CONSEIL INTERNATIONAL DES GRANDS RESEAUX ELECTRIQUES
INTERNATIONAL COUNCIL ON LARGE ELECTRIC SYSTEMS

STUDY COMMITTEE A2 TRANSFORMERS

# Presentation of CIGRE activities on Power Transformers

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# Presentation of CIGRE

**CIGRE aims to :**

- Facilitate and develop the exchange of engineering knowledge and information, between engineering personnel and technical specialists in all countries as regards generation and high voltage transmission of electricity
- Add value to the knowledge and information by synthesizing state-of-the-art and world practices
- Make managers, decision-makers and regulators aware of CIGRE's work

16 Study Committees

Exchanges with partners of CIGRE ( IEC; Eurelectric, IEEE, CIRED, ... )

# CIGRE SC Organization

- A1 Rotating electrical machines
- A2 Transformer
- A3 High voltage equipment

- B1 Insulated cables
- B2 Overhead lines
- B3 Substations
- B4 HVDC and power electronics
- B5 Protection and automation

- C1 System development and economics
- C2 System operation and control
- C3 System environ-mental performance
- C4 System technical performance
- C5 Electricity markets and regulations
- C6 Distribution systems and dispersed generation

- D 1 Materials and test techniques
- D 2 Information systems and telecommunication

# The Transformer Committee (A2)

**Scope** : Design, construction, manufacture and operation for all kinds of power transformers, including industrial , DC converters and phase-shift transformers and for all types of reactors and transformer components (bushing, tap-changer…)

**In the past** *( known as SC12 )* activities were focused on design problems related to the rapid increase of rated voltage and power

**Today**, the two Strategic Directions for A2 future activities are :

- **Services to Customers** ( Reliability, Life management, Economics, Tutorials, ...)
- **Technology Issues** (Safety, New technologies and New concepts, Electrical environment, Pre-standardization work, ...)

# Present A2 Activities

- 24 regular members
- 17 observer members
- + 162 experts involved in 10 WG's
- 7 AG's
- 14 Liaisons with other working bodies
- 40 countries represented

# Recent CIGRE BROCHURES

| *Scope* | *Ref* | *Year* |
|---|---|---|
| Thermal aspects | 96 | 1995 |
| Static electrification | 170 | 2000 |
| Effect of particles | 157 | 2000 |
| Customer specifications | 156 | 2000 |
| Design reviews | 204 | 2002 |
| Short circuit performance | 209 | 2002 |
| Life management of transformers | 227 | 2003 |
| Economics of Transformer Management | 248 | 2004 |
| Transformer Lifetime Data Management | 298 | 2006 |

**%**

# Recent CIGRE BROCHURES (cont.)

| *Scope* | *Ref* | *Year* |
|---|---|---|
| Mechanical Condition Assessment of Transformer Windings | 342 | 2008 |
| Recommendations for Condition Monitoring and Condition Assessment Facilities for Transformers | 343 | 2008 |
| Moisture Equilibrium and Moisture Migration within Transformer Insulation Systems | 349 | 2008 |
| Copper Sulphide in Transformer Insulation | 378 | 2009 |

**see also brochures issued by SC D1, resp. WG D1-01**

# Past SC A2 Sessions & Colloquium

| | |
|---|---|
| ***2004 Paris*** | ***- Thermal Performances & On-site operations*** |
| ***2005 Moscow*** | ***- Colloquium on Transformers Reliability (Technical, Economical and Strategic Aspects)***<br>***- New Development of electrical transients on transformer performances*** |
| ***2006 Paris*** | ***- Transformers Reliability, Technical, Economical and Strategical Aspects***<br>***- New Development of electrical transients on transformer performances***<br>***- Phase-Shifter Transformers*** |
| ***2007 Bruges*** | ***- Guidance in new insulation liquids for improvement on performance and reliability***<br>***- Life estimation of transformers in service***<br>***- Reactors and related items*** |
| ***2008 Paris*** | ***- Performance in service of new insulation systems for transformers***<br>***- Reliability and risk assessment of transformers in service***<br>***- Reactors (shunt, shunt with regulation, series, neutral) and related items*** |

# Present A2 Activities

**WG finishing editorial :**

| | | |
|---|---|---|
| **WG A2.24** | **Thermal performances** | **Declercq (BE )** |
| **JWG A2/B4.28** | **HVDC Converter Transformer** | **Saravolac (FR )** |

**WG underway :**

| | | |
|---|---|---|
| **WG A2.33** | **Aspects related to Fire Safety** | **Petersen (AU)** |
| **WG A2.34** | **Guide on maintenance** | **Rajotte (CA)** |
| **WG A2.35** | **Experiences with new liquids** | **Martin (UK)** |
| **WG A2.36** | **Guide for Transformer Procurement Process** | **Breckenridge (UK)** |
| **WG A2.37** | **Transformer Reliability Survey** | **Tenbohlen (DE)** |
| **WG A2.38** | **Temperature Modelling** | **Lapworth (UK)** |
| **JWG A2/C4.39** | **Electrical Transient Interaction between Transformer and the Power System** | **Rocha (BR)** |
| **WG A2.40** | **Copper sulphide long-term mitigation and risk assessment** | **J. Lukic (RS)** |

**New Working bodies in preparation :**

- **Reactor**
- **Transformer transportation**
- **Requirement for transformer tank**
- **Contingency of transformer practices, standardization**
- **Short circuit capability in the context of transformer ageing**
- **…**

# Present A2 Activities (cont.)

**Liaisons with other Study Committee or external bodies:**

- **IEC TC 10,**
- **IEC TC 14,**
- **IEEE,**
- **JOINT IEC-CIGRE COORDINATION GROUP (JICCG) to provide guidance to IEC and CIGRE in the development of UHV standardization**
- **ISO TC108 SC 5 - WG10 'Condition monitoring and diagnostics of electrical equipment**

- **WG D1.01 – Liquid Impregnated systems for transformers**
- **TF D1.01.12 - Oil maintenance**
- **TF D1.01.13 - Furans for diagnostic**
- **TF D1.01.14 - Dielectric Response diagnoses**
- **TF D1.01.15 - Progress in DGA technique**
- **TF D1.01.17 - Oxidation Stability of Transformer Insulating Oils**
- **WG D1.24 - Polymer Nanocomposites**
- **WG A3.22 - Technical requirements for s-station equipment exceeding 800 kV**
- **WG B3.22 - Technical requirements for s-station exceeding 800 kV**

# Interactions with the working programm in progress within

# IEC TC 14 – Transformer

# STRATEGIC POLICY STATEMENT
# June 2007/ SMB/3528/R

# Market demand

- **Need for standardization of transformers used in flexible a.c. transmission systems in combination with HVDC systems. These transformers will be controlled by power electronics switching equipment and will be subjected to high harmonic currents and fast switching transients.**

- **Demand for the replacement, refurbishment or life-extension of existing transformers.**

- **In many countries, the deregulation of the electricity supply industry may lead to a higher demand as networks are reinforced to allow power to be transmitted through the network between third parties.**

# Trends in technology and trade

- **Increasing demand for transformers with low fire risk …….**

- **Introduction of power electronics equipment is affecting the harmonic content of load currents.**

- **As the use of power electronic equipment increases it may be necessary to initiate work to provide standard information regarding the performance of windings and cores carrying high harmonic currents.**

- **Interest in the introduction of high temperature insulation. Use of hybrid insulation system ……..**

- **Natural Ester based insulating fluids are being used for small transformers and application for larger power transformers is under development**

# Trends in technology and trade (cont.)

- **System automation will affect communication systems concerning transformers but the major impact is likely to be in the area of transformer protection, monitoring systems and the remote control of fans, pumps and tap-changers. …increasing interest in monitoring systems**

- **…emerging interface problem between switchgear and transformers where large transients generated by the switchgear operation introduce dangerous transient voltages in the transformer windings. Work in IEEE and CIGRE is being undertaken to explore this phenomena. When work has been further developed it may be necessary to introduce new testing criteria as well as protection measures into transformer standards**

# Ecological environment

- The noise generated by transformers is becoming more important due to environmental requirements in particular load noise.
- Safety of people
- Recycling of used oil
- Use of natural ester oil
- Low loss transformers

# WG A2-24 - Thermal performances (2003)

- Fundamentals of thermal ageing of insulation system,
- Thermal modeling of transformers (for monitoring system)
- Thermal testing of transformers (contribution to measuring uncertainties at heat run tests)
- Final report ready for publication – mid 2009

# JWG A2/B4-28 - HVDC Converter Transformers (2004)

- Specifications for HVDC transformers and interaction with converter valves
- Revised guideline for:
  - Design Reviews
  - Test specification (recommendations in the field of the duration of the Polarity Reversal test)

# WG A2-33 - Transformer Fire Safety Practices (2006)

- Integrate recommendations regarding transformer fire into the relevant standards.
- The scope shall cover different parts, mainly:
  - Avoidance of tank rupture,
  - Precaution to fire victim and
  - Precautions to fire origin

# WG A2-34 - Guide for Transformer Maintenance (2006)

- Help transformer users to define and apply best practices for transformer maintenance.
- The Scope shall be accomplished in the three following parts:
  - best practices, list of periodic actions applied in service or with outage, checking and testing in order to evaluate transformers condition,
  - address advanced maintenance activities, usually referred as condition based maintenance, such as oil additives, oil filtering, oil regeneration, and insulation drying and
  - human and material aspects of transformer maintenance, with maintenance planning, maintenance tasks tracking, maintenance resources, cost references, level of competences required for different tasks, training, on-site repair, etc.

# WG A2-35 - Experiences in service with new liquids (2006)

- Collate and review the in-service experience
- Domains to be covered are :
  - Basic properties like physical and chemical and electrical differences, including fire safety, toxicity, etc.
  - Design considerations,
  - Maintenance, Retrofilling practice, Handling, experiences
  - Standards: Review what standards exist for these fluids, highlight deficiencies, propose remedies
  - Further work: identify the knowledge gaps/concerns and propose solutions, or work for other groups

# WG A2-36 - Guide for Transformer Procurement Process (2008)

- Review and update of the existing CIGRE A2 documents on procurement:
  - current market conditions
  - new commercial pressures
- Prepare a guide for assessing the capability of transformer manufacturers:
  - competence
  - experience
  - promotion of good engineering practices

# WG A2-37 - Transformer Reliability Survey (2008)

- Preparation of a brochure describing international transformer reliability survey practices.
  - Local survey identification
  - Compile and present the information available in these national survey reports
  - Recommendations to improve the compatibility of the data compiled in the different countries

# WG A2-38 - Transformer Thermal Modeling (2008)

- State of the art techniques in transformer thermal modeling
- Examples of advanced transformer modeling tools
- Direct measurement of hot-spot and best practices
  - Advantages and limitations of these technologies
  - Recommendation for standard improvement
  - The applicability of thermal modeling to revise old transformer thermal performance

# JWG A2/C4-39 - Electrical Transient Interaction between Transformer and the Power System (2008)

- Survey on high frequency pulses originated by the system and stressing relevant insulation.
- High frequency transformers modelling and testing
- Protection and critical connection configurations
- Survey of utility experiences regarding transformer failures and occurrences involving transients
- Manufacturer experience concerning technical specifications dealing with transient voltage requisites.
- Discussion on the possibility of pinpointing risk factors that may cause failures due to transients.
- Development of a methodology for transient system studies.

# WG A2-40 - Copper sulphide long-term mitigation and risk assessment (2009)

- Sources of sulphur other than oil
- Influential factors and mechanism
- Methods and tools in diagnostics
- Metal passivator stability and efficiency
- Efficiency of existing on-site oil treatment processes and new technologies

# CIGRE A2 TUTORIAL ACTIVITIES

- Objectives
  - Capture the knowledge and know-how developed by CIGRE SC A2 and other related SC and disseminate
  - Add value to this knowledge and information by synthesizing state-of-the-art documents
  - Improve visibility of recent development in transformer related topics
  - Identify the research that appear most promising
  - Disseminate at the regional level to reach a larger audience

# CIGRE A2 TUTORIAL ACTIVITIES (cont.)

- List of Tutorials
  - Transformer Overload Performance
  - Short Circuit Performance
  - Economics of Transformer Management
  - Copper sulphide in power transformer insulation
  - Recommendations for condition monitoring and condition assessment facilities for transformers
  - Transformer lifetime data management
  - UHVDC Convert Transformers: Reliability Aspects
- Tutorials prepared by SC D1, resp. WG D1-01
  - Partial discharge application
  - Diagnostics of oil-paper insulation by means of dielectric response methods
  - Ageing of cellulose insulation in transformers

# A2 Tutorial & External Events

- Transformer Technology Conference, Sydney, Australia, March 2008
- IV WORKSPOT, Belem, Brazil, April 2008
- CMD2008 – Int. Conf. on Condition Monitoring and Diagnosics, 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 Conf. - with the support of SC A2, A3 and B3, Capetown, 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

# SC A2 – Colloquium – 2009
# Somerset West, Western Cape, South Africa
# 17th - 21st August 2009

## Key themes

***End of Life Asset Management***

- ***Strategies for reinvestment***
- ***Residual life assessment***
- ***Timely & efficient replacement/refurbishment***
- ***Spare strategies & equipment re-use***
- ***Transportation***

***Maintenance of Equipment for Maximized Reliability***

- ***Different strategies and type of maintenance***
- ***Maintenance activities: solutions and benefits***
- ***Condition monitoring and maintenance regimes***
- ***Low/easy maintenance equipment***

# 2009 – Paris / SC A2 Transformer Session
# August 25, 2009 -

## Preferential Subjects

***PS1: Transformer incidents in service***

- ***Fire prevention, new oil, new bushings, avoidance of tank rupture***
- ***Fire mitigation, new oil, fire wall***
- ***Environment: oil spill containment, new types of oil, smoke***

***PS2: Transformer Life***

- ***Specification - experience with CIGRE TB 156 " Guide for customers specifications "***
- ***Procurement process - experience with CIGRE TB 204 "Guidelines for conducting design reviews***

***PS3: Transformer Modeling***

- ***Transients, HF modeling***
- ***Thermal, distribution of losses***

# *Thank you for supporting A2*

see www.cigre-a2.org