was 100% affirmative. One negative ballot was received, but due to the editorial nature of the comments, the balloter agreed to withdraw his negative ballot.

- Final paperwork must be submitted to IEEE before reaffirmation will be complete.
- Editorial comments will be needed to update the Guide.

It has been decided at the Admin SC level to assign the IEEE 62 document to the Standards SC and the other two to the Power Transformers SC.

The structure of the revised documents was discussed. The consensus of those present was to retain the existing structure of three separate documents. One WG operating in the Power Transformers SC will work on revision of C57.117 and C57.125. One WG will operate under the Standards SC and revise IEEE 62.

Those present completed an attendance sheet indicating their interest in each guide with 13 requesting membership in the Task Forces. From this interest profile, two Task Forces will be assembled to start revision of the respective documents.

There was no further business and the Task Force adjourned at approximately 9:00 AM.

After the Task Force discussions, the West Coast Working Group meeting adjourned 8:45 AM.

7.3.1.7 TASK FORCE FOR FUNCTIONAL LIFE TESTS OF DE-ENERGIZED TAP CHANGERS – Phil Hopkinson, Chairman

The Task Force on Life tests, De-energized Tap Changers was called to order at 9:35 am on March 9, 2004. There were 56 attendees comprised of 28 members, 5 requesting membership and 23 guests. The agenda for the meeting was reviewed and the Minutes from the October 7, 2003, meeting in Pittsburgh, Pennsylvania were approved.

The attendees agreed that the mission of the Task Force is to develop a functional life test and a supporting technical paper for de-energized tap changers.

The chairman presented the scope for the functional life test and reviewed his testing results presented at previous meetings.

A functional life test shall be performed as a Type Test to demonstrate the adequacy of the contact design to achieve long stable thermal life. The test consists of thermal cycling at accelerated current and temperature, with daily cool-down cycles. A successful test is completed if contact resistance remains within 25% of the original value and stability is achieved.

The test is conducted by passing twice rated current through the contacts for 8 hours per cycle at an ambient temperature of 130°C.

A total of 30 cycles (days) of the 8-hour on, 16 hour off 2X rated current are required to complete the functional test.

Transformers with high impact loading are most susceptible to thermal runaway. No tap changers failed in the field that passed this test.

The proposed paper, “Electrical Contacts for Off-Circuit Tap Changers for Oil-Immersed Transformers” by Phil Hopkinson is available on the website. Comments and co-authors are sought. Loren Wagenaar, Bill Henning, John Matthews, Mike Culhane, Dieter Dohnal, Larry Dix and Bob Degeneff were volunteered as co-authors.

The group reviewed the report on testing conducted by Dieter Dohnal or Reinhausen.

Mike Culhane and Dieter Dohnal volunteered to present additional test results at the fall meeting. Loren Wagenaar wanted to see more mineral oil examples of testing. The Chair countered that Mr. Dohnal’s work has been exclusively in mineral oil.

There was no new or old business and the meeting adjourned at 10:05 am.

7.3.1.8 WORKING GROUP FOR REVISION OF C57.12.10 - Javier Arteaga, Chairman

The Working Group met at 1:45 pm on March 9, 2004 with 10 members, 7 Guests and 5 Guests that requested membership in the Working Group.

After introduction of the attendees, the minutes from the Fall 2003 meeting were approved as written.

Since the last meeting a number of comments had been received pertaining to various areas of the construction section. The entire meeting focused on getting through as many of these comments as possible.

- Section 5.1.1 (Tap Changer) – Agreed to use the DETC terminology for de-energized tap changers.
- Sections 5.1.3 and 5.1.4 (LTI, WTI) – Looking for clarification of low and high ambient light conditions. The request was to have the same requirements for analog and electronic monitors. Is it necessary to be able to read in extreme conditions (direct sun, darkness)? It's not intended to start requiring a background light on analog devices. For low ambient conditions, a flashlight can be used to read either an analog or LCD display. Someone offered to provide suggestions on wording.
- The height of monitors was brought up and a discussion ensued regarding issues for both manufacturers and users. Lowering gauges can result in assed product costs for small units. Increasing weights may result in requiring ladders be used to either read or reset gauges in the field. It was agreed to recommend the heights to be between 4 and 6 feet.
- The minimum character height on electronic displays as challenged. The WG felt that the suggestion to use a 5.55 mm as a minimum was too small and decided to stay with 13 mm for now. A user and manufacturer can agree to smaller size if preferred.
- Display requirements will not discriminate against specific colors. Black will be added to the list for both LTI and WTI.
- Static electrification may be a concern if turning pumps on when the fluid temperature is below 50°C. Therefore contact set limits should be reviewed in order to allow users to block pumps from operating. The lower set point will be changed from 65°C to level to 40°C. Need to check with device manufacturers to see if this presents any problems.
- Section 5.1.4 (WTI): Consider adding a requirement for external shorting switch if the electronic temperature monitor brings the bushing CT's secondary directly into their unit. Existing text for analog devices don't address this. All load monitoring CT's for thermal monitoring should be connected to a shorting type terminal block. This issue is already covered in another section (refer to section 5.15.2 for terminal block requirements).
- Section 5.3.3 (Moving Facilities): Rewrite this section such that there's a radius on the steel or an upward flange. Need to be able to roll the unit into place. The

terminology for the base plate could use a better definition. A flat bottom base with material thickness of 0.5" or more must be rounded up. Also I-Beams need to have some radius. Formed bases are fine. A beveled edge can add significant cost. Skid toes can be added to I-beams.

- Section 5.7.2 (Other Oil Preservation Systems): Expand this section to include technologies for liquid preservation system for units greater than 60 MVA. Expansion tanks (conservator tank with rubber diaphragm) typically required on larger units. Also used to get shorter shipping heights. Just list the types of systems available, but don't define the requirement for a particular rating. If not specified, the manufacturer will then decide the most economical design.
- Top oil temperature range allowed for conservator system should be higher than 100°C. Normally, 110°C is acceptable. Allow up to 120°C? Decided on 110°C.
- Eliminate Gas-Liquid seal system?
- What to do with Free-Breathing systems? Some people still build.
- Need someone to address conservator tanks with and without bladders also the accessories and size this applies to. Javier Arteaga and Tom Lundquist will put something together and circulate for comments.

At the end of the meting, everyone was asked to review the remaining comments that were distributed and to offer comments. The meting adjourned at 3:00 pm.

7.3.1.9 WORKING GROUP ON THE APPLICATION OF ON-LINE MONITORING TO LIQUID IMMERSED TRANSFORMERS AND COMPONENTS- Donald Chu and Andre Lux, Co-Chairpersons

The Working Group met on Tuesday, march 9. Sixty-two members and guests were in attendance.

Draft 12 of the Guide was discussed. The Guide has to go through a significant amount of changes. A number of these changes were discussed during the meeting. Issues discussed and actions taken include:

Removal of the following sections

- Section 3.10, Load Tap Changer (LTC) Operations. This information is contained in an earlier section
- Annex 1 – Bushing Power Factor and Capacitance
- Annex 2 – Partial Discharge
- Annex 3 – Winding Temperature Measurements

A number of members volunteered to review key sections. The working group co-chairmen will contact additional monitoring equipment vendors and request that they also review key sections

The decision was made to significantly reduce he amount of text in Section 4. The sections regarding communications and communication protocols have to be reduced or edited significantly.

Discussion took place regarding the amount of information that is required in benefits and risk assessment methodology. Some of the existing information may be removed.

Discussion also took place regarding the necessity of having existing tables in the appendix that were taken from a CEA published report on On-Line Monitoring. One of the members volunteered to review the tables in the Annex and compare these to tables throughout the Guide.

A group of approximately six Working Group members will meet at the upcoming Doble Conference for the purpose of going through the Guide carefully and making as many of the necessary changes as possible.

7.3.1.10 TF/WG Revision of C57.135 – Tom Lundquist, Chairman

The meeting was called to order at 9:30 am with 26 in attendance including 21 members signed up as members of TF/WG

It was announced a Task Force (TF) is being formed to evaluate the need to conduct a revision of C57.135. Attendees were asked to review the document and submit too the chair those suggestions for change to the guide. Accumulation of the suggestions will be circulated to the members for comment. The winter meeting will be used to decide upon any revision, develop a scope, and prepare a PAR.

The meeting adjourned at 10:00 am.

7.3.2 OLD BUSINESS

Red Hager reported on the meeting of the IEEE 693 Working Group in San Diego last fall and the tutorial presentation at this meeting on seismic transformer design considerations.

7.3.3 NEW BUSINESS

Tom Prevost discussed the need for all groups working on Guides and Standards to review C57.12.80 to ensure consistency with Terms and Definitions.

Red Hager also reported that, following this meeting, he will submit a request to the Administrative Subcommittee requesting Tom Lundquist to serve as the Subcommittee Chair and Red Hager to then serve as Co-Chair.

The meeting adjourned at 2:45 pm.