



# 2009 PROGRESS REPORT

## STUDY COMMITTEE A2 (Transformers)

### 1. Highlights

The 2008 activities were mainly related to the edition of three Technical Brochures and the preparation of the final reports in the field of copper sulphide in power transformer insulation, thermal performances of power transformers and HVDC Converter Transformers.

AG "UHV AC & DC Transformers" continues to be involved in the domain of UHV to cover some specific aspects in relation with the development of 1000 kV transformers by a liaison with WG A3-22 'Technical requirements for substation equipment exceeding 800 kV', WG B3.22 'Technical Requirements for Substation exceeding 800 kV' and in the Joint IEC-CIGRE Coordination Group (JICCG) to provide guidance to IEC and CIGRE in the development of UHV standardization.

In 2008, and in collaboration with SC C4, a WG has been created in the field of Electrical Transient Interaction between Transformers and the Power System.

A new work item proposal 14/597/NP has been issued by IEC TC 14 on December 2008 based on the work done within WG A2.26 'Mechanical condition assessment of transformer windings' and finalized with the publication of the TB 342 in April 2008.

### 2. Status of SC reference model implementation

The strategic plan on the WEB site of SC A2 shows that the reference model for SC is fully implemented.

### 3. Main technical directions pursued

The two strategic directions of SC A2 have not been changed and are:

- To continue on transformer technology issues and to consider new information technologies (data, communication, web services)
- To provide services to CIGRE customers (reliability and availability including impact of accessories, life management, economical issues, tutorials, etc).

### 4. SC WG

Full progress report, scope and membership of the different groups are on the WEB site of A2. The convenors of the new WG have been asked to accept or to invite 1-2 young experts in their working bodies. On some WG, the young experts have taken an active role by taking the role of secretary, or acting in the editorial team. This effort will be emphasized in the future.

#### 4.1 Working groups disbanded or transferred to an other SC

Not applicable.

#### 4.2 Activities of WG

WG A2.24 - Thermal performances (J. Hermans / BE). The main objective is to give a recent overview in thermal performances. Three following areas are reviewed: Fundamentals on thermal ageing, Ratings of new transformers and Practical applications for in service transformers. The report is in the final stage for a publication in the first part of 2009.

WG A2.32 - Copper sulphide in power transformer insulation (M. Dahlund / SE) has finalized his work which will be published in April 2009. The WG has been asked to prepare the ToR for a new WG to continue investigations in this important matter, mainly in the field of mitigation.



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WG A2.33 - Fire Safety (A. Petersen / AU). The task is to prepare recommendations for transformer fire safety practices for transformer designers and transformer users. The following aspects are considered: a) Avoidance of tank rupture by defining key parameters influencing tank ruptures and with an overview of the state-of-the-art in that domain, b) Precautions to fire origin (transformer) by setting recommendations for electrical, thermal and pressure protection and considering fire resistant materials with dedicated design rules for fire safety, c) precaution to fire victim (substation asset) by setting recommendations for space separation, flame propagation prevention, liquid containment, fire barriers and extinguishing system.

WG A2.34 Guide for Transformer Maintenance (C. Rajotte / CA). The aim is to prepare a guide for transformer maintenance that will help transformer users to define and apply best practices for transformer maintenance. The intent is to include transformers rated 69 kV and above, and larger than 25 MVA.

The WG is divided in five TF: 1) Maintenance practices, condition assessment and diagnostic, 2) Transformer Oil: criteria, treatment and economics, 3) Transformer Accessories: specification and maintenance, 4) Human and material aspects of transformer maintenance and 5) On-site repair and testing.

WG A2.35 Experiences in service with new liquids (R. Martin / UK). The aim is to collate and review the in-service experience of using the new fluids in a way which is relevant and beneficial to the electrical industry. The work has been divided in TF: 1) Physical, Chemical and Electrical properties, 2) Design considerations, 3) Liquid applications, 4) Tests in service tests (Lab and field), 5) Maintenance, 6) Reliability and longevity. Other items like survey of standards, corrosive sulphur issues and identification of knowledge gaps are covered.

WG A2.36 Guide for Transformer Procurement Process (T. Breckenbridge / UK). The aim is to carry out a full review and update of the existing CIGRE A2 documents on procurement, taking into account the current market conditions and to prepare a new guide for assessing the capability of transformer manufacturers that evaluates technical competence and experience. The work has been divided into three TF. They are: TF1 - Review of CIGRE Brochure 156: Guide to Specifications, TF2 - Review of CIGRE Brochure 204: Guide to Design Review and TF3 - Creation of a Guide to Manufacturer Capability Assessment.

WG A2.37 Transformer Reliability Survey (S. Tenbohlen / DE). Specifically, the WG will: a) Review all existing national surveys and study different practices (data collection, compilation, etc.), b) Discuss the differences and identify best practices, c) Compile and present the information available in these national survey reports and d) Make recommendations to improve the situation. Failure statistic issued by third parties (utility, manufacturer, test facility) have also been collected. Considering the failure statistics that was presented, there is clearly a wide view of practices and of failure definitions. The WG will work on the definitions of failure and failure rate and a draft questionnaire related to the processes of data collection and definitions. The final questionnaire should give a guideline which data and information should be collected by the WG members from the national utilities. WG members are encouraged to get into contact their national A2 representatives and work to get utility failure statistics. Failures of transformers and reactors with primary voltage  $\geq 69\text{kV}$ , across all age groups, will be only considered.

WG A2.38 Transformer Thermal Modelling (J. Lapworth / UK). The aim is a) to clarify definitions, especially for cooling mode (e.g. ON/OFF/OD), b) to compare existing thermal design calculation tools for a common example, c) to make recommendations for the installation of fibre-optic sensors to measure hottest spot temperatures, d) to make suggestions for improved practices during heat run tests, especially regarding tap position, losses, overload factors, temperature measurements, d) improve understanding of cooling and hotspots in shell form transformers. Other aspects, as investigation regarding fundamental differences between ON and OF cooling, correlation between premature insulation ageing and failures, etc will be treated.



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### 4.3 New working Groups

#### JWG A2/C4.39 Electrical Transient Interaction between Transformers and the Power System (A. Rocha /BR).

The objective of the JWG is to assess and discuss the different types of electrical transient interaction between transformers and other components. The work has been divided in the following manner: a) Survey on high frequency pulses originated by the system and stressing relevant insulation, b) High frequency transformers modelling and testing, c) Protection and critical connection configurations, d) Survey of utility experiences regarding transformer failures and occurrences involving transients, including comparison and discussion of the relevant results, e) Manufacturer experience concerning technical specifications dealing with transient voltage requisites, f) Discussion on the possibility of pinpointing risk factors that may cause failures due to transients (case-by-case analysis, specification; operation/maintenance practices and g) Development of a methodology for transient system studies aimed at evaluating a range of frequencies appearing during switching short-circuits in substations, and incoming lines of different voltage level and arrangements.

### 4.4 Advisory Groups (AG) within A2.

Actually SC A2 has 7 AG's to support the management of SCA2. They are related to: a) transformer technology, b) transformer user, c) relation with other SC's, d) tutorial, e) A2 customers, f) development of UHV transformers and g) A2 strategy.

## 5. Joint WG & TF

### 5.1 Joint working Groups

JWG A2/B4.28 - HVDC Converter Transformers (M. Saravolac / UK) created in 2004. The JWG is working in the following directions: Reliability Survey Update, Design Review Guide for HVDC Converter Transformers and Test Specification. The JWG activities are currently focusing on the issue of a brochure as guide for design review and a Tutorial on Reliability of UHVDC Converter Transformers to be issued in 2009.

### 5.2 Activities with other Study Committee

- WG D1-01: Liquid impregnated insulation systems (L. Lundgaard / NO)
  - TF D1-01-12 \*: Oil maintenance - Insulating oil reclamation and and dechlorination (B. Pahlavanpour / UK)
  - TF D1-01-13: Furans for diagnostics (M.-Cl. Lessard / CA)
  - TF D1-01-14 \*: Dielectric response diagnoses for transformer windings (S. Gubanski / SE).
  - TF D1-01-15: Progress in DGA techniques and diagnoses (M. Duval / CA)
  - TF D1-01-17: Oxidation Stability of Transformer Insulating Oils (I. Atanasova Höhlelein / DE)
  - WG A3-22 \*: Technical requirements for substation equipment exceeding 800 kV (Dr. Hiroki Ito / JP)
  - WG B3-22 \*: Technical Requirements for Substation exceeding 800 kV (T. Yokota/ JP)
- \* Report ready for publication or already published

## 6. SC Publications and publication plan

- Report prepared by the SC A2 Advisory Group – Transformer Technology with the title ‘Power Transformers Technology Review and Assessments’ – February 2008
- Final report/brochure of WG A2-26 ‘Mechanical condition assessment of transformer windings’ - TB 342 - April 2008
- Final report/brochure of WG A2-27 ‘Recommendations for condition monitoring facilities’ - TB 343 - April 2008
- Short Report on Joint Colloquium A2/D1 2007 in Bruges/BE - June 2008
- Final report/brochure of WG A2-30 ‘Moisture in transformer’ - TB 349 - June 2008
- Short Report on local Conf. CIGRE A2 ‘Brazil’ - V Workspot in Belem/BR - Dec 2008
- Technical Report SC A2 for Electra - Role of SC A2 ‘Transformers’, Strategy, Current activities and future Developments - February 2009
- Final report /brochure of WG A2-32 - Copper sulphide in power transformer insulation - April 2009
- Final report /brochure of WG A2-24 - Thermal performances - mid 2009



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- Final report /brochure of JWG A2/B4-28 - HVDC Converter Transformers - mid 2009

### 7. SC Website

The new CIGRE format is fully implemented and a lot of relevant reports for the branch of the transformers have been put on this important interface. The last updating has been performed on 12.2.2009. Under the part 'Publication', multiple important reports dealing with the current activities of SC A2 are available.

### 8. SC Strategic plan & Action plan

SC A2 has fully implemented the reference model for SC (see strategic plan on the WEB site of A2). The strategic & action plans are available on the WEB site of A2. They have been updated in Sept. 2007.

### 9. SC meetings

The committee met on Aug 27, 2008 in Paris. 57 persons were present: 23 regular members including 2 substitutes, 5 observer members including 1 substitute, 7 WG convenors and 21 guests were present including 4 incoming new regular and observer members.

SC A2 has presently 24 regular members and 16 observers.

In 2009 SC A2 will have his meeting in South-Africa. SC meeting will be hold in Japan (2011) and Switzerland (2013).

### 10. Tutorial and SC participations to regional meetings, Colloquium and Symposia

SC A2 has prepared a series of tutorial in the field of Short-circuit, Economic of transformer management, Life management, Condition assessment, Design review, Overload and Thermal aging of Transformers, Copper sulphide in power transformer insulation, Recommendations for condition monitoring and condition assessment facilities for transformers, Transformer lifetime data management, Moisture migration, Partial discharge application in factory and in the field (with support WG D1.01), Ageing of cellulose insulation in transformers (with support WG D1.01), Diagnostics of oil-paper insulation by means of dielectric response methods (with support WG D1.01).

Other tutorials are in preparation in various domains. These tutorials have been, or will be, presented in conjunction with the events listed hereafter.

- Transformer Technology Conference - Sydney/Australia - March 2008
- V Workspot on Transformers - Belem/Brazil - April 2008
- CMD2008 – Int. Conf. on Condition Monitoring and Diagnostics - Beijing/China - April 2008
- 2nd CIGRE- IEC International Symposium on Standards for UHV - New Delhi/India - January 2009
- Int. Conf. on Power Transformers “Transformer '09” - Torun/Poland - June 2009
- 6th Southern Africa Regional Conference & CIGRE Colloquium prepared by SC A2, A3 and B3 - Cape town/South Africa - August 2009
- Colloquium 'Transformer Research and Asset Management' - Cavtat/Croatia - November 2009
- TRAFOTECH-2010 Eighth Int. Conf. on Transformers - Mumbai/India - January 2010

### 11. Relation with other organisation

- Joint IEC-CIGRE Coordination Group (JICCG) in the development of UHV standard.
- Good relations are established with IEC TC 14 and IEEE Transformers as delegates are reporting regularly to SC A2.

P. Boss / 26.3.09