Congratulations and Thank You!

On behalf of the Administrative Council of CIGRE,
The President and the Secretary General
Have the honour to bestow upon

Elizabeth MACKENZIE

the title of

Distinguished Member

In acknowledgement of her long-standing collaboration to the work of the Association

Michel AUGONNET
President

cigre 2022

Philippe ADAM
Secretary General

cigre
For power system expertise

Congratulations and Thank You!


On behalf of the Administrative Council of CIGRE,
The President and the Secretary General
Have the honour to bestow upon

Simon RYDER

the title of

Distinguished Member

In acknowledgement of his long-standing collaboration to the work of the Association

Michel AUGONNET
President

cigre 2022

Philippe ADAM
Secretary General

cigre
For power system expertise

Agenda

- **10:30 Registration and Tea/Coffee**
- **11:00 Welcome and Introduction to SC A2**
- **11:10 A2 Technical Activities | Working Group Status Updates | Technical Brochures Published in 2022 | New Working Groups**
- **12:30 D1 Relevant Technical Activities**
- **13:00 Lunch**
- **14:00 IEC TC14/TC10 Standards Activities**
- **14:30 Discussion – Papers for 2023 Colloquium and 2024 Session**
- **15:00 End of Meeting, Tea/Coffee/Networking**

cigre
For power system expertise

CIGRE UK A2|D1 Liaison

Introduction to CIGRE Study Committee A2

Zhongdong Wang
University of Exeter
UK A2 Regular Member

17/01/2023

A2 Study Committee

Mission

To facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of transformers and reactors. To add value to this information and knowledge by means of synthesizing state-of-the-art practices and developing recommendations.

Technological field of activity

- Power transformers including industrial, DC converter and phase-shifting transformers
- Reactors including shunt, series, saturated and smoothing
- Transformer components including bushings, tap changers and accessories

CIGRE A2 Study Committee

Scope

Within its technical field of activity, Study Committee A2 addresses topics throughout the asset management life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life. At all stages, technical, safety, economic, environmental and social aspects are addressed as well as interactions with, and integration into, the evolving power system and the environment. All aspects of performance, specification, testing and the application of testing techniques are within scope, with a specific focus on the impact of changing interactions and demands due to evolution of the power system. Life cycle assessment techniques, risk management techniques, education and training are also important aspects.

Within this framework additional specific areas of attention include:

- Theory, principles and concepts, functionality, technological development, design, performance and application of materials, efficiency.
- Manufacturing, quality assurance, application guidance, planning, routing and location, construction, erection, installation.
- Reliability, availability, dependability, maintainability and maintenance, service, condition monitoring, diagnostics, restoration, repair, loading, upgrading, uprating.
- Refurbishment, re-use/re-deployment, deterioration, dismantling, disposal.

Key Personnel and Activities – CIGRE Study Committee A2

- Chairman
  - **Pascal MUELLER**
- Secretary
  - **Marc FOATA**
- Webmaster
  - **Tim GRADNIK**
- UK Regular Member
  - **Zhongdong WANG**
- UK Additional Regular Member
  - **Elizabeth MACKENZIE**
- Working Groups
  - **Currently 15 working groups under the scope of SC A2**

e-cigre

This website is the online library and bookstore for CIGRE.

There is a wealth of information that can be searched by title, keyword, document type or study committee. It can be downloaded free by Cigre members, or purchased by non-members.

Documents include Technical Brochures, CIGRE SC. & ENG. Electra, Colloquia Papers, Symposia Papers, Green Books, Session Papers, ISH Collection, Reference Papers, Working Group Reports, Webinars, Membership Directory, Tutorials.

CIGRE Session 2024

- The Preferential Subjects for 2024 Paris Session are still in draft:
  - **PS 1: Design of Resilient Transformers**
    - Stresses from the environment: Impact of global warming, high temperatures heavy rain, high winds, offshore installations, etc.
    - Stresses from the system: Switching impulses, reverse flow, emergency overloading, harmonics, GIC, short-circuits and internal arcing etc.
    - Specifications: Design criteria, materials and testing requirements for new transformers. Suitable maintenance standard and refurbishment strategies.
  - **PS 2: Advances in Transformer Analytics**
    - Data management: Digitalisation and Information Model, online and offline test data, integration of condition and multiple data sources, data preparation for analytics.
    - Diagnostic and on-line monitoring: Algorithm/Guidelines for on-line monitoring, advanced interpretation of condition data, case studies.
    - Modelling: Transformer digital twins (thermal, dielectric, mechanical, etc.), physics-based and hybrid models, failure probability and ageing models, applications of Artificial Intelligence.
  - **PS 3: Reliability of Transformers for Renewable Energy**
    - Transformers for Low Carbon Technologies: Voltage < 100kV, wind and photovoltaic parks, battery energy storage and Electric Vehicle Charger etc.
    - Case Studies and Lessons Learned: Type of failure, root cause analysis, mode of operation. Recommendations concerning procurement, design, operation and asset management strategies.
    - Failure Prevention: Useful diagnostic methods and monitoring systems. Optimization of operating conditions and additional measures such as overvoltage protection, harmonic reduction, cooling optimisation etc.

CIGRE UK A2|D1 Liaison

SC A2 – Technical Brochures

Elizabeth MacKenzie

UK A2 Regular Member

17/01/2023

TB 857 On-Site Assembly, On-Site Rebuild, and On-Site High Voltage Testing of Power Transformers

- The aim of the working group was to address the new challenges presented by on-site assembly, onsite rebuild, and on-site high voltage testing.
- Site assembly of large transformers was shown to be a viable solution for severe transport limitations.
- Technology is available that allows all parameter and dielectric verification tests to be performed at site.
- This technical brochure shows a collection of many different procedures and experiences of the on-site assembly and the on-site rebuild. Many experiences of the on-site assembly show reliability with only FAT and on-site acceptance tests without on-site high voltage testing. This technical brochure summarizes the quality assurance aspects to ensure high reliability under on-site work.

TB 859 HVDC transformer failure survey results from 2013 to 2020 (B4)

- CIGRE Study Committee B4, collects data on the performance of HVDC systems around the world every year.
- This Advisory Group also identifies the poor performance of any component and makes recommendations of any work that should be performed by the study committee B4. In early 1990, poor performance of converter transformers was identified as one such subject.
- AG B4-04 conducted four surveys between 2013 and 2020. This report provides detailed information collected on converter transformer failures from 2013 to 2020. The report only provides the data and no specific recommendations are made.
- The last two surveys also included reports from VSC (Voltage Source Converter) systems whereas all previous surveys were related to LCC (Line-Commutated Converter) systems only.

TB 861 Improvements to PD measurements for factory and site acceptance tests (A2/D1)

- This Technical Brochure (TB) deals with possible improvements to partial discharge (PD) measurements for factory acceptance test (FAT) and site acceptance tests (SAT) of power transformers.
- The main improvement for FAT and SAT acceptance tests provided by this brochure is the possibility to provide repeatability and comparability for UHF PD measurements using systems from different manufacturers.

TB 887 Life extension of oil filled transformers and shunt reactors

- As transformer diagnostic techniques improved in recent years, operators have been looking for techniques, measures, and methods to extend the life span of installed transformers and reactors. This brochure should be considered as a guideline for approaching transformer life extension projects.
- The first chapter closes with a typical set of questions an asset manager could have when facing a transformer life extension project.
- The second chapter deals with the decision-making process and the related strategy.
- The third chapter provides an overview of the transformer and reactor main parts such as active part including solid and liquid insulation, bushings, tank and cooler, tap changer. It covers their aging mechanisms as well as the consequences regarding the lifespan of the equipment.

Green Book - Transformer and Reactor Procurement

- Provides guidance on industry best practice to make right decisions
- Serves those involved in transformer procurement
- Helps avoiding serious and long-lasting consequences
- Everything from tender process to identification of requirements, specification, loss and efficiency, design, testing, transport, storage, pre-commissioning and trial operation
- Purchase from Springer, £249.99
  - **E-book or hard cover**
- CIGRE individual member 40% discount available

CIGRE UK A2|D1 Liaison

SC A2 – New Working Groups

Elizabeth MacKenzie

UK A2 Regular Member

17/01/2023

New WG A2/D1 1.66 Breathing systems of liquid filled transformers and reactors

- Convener – Daniel Koch (DE)
- Overview of breather and sealed expansion systems.
- Likely influence of systems on transformer operation including thermal ability and lifetime.
- Maintenance requirements and failure rates of various systems.
- Gather data form operational transformers.
- Recommendations on when and how to use breathing and sealed systems.
- Recommendation on the choice of system in terms of condition monitoring and lifecycle cost.

New WG A2/D1 1.67 Guideline for Online Dissolved Gas Analysis Monitoring

- Convener – Tara-Lee MacArthur (AU)
- Guidelines to selection of a suitable monitoring system.
- Develop a list of recommended actions users should take when an alarm occurs.
- Develop a guide to selecting an online DGA system, evaluation criteria for online DGA systems, guidelines for maintenance requirements for online DGA systems
- Provide examples of the different use cases for online DGA systems.

New WG A2 1.68 Failure Survey of Lower Voltage Generator Step Up Transformers installed in Wind farms and Photovoltaic Parks

- Convener – Peter Werle (DE)
- Failures in GSUs for wind and solar parks have been reported – may be less reliable than large GSUs.
- Smaller transformers (<10MVA), influenced by harmonics and fluctuating loads.
- Survey of failures in GSUs for these applications – identify failure root causes, how to identify failure at early stage.
- Best practices in design of GSUs for future applications, can this be applied to other areas (battery storage etc)?
- Recommend additional working groups for analysis of most common root causes

New WG A2.69 Guide for Transformer Maintenance Update

- Convener – Claude Rajotte (CA)
- With the evolution of the maintenance practices, materials, design and manufacturing, an update of TB 445 (2011) is needed – most downloaded TB over last 4 years.
- Next Green Book – Transformer Life Management – chapter on maintenance needed.
- Survey on current maintenance practices and strategy.
- New techniques and technologies available for each component. New testing technologies.
- Update on on-site repair, test, economics and environmental considerations.

CIGRE UK A2|D1 Liaison

PEL/14 – BSI Committee on Power Transformers – Standards Work

Elizabeth MacKenzie

UK A2 Regular Member

17/01/2023

Updates to BS EN IEC 60076 – in progress

- 60076-1 General - ongoing
- 60076-2 Temperature Rise for Liquid Immersed Transformers – ongoing
  - **Parts 1 & 2 being updated together. Part 1 will contain requirements and Part 2 will be a guide to temperature rise test**
- 60076-4 Guide to lightning impulse and switching impulse testing
- 60076-5 Ability to withstand Short-circuit
- 60076-6 Reactors
- 60076-19 Rules for determination of uncertainties in measurement of losses - ongoing
- 60076-25 Neutral Earthing Resistors – to be published early 2023

Published Standards 2022

- BS EN 50708-2-3:2022 Power transformers. Additional European requirements. Medium power transformer. Accessories
- BS EN 50708-3-4:2022 Power transformers. Additional European requirements. Large power transformer. Special tests for corrugated tank and radiators
- BS EN 50708-2-6:2022 Power transformers. Additional European requirements. Medium power transformers. Non-conventional magnetic steel technology WITHDRAWN
- BS EN 50708-2-6:2022 Power transformers. Additional European requirements. Medium power transformers. Nonconventional magnetic steel technology
- BS EN 50708-2-4:2022 Power transformers. Additional European requirements. Medium power transformer - Special tests

CIGRE UK A2|D1 Liaison

Advisory Group AG A2.06:

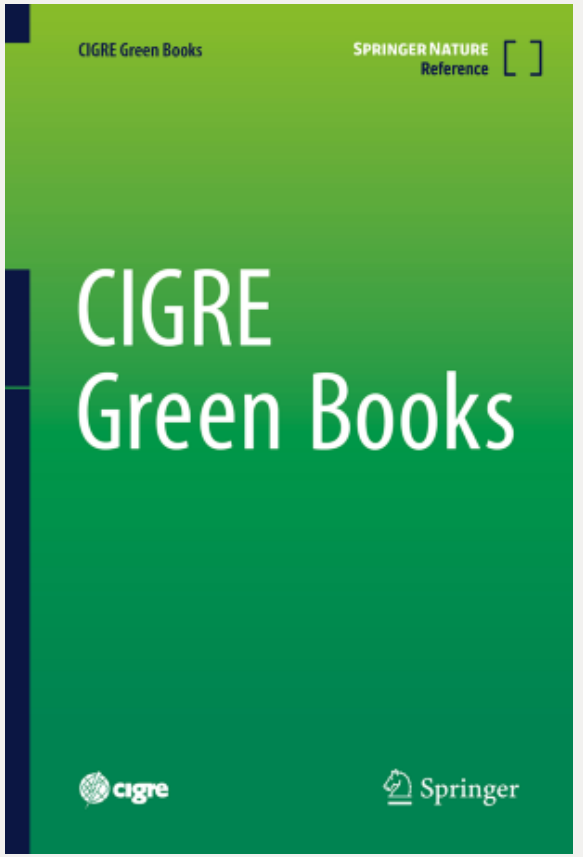
Green Books

Prepared by: Simon Ryder
Doble Engineering

17/01/2023

AG A2.06 Scope

- Green Books are CIGRE's state of the art, flagship reference publications. CIGRE aims to produce the very best, most comprehensive set of reference publications encompassing all the subjects covered by CIGRE and its Study Committees. Green Books consolidate, in a single book, all the CIGRE knowledge in a domain of work, i.e. all of the Technical Brochures, reorganised and carefully compiled.
- **SC A2 has two Green Books:**
  - **Transformer and Reactor Procurement**
    - Published in September 2022
  - **Transformer and Reactor Life Management**
    - In progress
    - Planned completion 2025



AG A2.06 Membership – 1st Green Book

Editor	Country	Chapter Author	Country
Gilson Bastos	BR	Khayakazi Dioka	ZA
Tom Breckenridge	GB	Paul Jarman	GB
Mike Lamb	US	John Lapworth	GB
Tara-Lee MacArthur	AU	Asgeir Mjelve	NO
Simon Ryder	GB	Santhiago Montenegro	BR
		Alvaro Portillo	UY
		Adesh Singh	ZA
		Craig Swindermann	US
		Anthony Walsh	IE
		Ross Willoughby	AU
		Bert Wouters	BE

AG A2.06 Final Table of Contents – 1st Green Book

Chapter	Title	Author	Chapter	Title	Author
	Foreword	SR	10	Design	AP
	Dedication	PJ	11	Manufacturing	ML
1	Overview	TB/SR	12	Testing - general	TB/SM
2	Tender Process	KD/BW	13	Testing – temperature rise	TB/SM
3	Functional Requirements	TB/ML	14	Testing – dielectric	TB
4	Specs – design and construction	TLM/AS	15	Transport	AM
5	Specs – components	TLM/AS	16	Storage	KD/TLM
6	Sound Levels	Eds	17	Installation	ML/RW
7	Losses and Efficiency	AW	18	Pre-Commissioning	JL
8	Supplier Selection	KD	19	Trial Operation	JL
9	Project Management	CS			

AG A2.06 Membership – 2nd Green Book

Editor	Country	Chapter Author	Country
Luiz Cheim	US	Werner Boonen	BE
Adesh Gupta	IN	Khayakazi Dioka	ZA
Tara-Lee MacArthur	AU	Marc Foata	DE
Simon Ryder	GB	Ahmed Gamil	DE
		Michael Heinz	DE
		Stefan Jaufer	CH
		Lars Lundgaard	NO
		Dan Martin	NZ
		Sidwell Mtetwa	ZA
		Pascal Mueller	CH
		Patrick Picher	CA
		Claude Rajotte	CA
		Ralf Schneider	CH

AG A2.06 Provisional Table of Contents – 2nd Green Book

Chapter	Title	%	Author	Chapter	Title	%	Author
	Foreword and Dedication		Eds	12	Condition Assessment		TLM
1	Overview	50	SR	13	Condition Monitoring	80	LC
2	Ageing Processes	50	DM		Digital Twins		PP
3	Procurement		KD	14	Troubleshooting		AG
4	Economics		MF/RS	15	Solid Insulation Ageing		LL
5	Operation	80	Eds	16	Dielectric Cond Ass		AG
6	Losses	80	Eds	17	Mechanical Cond Ass	50	PP
	Sound Levels		WB	18	Thermal Cond Ass	80	TLM/SR
7	Temperature Rise	25	AG	19	Bushing Cond Ass	95	Eds
8	Maintenance Strategies	50	CR	20	Tapchanger Cond Ass		MF
9	Maintenance Tasks	50	CR	21	External Cond Ass		AG
10	Life Extension		RS	22	Liquid Cond Ass		AG
11	FMEA	90	LC	23	Circular Economy	25	MH

A2 Working Group Updates

1. A2|C4.52 - High Frequency Transformer Models for Non-Standard Waveforms (Updates from A2 UK Report 2022)
2. A2.54 - Power Transformer Audible Noise Requirements
3. A2.55 - Transformer Life Extension (Completed - TB 887)
4. A2.56 - Power Transformer Efficiency (No Updates)
5. A2.57 - Effects of DC Bias on Power Transformers
6. A2.58 - Installation and Pre-Commissioning of Transformers and Shunt Reactors (Updates from A2 UK Report 2022)
7. A2.59 - On-Site Assembly, On-Site Rebuild, and On-Site High Voltage Testing of Power Transformers (Completed - TB 857)
8. A2.60 - Dynamic Thermal Behaviour of Transformers
9. A2.61 - On-Load Tap-changer Best Practices (Disbanded)
10. A2.62 - Analysis of AC Transformer Reliability
11. A2.63 - Transformer Impulse Testing
12. A2.64 - Condition of Cellulose Insulation in Oil Immersed Transformers After Factory Acceptance Test
13. A2|D2.65 - Transformer Digital Twin – Concept and Future Perspectives
14. A2|D1.67 - Guideline for Online Dissolved Gas Analysis Monitoring
15. A2.69 - Guide for Transformer Maintenance Update
16. D1|A2.77 - Liquid Tests for Electrical Equipment

cigre
For power system expertise

CIGRE UK A2|D1 Liaison

JWG A2|C4.52:

High Frequency Transformer Models for Non-Standard Waveforms

Updates from CIGRE A2 UK Report 2022

17/01/2023

JWG A2|C4.52 Update

- **Update extracted from CIGRE A2 UK Report 2022**
  - The 5 TBs are TB1 White-box Models, TB2 Black-box Models, TB3 Grey-box Models, TB4 Model Interfacing and Specifications, TB5 Measurements and Design Data.
  - They are under review by the SC A2.

CIGRE UK A2|D1 Liaison

WG A2.54:

Power Transformers
Audible Sound Requirements

Prepared by: Janine Dickinson
National Grid

17/01/2023

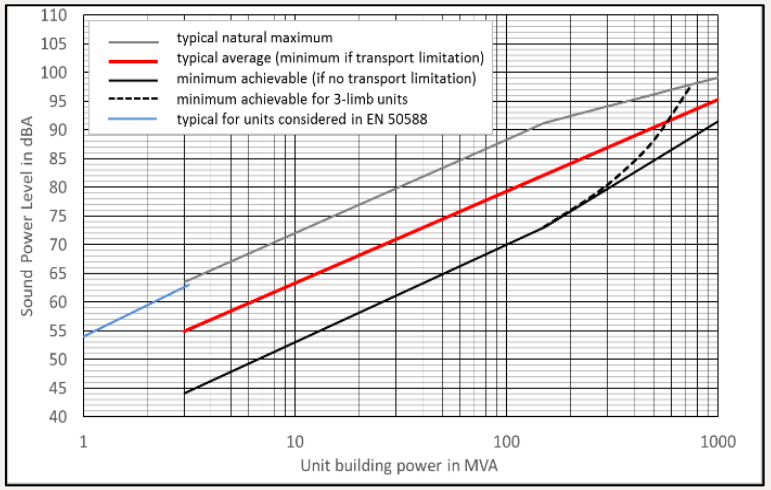
WG A2.54 Scope

- **Context**
  - Lack of reliable guidance on how to specify Tx sound power levels.
  - Insufficient guidance on the range of typical and achievable sound power levels for Txs of different rated power.
  - Sound power levels for new Txs frequently specified too low. Impossible to achieve without external sound mitigation e.g. sound panels or enclosures.
- **Objectives**
  - To inform the industry by providing:
    - Best practice guidelines for the sound level specification of Txs.
    - Guidance on the range of typical and achievable sound power levels for Txs of different rated power (10kVA….1000MVA).
    - Distinguish components: no load, load and cooling sound and combined sound level.
    - Consider 50Hz/60Hz, 3~/1~, sound level legislation and sound mitigation techniques.

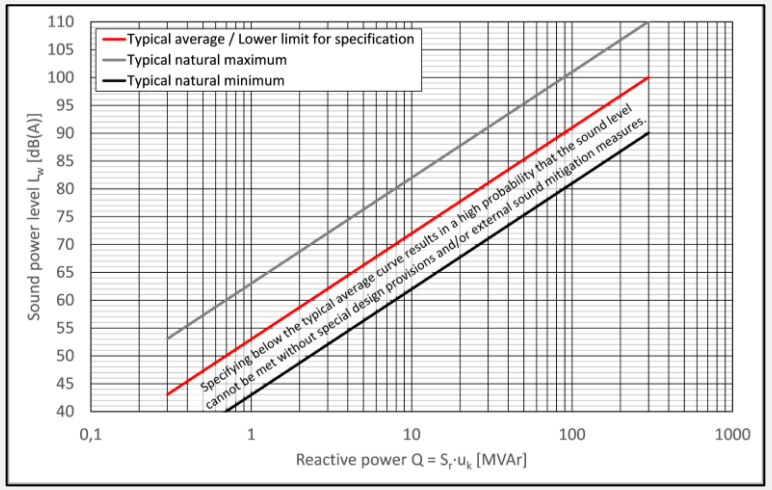
WG A2.54 Key Highlights

- Typical ranges of sound power levels

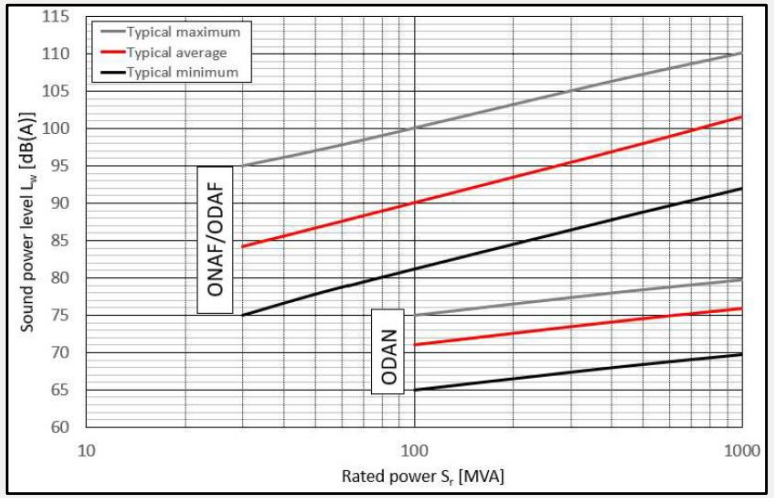
No Load Sound Model



Load Sound Model



Cooling Sound Model



WG A2.54 Progress in 2022

- Technical work complete.
- Work on Brochure, small sections remain outstanding.
- Final meeting in Nuremburg in April 2023.
- Completion and publication of brochure Spring 2023.
- Presentation at Cigre Colloquium – Croatia Nov/Dec 2023.

Chapter	Title	%
1	Introduction	100
2	Background – Physics of Sound, Power Transformer Sound level Development and Control	100
3	Sound Levels of liquid-immersed Xfmr – typical ranges, combination, 50 vs 60 Hz (20 pages)	70
4	Sound levels of other transformer types – Dry-type, Gas insulated, Amorphous core transform.	100
5	Sound level specification and legislation – practice as per survey results, impact on losses+cost+transport, tender process, sound level measurement at site …	100
6	Sound mitigation techniques – in-tank and cooling system solutions, Barrier design and installation at factory and at site	100
7	Conclusion and future work (1-2 pages)	0
Appendix A	Typical sound power level ranges of power transformers – Essential information at a glance	100
Appendix B	Sound level specification using frequency bands	100
Appendix C	Extended formulation for load sound level prediction (4 pages)	50
Appendix D	Cavitation	100
Appendix E	Survey on transformer sound level specification – questionnaire and results	100

CIGRE UK A2|D1 Liaison

WG A2.55

Life extension of oil filled transformers and shunt reactors

UK Members

David Walker (SP Energy Networks)

Asim Bajwa (Doble)

17/01/2023

WG A2.55 Scope and Progress

- Review existing CIGRE documents and other literature that relate to this subject such as those related to diagnostics, monitoring, life management, maintenance, fire safety and economics. Where appropriate, these documents will be referenced in the Technical Brochure
- Define families of ageing modes and related defects considering vintage, operation and maintenance history and events.
- Determine possible solutions with actions to be implemented and fall back plans to limit risks
- Define the criteria to be consider, in order to decide what is the optimum solution given the existing priorities in the company and associated technical and economic arguments including end of live concept
- Conduct a survey of best practice in utilities, industries, transformer manufacturers and service providers
- Provide a catalogue of real cases, illustrating different solutions implemented to enhance lifetime and/or reduce risks for the major families of ageing modes and defects
- **Brochure published in 2022: CIGRE Technical Brochure 887**

CIGRE UK A2|D1 Liaison

WG A2.57

Effects of DC Bias on Power Transformers

UK Members

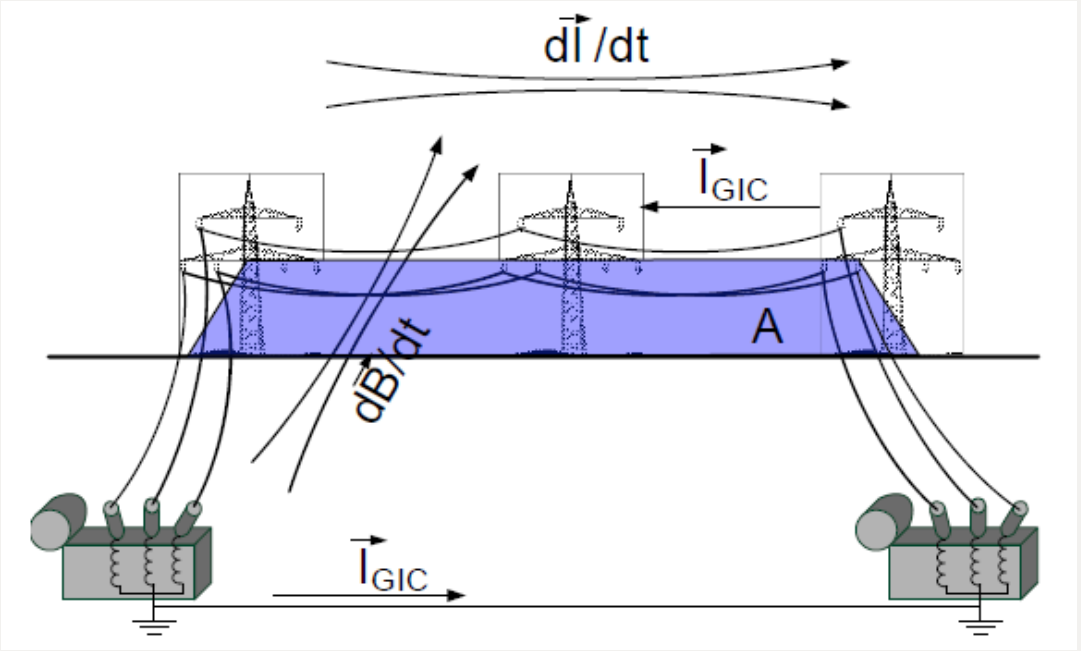
Dongsheng Guo (National Grid)

Paul Jarman (The University of Manchester)

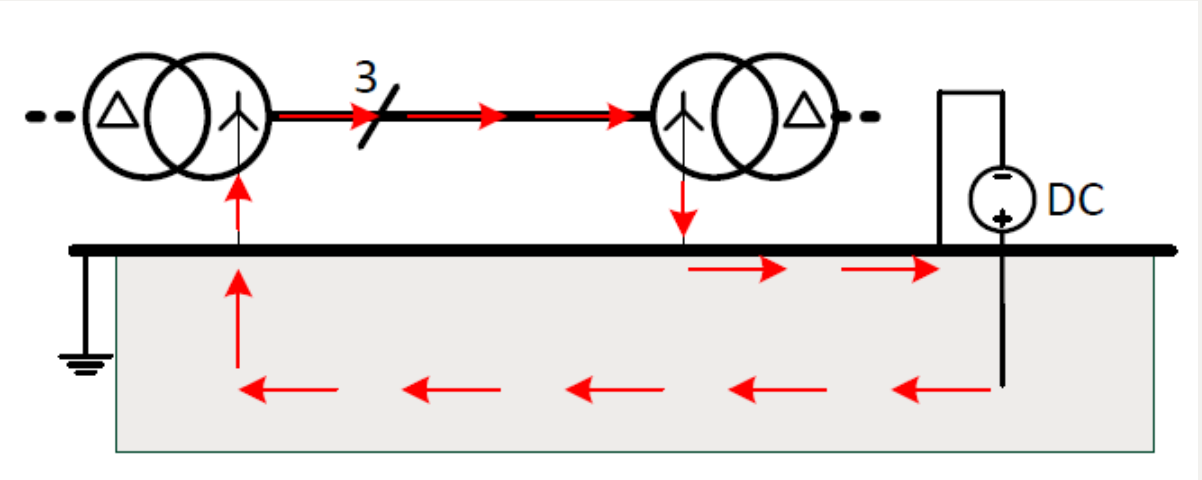
17/01/2023

WG A2.57 Background

- GIC



- Other (quasi-)DC



WG A2.57 Aspects to be addressed

- **Typical DC current patterns** that transformers should be designed to withstand
- **Typical B/H and V/I characteristics** for core steel and transformers at very high flux levels
- **Design implications** & best practices for transformers to withstand such stresses
- **Methods** to can prove the capability of the transformer to withstand such stresses and possible effects
- **Tests** that can be performed to assess such capability
- Definition of possible **mitigation and monitoring techniques** for existing transformers.

WG A2.57 Activities in the past year and progress

- Meetings held in May (online) and August 2022 (in Paris).
- Main tasks had been going through the draft versions of the Technical Brochure.
- Outstanding areas are mainly the summary sections of some chapters and also the executive summary of the TB.
- However, not much progress since August 2022, due to the availability of convenor.
- **For information:** Norwegian member company is investigating into the site experimental studies, which is related to the subject but outside the scope of WG TOR.
- TB will be finished in 2023.

CIGRE UK A2|D1 Liaison

WG A2.58:

Installation and Pre-Commissioning of Transformers and Shunt Reactors

Updates from CIGRE A2 UK Report 2022

17/01/2023

WG A2.58 Update

- **Update extracted from CIGRE A2 UK Report 2022**
  - This working group was set up in Spring 2017 and is hopefully completed in 2024.
  - Three Task Forces were set up as TF1 Site Installation, TF2 Pre-commissioning and Site Acceptance Tests and TF3 Trial Operation.
  - Four meetings in Sydney, Nuremberg, Glasgow and Prague before the 2020 COVID shutdown, and since then have held virtual meetings with a face-to-face meeting at the Paris 2022 Session.
  - A draft Technical Brochure has been produced, with detailed and comprehensive discussion of all topics, the latest version (16) of which is being finalised within the WG, before being submitted for SC A2 to review.

CIGRE UK A2|D1 Liaison

WG A2.60

Dynamic Thermal Behaviour of Power Transformers

Convenor: Tim Gradnik

Secretary: Xiang Zhang

UK members:

Xiang Zhang (Manchester Metropolitan University)

Jose Quintana (SP Energy Networks)

Muhammad Daghrah (M&I Materials)

Paul Jarman (The University of Manchester)

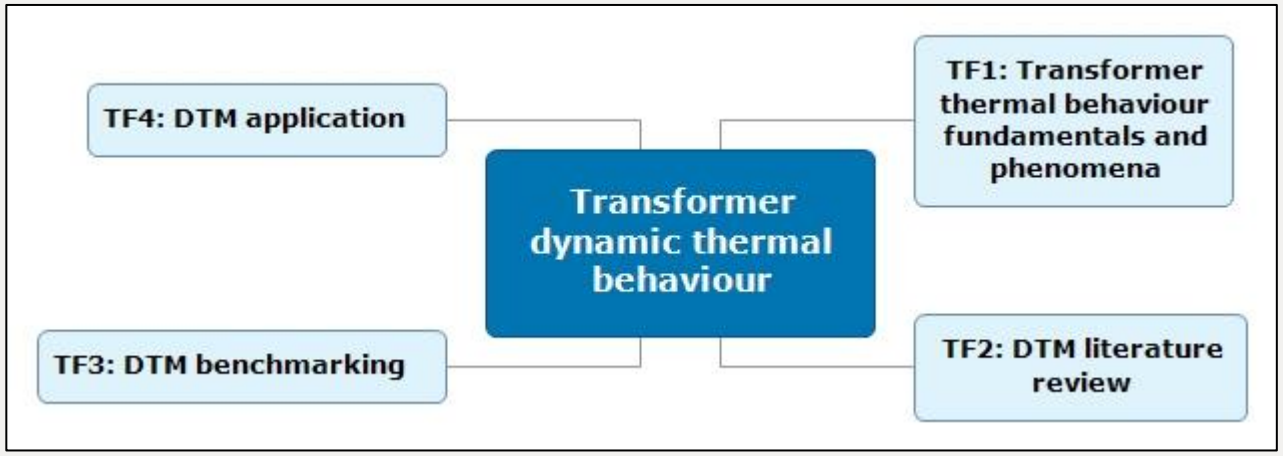
17/01/2023

WG A2.60 Scope

The scope of this working group is to review the state-of-the-art tools and approaches to power transformers' **dynamic thermal modelling (DTM)**, and to **propose suggestions for improving the existing standard models**, with focus on the effects of using **new insulating liquids** and **sub-zero ambient** temperature operational conditions.

Goals (TFs)

1. Explanation of transformer thermal behaviour fundamentals and phenomena
2. Literature review on historical development of DTM
3. DTM Benchmarking and evaluation of possible DTM improvements
4. Applications of DTMs



WG A2.60 Progress and Plans

- Meetings in 2022
  - **TF meetings followed by WG plenary meeting in 2022-05 online**
  - **TF meetings followed by WG plenary meeting in 2022-08 CIGRE Paris Session**
- Plans
  - **TF meetings followed by WG plenary meeting in 2023-01 online**
  - **TF meetings followed by WG plenary meeting in 2023-10 Split, Croatia**

Define brochure contents and structure	May 2020	√
Prepare chapter drafts	Feb 2023	
Compile brochure draft	Nov 2023	
Review and edit brochure draft	Feb 2024	
Publish technical brochure	Jun 2024	

CIGRE UK A2|D1 Liaison

WG A2.62:

Analysis of AC Transformer Reliability

Convenor: Stefan Tenbohlen

Commenced: November 2019
Expected Completion: Late 2023

Prepared by: (Tee) ShengJi Tee

SP Energy Networks

17/01/2023

WG A2.62 Scope and Progress

- Background
  - **WG A2.37 completed failure data survey with 964 major failures that occurred in 1996-2010**
  - **Age distribution of transformer population was not collected**
- Key Tasks
  - **Meeting 1: 18 Nov 2019, Meeting 2: 29 May 2020, Meeting 3: 15 Oct 2020, Meeting 4: 2 Aug 2021, Meeting 5: 7 Apr 2022, Meeting 6: 29 Aug 2022, Meeting 7: 22 Nov 2022**
  - **Update transformer failure data survey/questionnaire**
  - **Conduct survey on major failures & replacements for 2010-2019 for AC power transformers ≥100kV**
  - **Analyse failure data in terms of failure rate, location, mode and cause (ongoing)**
  - **Determine hazard curve for different transformer populations (ongoing)**
  - **Drafting of brochure (ongoing)**

CIGRE UK A2|D1 Liaison

WG A2.63:

Transformer Impulse Testing

Convenor: Ebrahim Rahimpour

Secretariat: Alvaro Portillo

Members: 35 (26 regular and 9 corresponding)

UK Member:

Qiang Liu (The University of Manchester)

17/01/2023

WG A2.63 Background and Meetings Completed

- Background
  - Transformer impulse testing is defined in details in existing standards, for instance, IEC 60060-1, IEC 60076-3 and IEC 60076-4. But there are still a lot of unclear or unsolved questions which arise frequently among the test engineers.
  - Improvement of standards on transformer impulse testing needs studying of transient phenomena and material properties, and accumulation of best practice of testing.
- Meetings:
  - Meeting 1 – 08 Oct 2019
  - Meeting 2 – 17-19 Aug 2020 (online)
  - Meeting 3 – 23-24 Nov 2020 (online)
  - Meeting 4 – 19-20 April 2021 (online)
  - Meeting 5 – 16-17 August 2021 (online)
  - Meeting 6 – 29 November 2021 (online)
  - Meeting 7 – 04-05 April 2022 (online)
  - Meeting 8 – 27-29 June 2022 at Manchester (hybrid)
  - Meeting 9 – 26-28 September 2022 at Zagreb (hybrid)
  - Meeting 10 – 12-14 December 2022 at Porto (hybrid)

WG A2.63 Scope and Objectives

Scope

- Full wave lightning impulse test
- Chopped wave lightning impulse test
- Switching impulse test
- Non-standard waveforms and high-frequency overvoltages
- Positive and negative polarities in impulse test
- Use of internal surge arresters

Objectives

- The IEC 60076-3 and IEC 60076-4 recommendations do not consider all the complexity of transient phenomena in transformer windings and must be reconsidered.
- The working group is focused on studying of transient phenomena and material properties and on accumulation of best practices for testing in order to establish the recommendations for IEC 60076-3 and IEC 60076-4 improvement.

WG A2.63 Task Forces

- **TF1: High Frequency Power System Transients (Bruno Jurišić)**
  - Measurement equipment and measurement techniques
  - Field measurement and simulation – Lightning, switching
  - Comparison of actual overvoltage waveshapes with standard dielectric test
- **TF2: Power Transformer Testing - Test Equipment and Techniques (Stefan Dragostinov)**
  - Impulse testing (standard comparison)
  - Non-standard waveforms and high-frequency overvoltages
  - Positive and negative polarities in impulse test (dry and liquid immersed)
- **TF3: Transformer Transient Simulations (Ricardo Castro Lopes)**
  - Transformer transient modelling using a common template)
  - Effects of LI front time, tail time, chopped LI waveform and etc
  - Effect of non-standard waveforms on winding internal insulation stress

WG A2.63 Brochure Structure

Chapter	Title
1	Introduction
2	Literature review
3	Part A – Power transformer impulse testing
4	Part B – High voltage and high frequency test equipment and techniques
5	Part C - Transformer transient simulations
6	Part D - Power system transients
7	Conclusion

- Expected delivery date TB: August 2023.
- Expected delivery date of Tutorial: December 2023.

CIGRE UK A2|D1 Liaison

WG A2.64:

Condition of Cellulose Insulation in Oil-Immersed Transformers after Factory Acceptance Test

Prepared by: Hongzhi Ding
Doble PowerTest Ltd

17/01/2023

WG A2.64 Introduction

- **Convenor**
  - Claes BENGTSSON (SWEDEN)
- **Secretary**
  - Emre OZTURK (TURKEY)
- **Membership**
  - 18 members from 12 countries. 2 UK NGN members.
    - Anabela Falcao (Portugal); Anabela Marques Peixoto (Portugal); **Andrew Fieldsend-Roxburough (UK)**; Anthun Mickulecky (Croatia); Christoph Krause (Switzerland); Claes Bengtsson (Sweden); Claude Beauchemin (Canada); Dharam Vir (USA) ; Dijana Vrsaljiko (Croatia) ; Emre Ozturk (Turkey); George Frimpong (USA) ; **Hongzhi Ding (UK);** Lena Melzer (Sweden) ; Lucie Borion (France) ; Mario Scala(Austria); Ortiz Fernandez Alfredo (Spain); Tom Prevost (USA) ; Wilerson Calil (Brazil).
- **Start Date and End Date (Expected)**
  - October 2019 – May (?) 2023

WG A2.64 Scope

- **The WG shall address the following main issues and questions:**
  - Which insulation material parameters have a significant impact on and are relevant and representative for the long-term function of a transformer?
  - If physical cellulosic insulation samples are required, what material to use and how to get representative samples before and after the drying process?
  - What are the guidelines for acceptance criteria for the properties of the insulation system after completed Factory Acceptance Test, including repeated tests?
  - What are the guidelines for measures and compensation in case the criteria are not met?
- **The scope of the WG includes**
  - Mineral oil-cellulose insulated transformers and reactors (distribution and transmission including HVDC converter transformers)
  - Insulation material properties during the manufacturing process, starting when the insulation material enter the transformer factory and ending when the transformer leaves the factory. This includes the requirements of moisture after tanking.
  - All cellulose material parameters that affect the long-term function of the transformer, e.g. Degree of Polymerisation and moisture content of insulation
  - Guarantee aspects

WG A2.64 Out of Scope

- Measurement techniques for the properties identified as relevant
- Short circuit withstand properties (already being studied by Working Group D1.65)
- Dielectric withstand properties
- Aspects related to residual air in the insulation system
- Manufacturer specific design aspects
- All aspects related to pressing of windings and active part
- Drying processes procedure and details, e.g. impregnation time or time between vapor phase drying and oil filling
- Transport and site installation (already being studied be Working Group A2-58)
- Dry type insulation systems or insulation systems based on non-cellulose materials and alternative liquids, e.g. esters, aramid solid insulation

WG A2.64 Task Forces (Groups)

- **Subject 1:** Visualize the effect of different stages in production and effect of different parameters on the consumption of insulation life.
- **Subject 2:** Define what relevant parameters should be consider and how they should measure in the factory
  - What are the options?
  - Pros and Cons with those options.
  - Recommendations for discussions in the team
- **Subject 3:** Use the available simulation models and results to come up with the acceptance criteria for the condition of the insulation by using the parameters that the simulations take into account.

WG A2.64 Technical Brochure (TB)

- The CIGRE WG A2.64 TB will cover the selection of relevant acceptance parameters, simulations of the relative influence of these parameters and suggested acceptance criteria.
- The CIGRE WG A2.64 TB will also cover how to measure these parameters. Focus has been to define parameters that are relevant in terms of a direct effect on the transformer insulation lifetime, that are measurable and where achievable limits can be defined and set.
- The technical brochure comprises the following chapters:
    1. **Parameters to be measured**
    2. **Sensitivity of DP and Ageing to Moisture, Drying Temperature and Starting DP**
    3. **Simulations of permissible DP and moisture value pairs when the unit leaves the factory, acceptance criteria**
    4. **Compensation**
    5. **General and concluding remarks**
- The draft complete technical brochure has been completed by 31 December 2022.
- The 9th WG meeting (online) will take place in January 2023 to review the draft complete TB to deliver a final draft TB ready to be submitted to SC A2 for review
- The 10th (final) WG meeting to review comments from SC A2 may either be an online - or a physical meeting depending on how many of the members can attend a physical meeting in Europe.

CIGRE UK A2|D1 Liaison

JWG A2|D2.65:
Transformer Digital Twin – Concept and Future Perspectives

Convenor: Patrick Picher

Secretary: Alexander Alber

Members: 37 regular members from 15 countries

UK Members:

Sicheng Zhao (Manchester Power Solutions Ltd)

Zhongdong Wang (University of Exeter)

17/01/2023

JWG A2|D2.65 Introduction

- **Start date**: May 2022
- **Expected end date**: December 2025

- **Meetings held**:
  - 1st meeting held virtually in June 2022
  - 2nd meeting held physically in Paris in August 2022

JWG A2|D2.65 Scope and Task Forces

- **Aim to study the digital twin concept when applied to transformers and discuss the perspectives for future developments.**
- **So far, the skeleton of the technical brochure was confirmed, and 8 task forces (TF) have been assigned:**
  - Chapter 2 Literature review
  - Chapter 3 Definitions of transformer digital twin: present the data, models, analytics and other aspects which need to be encompassed in a complete digital twin;
  - Chapter 4 Applications and benefits: identify the processes in the transformer lifecycle that could benefit from the digital twin and identify means for that benefit to be achieved;
  - Chapter 5 Physics-based model: present the state-of-art physics-based models that can be used to construct the digital twins of transformers;
  - Chapter 6 Data-driven model: data driven models help in analysing transformer behaviours where physics-based modelling fails to find a correlation between parameters and conditions;
  - Chapter 7 Digitalization of transformer asset management: present digitalization potential for condition indicators and frame an advanced transformer assessment indices (TAI);
  - Chapter 8 Reliability of digital twins
  - Chapter 9 Recommendations for future developments
- **The Chapter 2 is led by Sicheng Zhao, and Chapter 5 is led by Zhongdong Wang.**

JWG A2|D2.65 Future Work in 2023

- **Future work will be firstly focused on the literature review**
  - Review the concept of digitalization from international standards and other sectors;
  - Collect the latest publications of transformer digital twins, critically interpret and review these work;
  - Review the methodologies for physics-based and data-driven modelling, and the other relevant work from published CIGRE brochures.
- **Individual meeting will be held in each task forces**
- **Regular meeting in 2023**
  - In June in Quebe, Canda
  - In Nov in Split, Crotia (A2 Colloqium)

CIGRE UK A2|D1 Liaison

JWG A2|D1.67:

Guideline for Online Dissolved Gas Analysis Monitoring

Convenor: Tara-lee MacArthur

UK Members:

Shuhang Shen (University of Exeter)

Michelle Fiddis (GE Grid Solutions)

17/01/2023

JWG A2|D1.67 Background

- DGA has been used as an industry standard for detecting and determining faults in transformer for over 50 yrs
- Online DGA monitoring has been used as a valuable tool for detection of incipient faults & aids in condition monitoring of power transformers for the last 30 years
- Final report to be delivered in Spring 2024.

- **Advantages of online DGA:**
  - **High sampling rate of measured parameter compared to traditional offline testing**
  - **Significant volumes of data**
    - for trending and continuous analysis
  - **new insights into the performance,**
  - **ability to observe a high rate of change including rapid deterioration of the asset condition**
  - **Can be configured to alert the asset operator enabling**
    - detection/observation of incipient failure modes
    - rapid decision-making and possible action;
    - when responded promptly, major failures can be prevented.

- **Existing limitations**
  - **Lack of information regarding**
    - typical values and
    - rates of gas formation based on online DGA
  - **Gas rates are often given in**
    - minute or hourly ranges
    - which may have transient oscillations that are not compatible with offline DGA observations, typically obtained after yearly sampling rates

JWG A2|D1.67 Scope

- Develop
  - **guidelines for the interpretation, acceptable limits and trends for online DGA monitoring equipment (Which are not covered by existing standards and guides)**
  - **recommended actions users should take when an alarm occurs**
  - **define other useful correlating data measured in monitors to assist diagnostics e.g. temperature, PD, moisture**
  - **a guide to selecting an online DGA system**
    - evaluation criteria for online DGA systems (e.g, mounting options, the criticality of the equipment, value of the equipment);
    - the verification processes of results of online DGA systems
    - recommendation for the application of key gas or multiple gas monitors (2 gas, 3 gas, 5 gas or 9 gas)
  - **guidelines for maintenance requirements for online DGA systems**
  - **examples of the different use cases for online DGA systems**
- Gather online sensors data based on anonymity for initial analysis to be performed by the WG. This data is fundamental;
  - **Assess the impact of sensor output resolution (if in the seconds, min, or hourly range);**
  - **If possible, associate gas readings (levels and trends) to failure data,**
- Compare the different interpretation methods according to their application for monitoring electrical equipment (advantages/challenges)

JWG A2|D1.67 Plan in 2023 and Deliverables

- **Workplan in 2023**
  - First meeting in virtual mode (TEAMS) to be held on 9th February 2023
  - Create outline of the technical brochure
  - Nominate task force leaders (Chapter leaders)

- **Deliverables**
  - Technical Brochure and Executive Summary in Electra
  - Electra Report
  - Tutorial

CIGRE UK A2|D1 Liaison

WG A2.69:

Guide for Transformer Maintenance Update

Convenor: Claude Rajotte

UK Member:

Paul Jarman (The University of Manchester)

17/01/2023

WG A2.69 Working group scope

- WGA2.34 was created in November 2006 and published Technical Brochure #445 “Guide for Transformer Maintenance” in February 2011. It has been the most downloaded Technical Brochure over the last 4 years and still is in 2021 which testifies of its importance and relevance.
- Considering the sustained interest of the CIGRE community for this topic and the evolution of the maintenance practices, materials, design and manufacturing, an update of the brochure is required in order to assure that CIGRE delivers the most complete and up to date information to its members.
- Moreover, SC A2 is just starting work on its next Green Book on Transformer Life Management in which a chapter on maintenance is needed. The revision of TB445 will also provide the required material for that purpose.

WG A2.69 Members

Name	Country	Aff	Email	Timezone	Virtual meeting time
Juan Acosta	US	S	juan.acosta@ergon.com	-5	7:00 to 9:00
Andreas Baer	DE	M	andreasbr.baer@siemens-energy.com	+1	13:00 to 15:00
Anton Bergstrom	SE	M	anton.bergstrom@hitachienergy.com	+1	13:00 to 15:00
Stina Bertlilsson	SE	M	stina.bertilsson@hitachienergy.com	+1	13:00 to 15:00
Colin Clark	CA	U	colin.clark@altalink.ca	-7	5:00 to 7:00
Oliver Derigs	DE	M	oliver.derigs@hitachienergy.com	+1	13:00 to 15:00
Alex Drobyshevski	RU	S	alexander.drobyshevski@gmail.com	+3	15:00 to 17:00
Christophe Elleau	FR	U	christophe.elleau@edf.fr	+1	13:00 to 15:00
Marc Foata	DE	M	m.foata@reinhausen.com	+1	13:00 to 15:00
Nagamanickam Ganesan	IN	M	nagamanickam.ganesan@ge.com	+5,5	17:30 to 19h30
Lutz Hulka	AT	S	Lutz.Hulka@megger.com	+1	13:00 to 15:00
Paul Jarman	UK	S	paul.jarman@manchester.ac.uk	0	12:00 to 14:00
Erik Mortensen	DK	U	eom@energinet.dk	+1	13:00 to 15:00
Ralf Schneider	CH	M	ralf.schneider@hitachienergy.com	+1	13:00 to 15:00
Anatoly Shkolnik	IS	S	shkola50@gmail.com	+2	14:00 to 15:00
Ross Willoughby	AU	M	willoughby.ross@icloud.com	+10	22:00 to 00:00
Chao Wu	CN	S	wuchao@epri.sgcc.com.cn	+8	20:00 to 22:00
Dan Zhou	CN	S	dan_zhou@189.cn	+8	20:00 to 22:00
Claude Rajotte, convenor	CA	U	rajotte.claude@hydroquebec.com	-5	7:00 to 9:00

Affiliation:
M: Manufacturer U: Utility S: Services (engineering, university, research, analytic, instrument, etc.)

WG A2.69 Structure

- TF1: Chapters 1, 2,3: Intro, Maintenance Strategy, Maintenance Process (22 pages) + Greenbook 2 contribution
- TF2: Chapter 4: Transformer Component Selection and Maintenance (23 pages)
- TF3: Chapter 5: Maintenance action catalogue (44 pages)
- TF4: Chapter 6: Major Work – Transformer repair (10 pages)

WG A2.69 Meetings

Event	Meeting dates [1]	Type of meeting [2]
Launching email	Tuesday November 8th, 2022	
1st meeting	Tuesday December 6th, 2022	Virtual
2nd meeting	Tuesday January 24th, 2023	Virtual
3rd meeting	Wednesday March 29th, 2023	Virtual [3]
4th meeting	Wednesday May 31st, 2023	Virtual [3]
5th meeting	Wednesday August 30th, 2023	Virtual
6th meeting	October 2-3, 2023	In person – SCA2 Colloquium Split, HR
7th meeting	Wednesday November 29th, 2023	Virtual
8th meeting – if necessary	To be confirmed, 2024	Virtual
9th meeting – if necessary	To be confirmed, 2024	Virtual
10th meeting – if necessary	To be confirmed, 2024	Virtual

1.Typically, one meeting per two-months; additional meetings may be organized between members and convenor.
2.Virtual meeting duration is typically two hours – see "Virtual meeting time" in the member list.
3.If needed and desirable, one of these two meetings may be converted in a two-days meeting held in-person

CIGRE UK A2|D1 Liaison

JWG D1|A2.77:

Liquid Tests for Electrical Equipment

Convenor: Fabio Scatiggio

Secretariat: Carl Wolmarans

Members: >72 full time members and corresponding members

UK Members:

Russell Martin (M&I Materials)
Attila Gyore (M&I Materials)
Qiang Liu (The University of Manchester)
Dave Walker (SP Energy Networks)
Gordon Wilson (National Grid)

17/01/2023

JWG D1 | A2.77 Scope

- Verification of Ostwald coefficients, given large differences between values given in different standards
- Improving interpretation models for natural and synthetic esters.
- Recommend a data format or template for DGA and other liquid tests, with respect to transformer design and service data suited for data storage and exchange.
- Providing guidance to differing gas levels/patterns in different transformer types i.e. small distribution transformers, wind & solar transformers, traction vs large power transformers.
- Clustering of oil test results (DGA, furans, alcohols, chemical and physical tests) as function of the transformer age, type, liquid preservation system, etc.
- Investigate, based on real failure cases, if different DGA interpretation criteria (Rogers, IEC, IEEE, Duval, etc.) lead to the same conclusion
- Verification of new DGA detectors (helium, NDIR, PAS) not in accordance with existing standards.
- **The team first met in October 2020 and then was split into 3 working groups to research separate areas for the brochure.**

JWG D1 | A2.77 Task Force Work Allocations

- **Task Force 1 – Measurement Aspects**
  - Verification of Ostwald coefficients, given large differences between values given in different standards
  - Verification of new DGA detectors (helium, NDIR, PAS) not in accordance with existing standards.
  - Lab Based –focusing on Helium Detector.
  - Online –Focussing on Photoacoustic and NDIR? Input from TB 783?

- **Task Force 2 – Data Handling and Categorisation**
  - Recommend a data format or template for DGA and other liquid tests, with respect to transformer design and service data suited for data storage and exchange.
  - Clustering of oil test results (DGA, furans, alcohols, chemical and physical tests) as function of the transformer age, type, liquid preservation system, etc.
  - Providing guidance to differing gas levels/patterns in different transformer types i.e. small distribution transformers, wind & solar transformers, traction vs large power transformers.

- **Task Force 3 – Modelling and Case Studies**
  - Investigate, based on real failure cases, if different DGA interpretation criteria (Rogers, IEC, IEEE, Duval, etc.) lead to the same conclusion.
  - Improving interpretation models for natural and synthetic esters.
  - Literature Survey
  - Analytical Approach (considering ester chemistry, expected reactions & thermodynamics).

JWG D1 | A2.77 Meetings

Plenary	TF1	TF2	TF3
1: 8 Oct 2020 2: 8 Oct 2020 3: 3 Dec 2020 4: 2 Sep 2021 5: 6 Apr 2022 6: 29 & 30 Aug 2022	1: 2 Feb 2021 2: 11 March 2021 3: 21 April 2021 4: 20 May 2022 5: 12 December 2022	1: 3 Feb 2021 2: 7 April 2021 3: 31 August 2021	1: 4 Feb 2021 2: 8 Apr 2021 3: 1 Sept 2021

JWG D1 | A2.77 Table of Contents

JWG D1 | A2.77 Table of Contents

JWG D1 | A2.77 Table of Contents

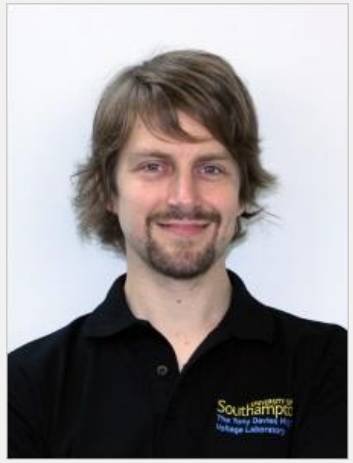
D1 Updates

Materials and Emerging Test Techniques

- **UK Regular Member**
  - **Thomas Andritsch (University of Southampton)**

cigre
For power system expertise

Introduction



Dr Thomas Andritsch - D1 UK Regular Member

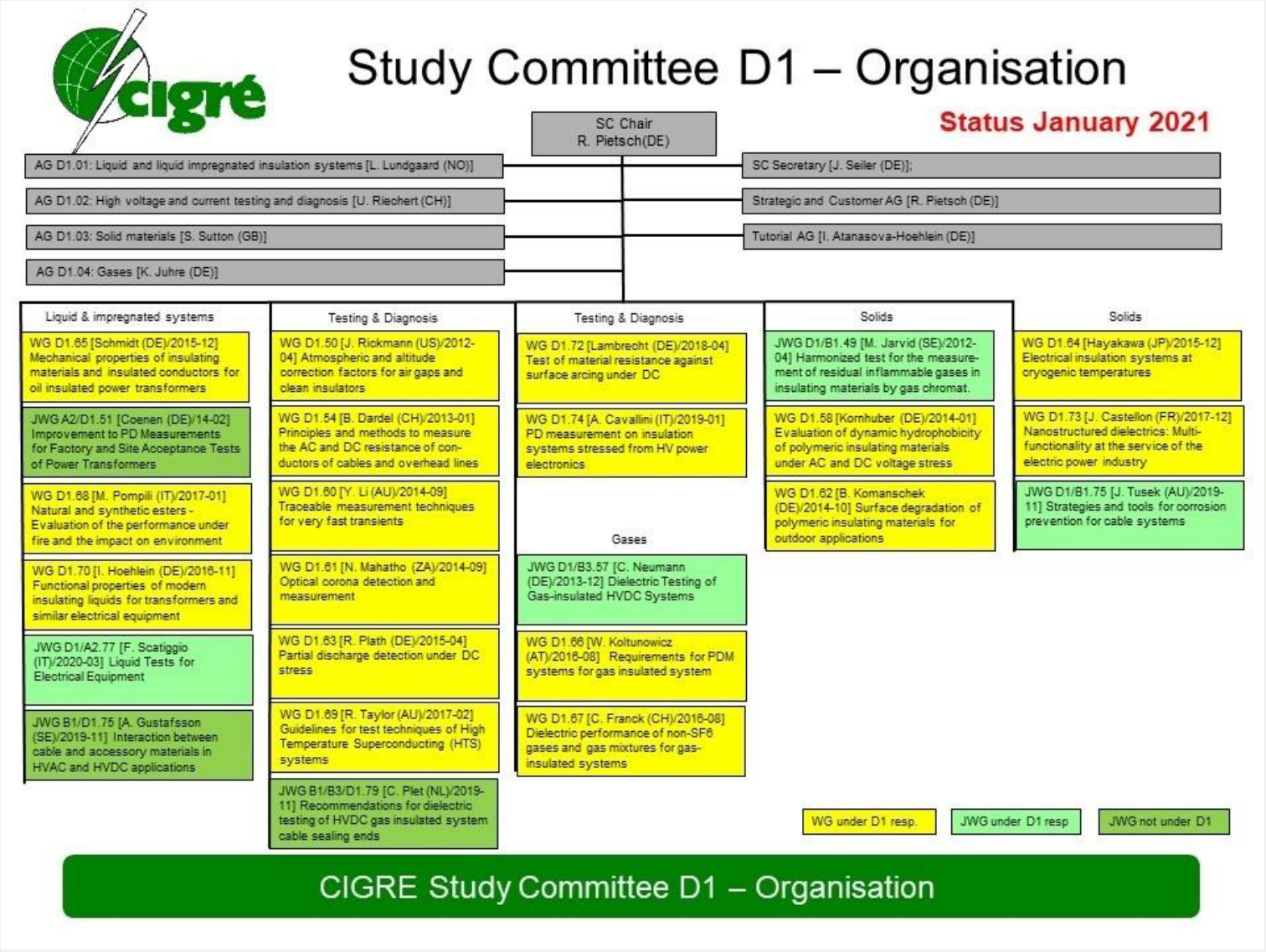
T.Andritsch@soton.ac.uk

- Associate Professor, University of Southampton
- Role includes Education (UG and MSc), Research (Industry and research council funded R&D on materials for HV systems, PhD supervision), Enterprise (HV consultancy) and Management (Tony Davies HV Laboratory)
- Previously roles at TU Delft (NL),TU Graz (AT), and Prince Songkhla University (TH)
- Cigre activities include UK member of D1.73, B1/D1.75 and previously D1.40
- Also active in IEEE (Senior Member, DEIS Administrative Committee, TC on Transport Electrification, Smart Grids, Nanodielectrics)

Study Committee D1 Scope

- **The scope of SC D1 is concerned with the monitoring and evaluation of:**
  - New and existing materials for electrotechnology,
  - Diagnostic techniques and related knowledge rules,
  - Emerging test techniques which may be expected to have a significant impact on power systems in the medium to long term.
  - Support of other study committees in their analysis of recently introduced and developing materials, emerging test techniques and diagnosis techniques

Study Committee D1 - Organisation



New 2022:

- SC Chair: Simon Sutton, UK
- Secretary: Gordon Wilson, UK
- Strategic Advisory Groups:
- AG D1.01 Liquids and Liquid Impregnated Insulation Systems (Qiang Liu, UK)
- AG D1.02 High Voltage and Current Testing and Diagnostic (Uwe Riechert, CH)
- AG D1.03 Solid Materials (Jerome Castellon. FR)
- AG D1.04 Gases (Karsten Juhre, DE)
- Tutorial AG (Ivanka Atanasova-Hoehlein, DE)
- Strategic and Customer AG (Simon Sutton, UK)

CIGRE UK A2|D1 Liaison

Study Committee D1
Active Working Groups

17/01/2023

Study Committee D1 – Active Working Groups

WG	Title
D1.50	Atmospheric and altitude correction factors for air gaps and clean insulators
D1.54	Basic principles and practical methods to measure the AC and DC resistance of conductors of power cables and overhead lines
D1.58	Evaluation of dynamic hydrophobicity of polymeric insulating materials under AC and DC voltage stess
D1.60	Traceable measurement techniques for very fast transients
D1.61	Optical corona detection and measurement
D1.62	Surface Degradation of Polymeric Insulating Materials for Outdoor Applications
D1.63	Partial Discharge Detection under DC voltage stress
D1.65	Mechanical properties of insulating materials and insulated conductors for oil insulated power transformers

Study Committee D1 – Active Working Groups

WG	Title
D1.66	Requirements for partial discharge monitoring systems for gas insulated systems
D1.68	Natural and synthetic esters - Evaluation of the performance under fire and the impact on environment
D1.69	Guidelines for test techniques of High Temperature Superconducting (HTS) systems
D1.70	Functional Properties of modern insulating liquids
D1.72	Test of material resistance against surface arcing under DC
D1.73	Nanostructured dielectrics: Multi-functionality at the service of the electric power industry
D1.74	PD measurement on insulation systems stressed from HV power electronics

Study Committee D1 – Active Joint Working Groups

WG	Title
B1/B3/D1.79	Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends
B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC applications
D1/B1.75	Strategies and tools for corrosion prevention for cable systems
D1/A2.77	Liquid Tests for Electrical Equipment

Study Committee D1 – New Working Groups

WG	Title	UK Member
A2/D1.67	Guideline for online dissolved gas analysis monitoring	TBC
B3/D1/63	Guideline for assessing the toxicity of used SF6 gas onsite and in the lab of T&D equipment above 1 kV in substations	
A2/D1.66	Breathing systems of liquid filled transformers and reactors	TBC

D1.50 Atmospheric and altitude correction factors for air gaps and clean insulators

- Convenor: Johannes Rickmann
- UK Member: -
- Start Date: 2012
- Completion Date: 2021?

Scope of Activities:

- Correction factors for T, P and humidity for AC, SI, LI and DC test voltages greater than 1000 V
- Relevant for cable terminations and bushings

Status Update:

- No meeting since Paris 2018, but claim will finish 2021. Only one chapter to finalise 'pending finalization of comments'.
- Many CIGRE and IEC groups waiting on the output – been disseminating work via ISH

D1.54 Basic principles and practical methods to measure the AC and DC resistance of conductors of power cables and overhead lines

- Convenor: Boris Dardel
- UK Member: -
- Start Date: 2013
- Completion Date: 2023

Scope of Activities:

- State of the art measurements, equipment, procedures.
- Hollow and solid conductor

Status Update:

- Round robin test taking place across 10 parties using real and model samples. Inevitable delays!
- Testing has been slow and is delaying progress
- ELECTRA Article and TB have been completed and are currently under review (01/2023)

D1.58 Evaluation of dynamic hydrophobicity of polymeric insulating materials under AC and DC voltage stress

- Convenor: Stefan Kornhuber
- UK Member: -
- Start Date: 2014
- Completion Date: ??

Scope of Activities:

- Looking at improvements to dynamic drop test with intention to incorporate into IEC

Status Update:

- This is a huge group: 13 countries, 21 members plus 30 guests!
- RRT finished – RRT results will go in an annex
- No meetings in 2020 but TB is in editorial review.
- TB will focus on test method.
- D1.59 will perform RRT on different material classes
- Considering another WG to deal with surface recovery properties

D1.63 Partial discharge detection under DC voltage stress

- Convenor: Ronald Plath
- UK Member: Malcom Seltzer-Grant
- Start Date: May 2015
- Completion Date: 2021

Scope of Activities:

1. Physical process: difference between AC and DC PD behaviour.
2. Operating conditions (polarization, temperature etc.) of different insulation systems under DC stress and effects on PD phenomena.
3. Basic PD parameters useful for PD measurements under DC voltage.
4. Preferred PD measurement techniques at DC voltage.
5. Procedures for measuring PD under DC voltage (suppression and/or discrimination of noise and other external disturbances from relevant PD).

Status Update:

- WG activities on above distributed in four task forces: TF-1 Physics, TF-2 Solid Insulation, TF-3 Liquid Insulation, TF-4 Gas Insulation
- An interim report has been presented at CIGRE Colloquium SCA2 /SCB2/ SCD1, New Delhi, India, 21st November 2019, https://www.cigreindia.org/colloquium2019/web/index.html - Download Proceedings - D1 Proceeding
- If anyone has any case studies or general interest please get in touch: malcolm.seltzer-grant@hvpd.co.uk

D1.66 Requirements for partial discharge monitoring systems for gas insulated systems

- Convenor: Wojciech Koltunowicz
- UK Member: -
- Start Date: 2016
- Completion Date: 2022

Scope of Activities:

Tasked with defining GIS PD monitoring system requirements to ensure that signals from incipient PD defects are reliably detected, monitored, and interpreted, so that asset managers can take prompt and appropriate actions to prevent equipment malfunction

Status Update:

- Regular meetings, 11 countries represented
- Technical guidance will help users to specify and choose a PDM system best fitted to their needs and level of PD know-how
- Review of functions and features of current PDM systems
- Identified weaknesses (technical and otherwise) of PDM systems
- Most pressing challenge is to significantly reduce number of false alarms; novel proposals made for improving warning/alert procedures

D1.68 Natural and synthetic esters - Evaluation of the performance under fire and the impact on environment

- Convenor: Massimo Pompili
- UK Member: Russel Martin
- Start Date: 2017
- Completion Date: 2023

Scope of Activities:

1. Fire behavior comparison between natural and synthetic esters and mineral insulating oils;
2. Environmental impact comparison in case of spills of natural and synthetic esters and mineral insulating oils.

Status Update:

- Large interest of IEC TC10 for natural and synthetic ester insulation liquids
- Activities practically stopped during pandemic
- Activities restarted in Autumn 2021
- Questionnaire circulated to the 34 WG members on local fire and environmental rules
- TB expected to be ready in 2023

D1.69 Guidelines for test techniques of High Temperature Superconducting (HTS) systems

- Convenor: Richard Taylor
- UK Member: Bartek Glowacki
- Start Date: Q1/2017
- Completion Date: 2020*

Scope of Activities:

To study the existing HTS power installations and compile the relevant data that will assist the power industry to test HTS technology used in the transmission and distribution grid

Status Update:

- TB is being reviewed and chapters reconfigured before sending it out to WG members to comment, will pay attention to:
- The present and future need for HTS power installations.
- Update on the status of field test experience of HTS power installations and comparison with existing guidelines.
- Aging of electrical insulation, superconductors and cooling systems.
- Failure mode analysis

D1.70 TF3 Dielectric performance of insulating liquids for transformers

- Convenor: Lars Lundgaard
- UK Member: Qiang Liu, Attila Gyore, Zhongdong Wang
- Start Date: 07/2017
- Completion Date: 12/2021

Scope of Activities:

To review the requirements and test standards of dielectric liquids as seen from a transformer designer, to review

the behaviour of dielectric liquids under various electric stresses, and finally, to identify knowledge gaps.

Status Update:

- Technical brochure 856 was published in Dec 2021
- A tutorial was delivered during ICDL2022, at Seville, Spain on 29th May 2022.
- Main brochure contents:
  - ✓ **Pre-breakdown and breakdown phenomena in transformer liquids**
  - ✓ **Review of IEC liquid breakdown test methods**
  - ✓ **Transformer insulation design**
  - ✓ **Suggestions for future work**

D1.73 Nanostructured dielectrics: Multi-functionality at the service of the electric power industry

- Convenor: Jerome Castellon
- UK Member: Thomas Andritsch and Raed Ayoob
- Start Date: 01/2020
- Completion Date: 10/2023

Scope of Activities:

- Review of recent progress in the field of nano-dielectrics.
- Design, manufacture, and characterisation of nano-dielectrics with improved properties.
- Propose different possible applications for the use of nano-dielectrics in the power industry.

Status Update:

- Literature review ongoing.
- Some samples have been manufactured and are currently being characterised in different laboratories.
- A physical meeting is being scheduled in January/February 2023 in Montpellier to discuss the characterisation results.
- 5 meetings have been held so far.
- WG meeting at Paris 2022 session.

D1.74 PD measurement on insulation systems stressed from HV power electronics

- Convenor: Andrea Cavallini
- UK Member: -
- Start Date: 2019
- Completion Date:

Scope of Activities:

Transversal sub-WGs

Measurements, UHF, Antennas, Systems, Electrical, Acoustic, Optical, Propagation

Apparatus-specific sub-WGs

Rotating machines, power electronics

Status Update:

Rotating Machines

- Review of antennas suitable for PD detection
- Analysis of PD emission spectra
- Comparison between different detection mechanisms
- Most likely failure modes -> sensor position

Power Electronics

- Review of failure modes
- Oil- or gel-filled modules (RRT)

D1.76 Tests for verification of quality and ageing performance of cellulose insulation for power transformers

- Convenor: Jelena Lukic
- UK Member: Attila Gyore, Richard Heywood, Qiang Liu, Mike Munro, Shanika Matharage and Gordon Wilson
- Start Date: Apr 2021
- Completion Date: Dec 2024

Scope of Activities:

- DPv method acc. to IEC 60450
- Correlations of DPv to Mechanical properties of insulating papers
- Ageing tests of oil paper insulations
- Paper ageing mechanisms and kinetic models

Status Update:

- TF1 DP measurement method
  - ✓ RRT 1 was complete
- TF2 Ageing tests of oil paper insulations
  - ✓ RRT 1 is ongoing (Non-thermally upgraded paper with various liquids)
- TF3 Paper ageing kinetics
  - ✓ Literature review complete
  - ✓ Collecting case study data

JWG D1/A2.77 Liquid Tests for Electrical Equipment

- Convenor: Fabio Scatiggio
- UK Member: Attila Gyore, Qiang Liu, Russel Martin, David Walker, Gordon Wilson
- Start Date: October 2022
- Completion Date: exp 2024

Scope of Activities:

1. Verification of Ostwald coefficients
2. Improving interpretation models for natural and synthetic esters.
3. Recommend a data format or template for DGA and other liquid tests […]
4. Providing guidance to differing gas levels/patterns in different transformer types
5. Clustering of oil test results
6. Investigate, based on real failure cases, if different DGA interpretation criteria (Rogers, IEC, IEEE, Duval, etc.) lead to the same conclusion
7. Verification of new DGA detectors

Status Update:

- Brochure list of contents ready
- Chapter on liquids and tests complete
- TF1 – Measurement aspects
  - ✓ **Show state of the art**
  - ✓ **First RRT on partition constant and Oswald's coeff.**
  - ✓ **Evaluation of alternative DGA techniques**
- TF2 – Data handling and categorisation
  - ✓ **Template has been agreed**
  - ✓ **NDA for perpetual data collection in progress**
- TF3 – Modelling and case studies
  - ✓ **DGA interpretation models literature survey**
  - ✓ **Simulations with new types of liquids planned**
  - ✓ **Liaison with IEC WG 45 started**
  - ✓ **Models simulation with real cases**

cigre For power system expertise

JWG D1/B1.75 Strategies and tools for corrosion prevention for cable systems

- Convenor: Joe Tusek
- UK Member:-
- Start Date: 02/2020
- Completion Date: mid-2023

Scope of Activities:

1. Collect case studies of unexpected corrosion and detail the root cause of the problem.
2. Report on practical measures adopted by asset owners to mitigate against corrosion, either through enhanced specifications, factory audits, onsite testing etc.
3. Strategies adopted by asset owners to safeguard against corrosion in service

Status Update:

- Follow on from more general D1.71
- Collect case studies on unexpected corrosion
- Report on practical measures to mitigate corrosion
- Specifications, factory audits, onsite testing
- Strategies to safeguard against corrosion in service
- Hoping to complete mid-2023

JWG B1/D1.75 Interaction between cable and accessory materials in HVAC and HVDC applications

- Convenor: Anders Gustafsson
- UK Member: Thomas Andritsch
- Start Date: 02/2020
- Completion Date: mid-2023

Scope of Activities:

- Generate reference guide on interface issues in HV cables
- Propose testing methodologies to assess compatibility
- HVAC, HVDC, land and submarine cables in scope

Status Update:

- Literature review near completion
- 16 meetings so far (of which 11 were online)
- WG meeting at Paris 2022 session
- Draft of development tests

CIGRE UK A2|D1 Liaison

Study Committee D1
New Technical Brochures

17/01/2023

Study Committee D1 – New Technical Brochures

In the past 12 months the following technical brochures have been published:

- TB861 Improvements to PD measurements for factory and site acceptance tests of power transformers

  Link to TB861 (e-cigre)

- TB856 Dielectric performance of insulating liquids for transformers

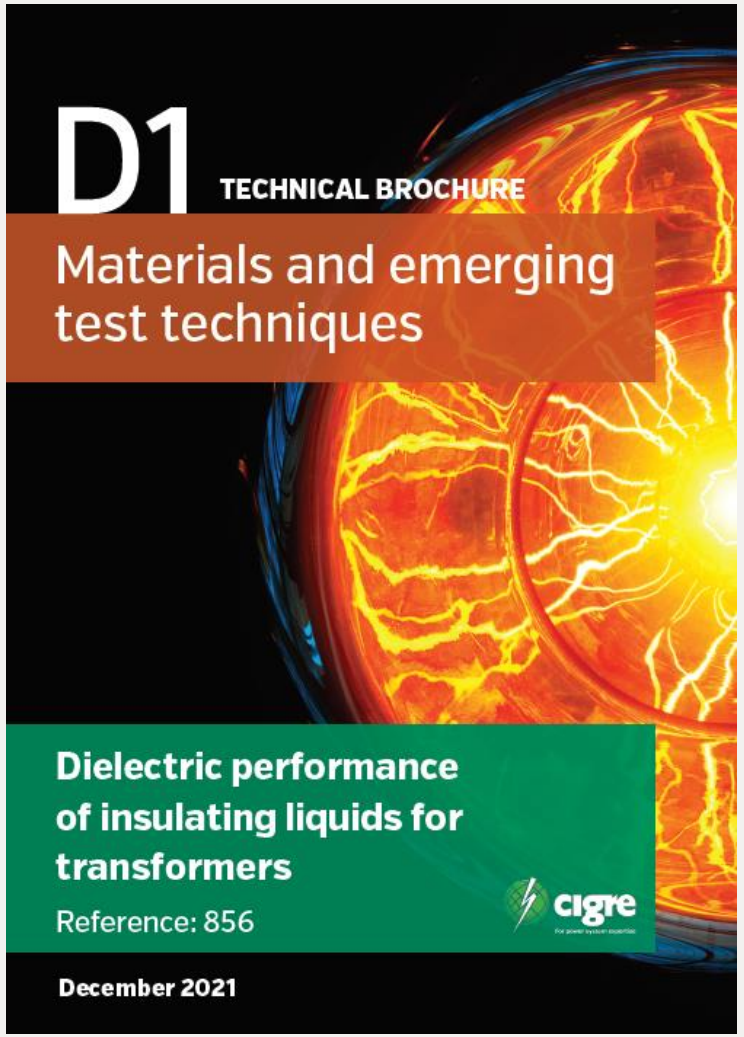
  Link to TB856 (e-cigre)

- TB849 Electric performance of new non- SF6 gases and gas mixtures for gas-insulated systems

  Link to TB849 (e-cigre)

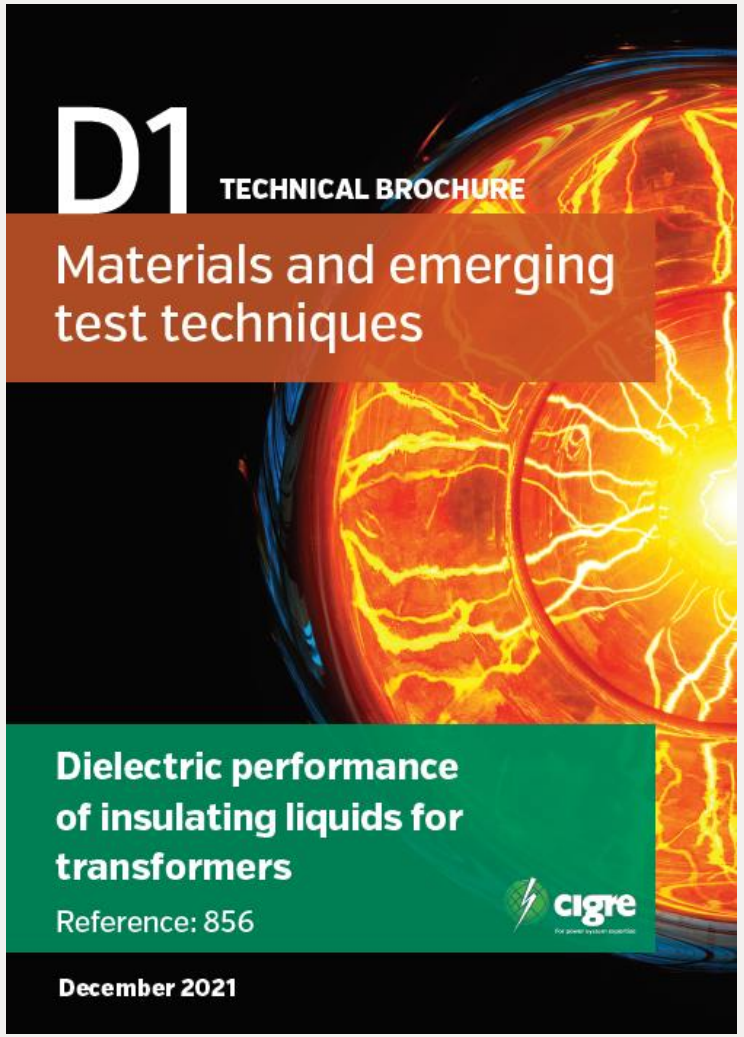
TB 856

- Convener: Lars Lundgaard
- UK Contributors: Qiang Liu, Attila Gyore, Zhongdong Wang
- A tutorial was delivered during ICDL2022, at Seville, Spain on 29th May 2022.
- Main brochure contents:
  - **Pre-breakdown and breakdown phenomena in transformer liquids**
  - **Review of IEC liquid breakdown test methods**
  - **Transformer insulation design**
  - **Suggestions for future work**
- Further research needed to better understand streamers; until then reliance on testing



TB 856

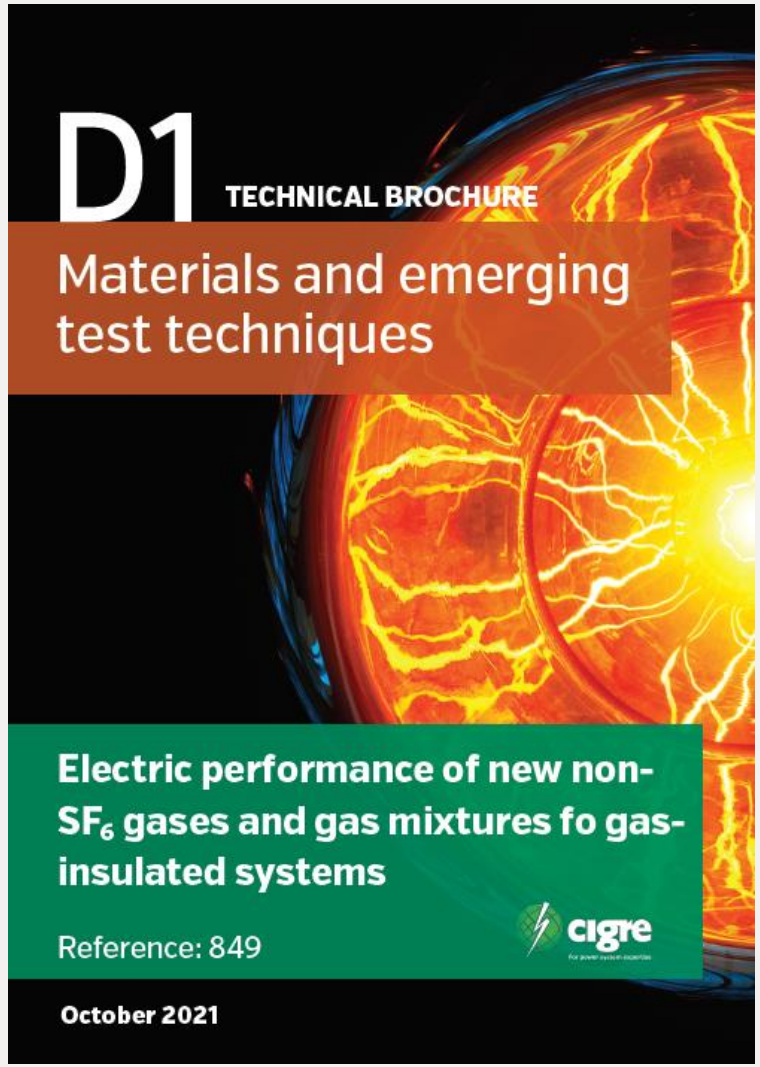
- Dielectric performance of insulating liquids for transformers
- How streamers start and develop will depend on the background field geometry. Two main situations may exist:
- “Initiation-controlled breakdown”. This corresponds to the situation where a streamer, once initiated, will systematically propagate to breakdown. Typically, under uniform fields and being very sensitive to contamination.
- “Propagation-controlled breakdown”. This corresponds to the situation where a streamer, once initiated, will not necessarily propagate to breakdown. Typically, under divergent fields (point-toplane). Breakdown will depend on streamer velocity, gap and duration of the stress.



cigre
For power system expertise

TB 849

- Convener: Christian Franck (CH)
- UK Contributors: Manu Haddad, Tony Chen, P. Widger
- Follow-up of WG D1.51
- Brochure contents:
  - **State-of-the-art literature summary**
  - **Set of tests suited to determine practical insulation strength of alternative gases**
  - **Two round-robin tests:**
    - Electrical test campaign
    - Gas analysis campaign



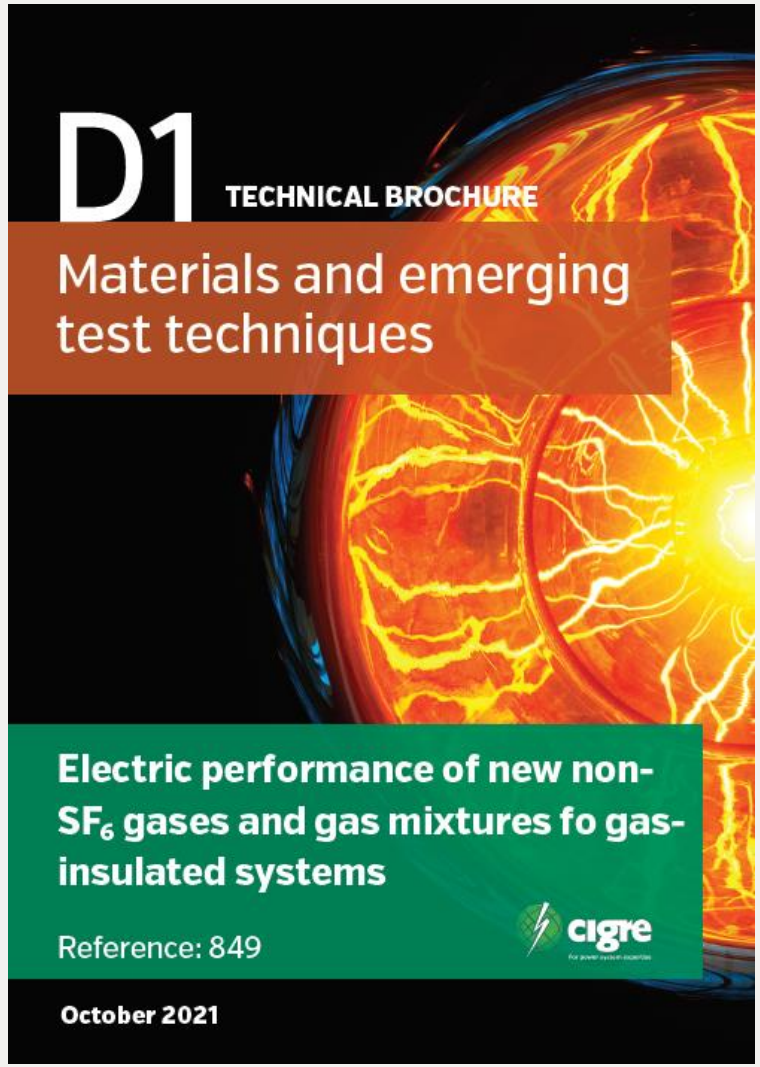
cigre
For power system expertise

TB 849

- Electric performance of new non- SF6 gases and gas mixtures for gas-insulated systems

RRT electrical test campaign

- 232 test series performed in 14 (fourteen) different laboratories
- Every test series completed by at least 2 different labs
- Novel gases, as well as SF6 reference measurements
- While some tests were in good agreement (e.g. SF6), it was not trivial to get consistent results for some gas mixtures
- All measurement data available open access for further evaluation (must be clearly referenced to this TB)



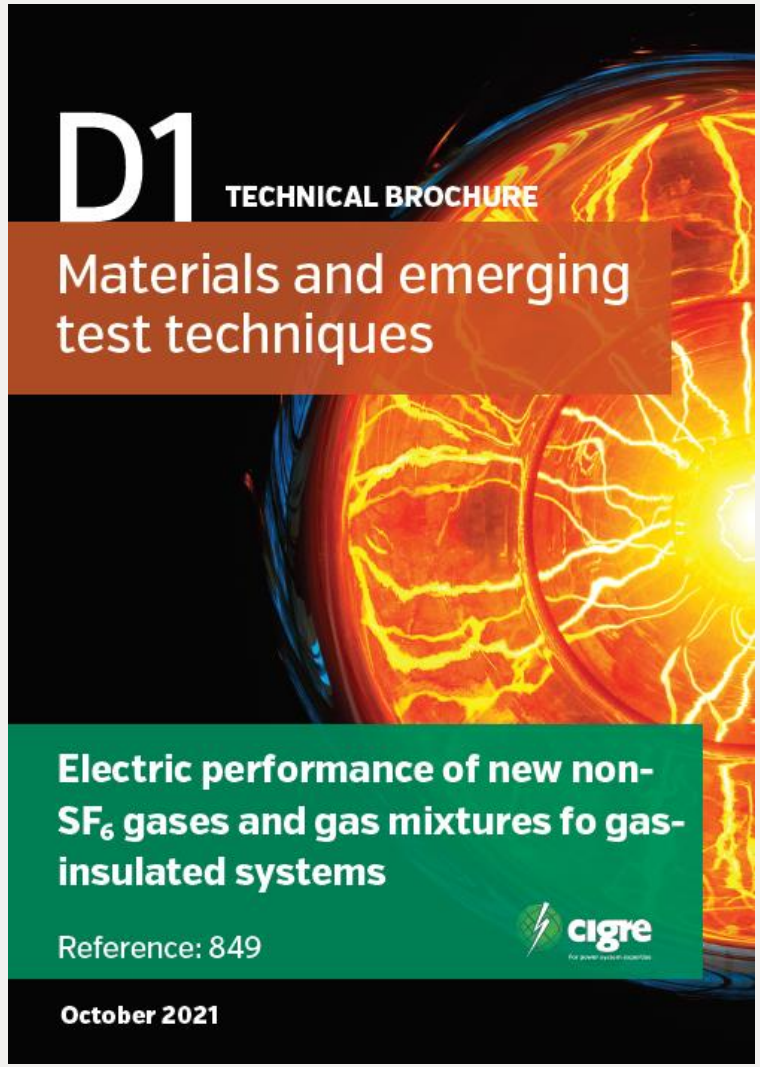
cigre
For power system expertise

TB 849

- Electric performance of new non- SF6 gases and gas mixtures for gas-insulated systems

RRT gas analysis campaign

- Single-source gas samples of C4-FN and C5-FK mixtures prepared and shipped to 7 labs around the world
- Assessment of accuracy with which gas can be analysed
- Different methods used by different laboratories to produce calibration gases and analyse gas composition
- Gas chromatography (GC) with Mass-spectrometry (GC-MS) and/or thermal conductivity (GC-TC), FTIR or UV analysis
- Accurate results with an uncertainty of ☐0.2% abs. not trivial or consistently achievable



cigre
For power system expertise

CIGRE UK A2|D1 Liaison

Study Committee D1
2023 Cairns Symposium

17/01/2023

2023 Cairns Symposium

The session will be on the theme of The End to End Electricity System: transition, development and integration. This will be divided into three topic streams:

- **Learning from experiences. What can we draw from past experience to develop the power system?**
- **Developing practices, functionalities and applications. What are the current developments and their application to the future power system?**
- **Towards a sustainable power system. What are the future needs and requirements of the power system?**

2023 Cairns Symposium

- The symposium focuses on the integrated electricity system and the transformation into the electricity system of the future. It will identify what can be learned from the experience with current developments in technology, equipment, controls as well as electricity system architecture, operational practices and planning criteria.

- The conference embraces many of the CIGRE domains of work as shown by including planning, operations, markets and economics as well as the technical aspects of the network and then through to the integration of distributed energy resources.

IEC Updates

IEC TC14 Power Transformers

- **Tom Breckenridge (TB TCS)**

IEC TC10 GEL 10 Fluids for Electrotechnical Applications

- **Russell Martin (M&I Materials)**

CIGRE UK A2|D1 Liaison

IEC TC14
Power Transformers

Prepared by:

Tom Breckenridge BSI PEL/14 Chair

17/01/2023

IEC TC14 Scope

- Standardization in the field of power transformers, tap-changers and reactors for use in power generation, transmission and distribution. Generally these transformers have power ratings above 1 kVA single phase and 5 kVA polyphase with a higher voltage winding of 1000 V or more, however the scope includes lower voltage transformers and regulators used in power delivery applications.

- Excluded:
  - Instrument transformers
  - Testing transformers
  - Traction transformers mounted on rolling stock
  - Welding transformers
  - Transformers for applications covered by TC 96

IEC TC14 Structure

- Chair – Christoph Ploetner (Germany)
- Secretary – Stephanie Lavy (UK)
- IEC Personnel
  - **Technical Officer**
  - **Standards Project Administrator**
  - **Editor**
- 3 Working Groups
- 3 Project Teams
- 13 Maintenance Teams
- 1 Joint Working Group
- 2 Advisory Groups
- 1 Ad-hoc Group

- 35 Participating Countries
- 13 Observer Countries
- Last plenary meeting – 15-16 June 2022 in Bled, Slovenia

IEC TC14 Scope

- **IEC TC14 is responsible for developing and maintaining the following international standards:**
  - IEC 60076 series – 33 documents and sub-documents
  - IEC 60076-57 series – 2 documents jointly published with IEEE
  - IEC 60214
  - IEC TR 60616 – in process of being integrated as IEC 60076-9
  - IEC 61378 series – 3 documents
  - IEC 62032

IEC TC14 Update

- **New Standards published in recent years includes:**
  - IEC 60076-10-1: 2016 AMD1:2020 - Determination of sound levels - Application guide
  - IEC 60076-22-5: 2021 - Electric pumps for transformers
  - IEC 60076-22-6: 2021 - Electric fans for transformers
  - IEC 60076-22-7: 2020 - Accessories and fittings
  - IEC 60076-22-8: 2020 - Devices suitable for use in communication networks
  - IEC 60076-24: 2020 - Specification of voltage regulating distribution transformers (VRDT)
  - IEC TR 60076-26: 2020 - Functional requirements of insulating liquids for use in power transformers

IEC TC14 Update

- **Current Work in Progress Includes;**
  - IEC 60076-1 – Major update started 2018
  - IEC 60076-2 – Major update started 2018
  - IEC 60076-4
  - IEC 60076-5
  - IEC 60076-6
  - IEC 60076-9 – Confirmed in Bled, this is IEC 60616 terminal marking
  - IEC 60076-18 – Maintenance confirmed in Bled – SFRA standard
  - IEC 60076-19-1 and 19-2 – Split in Bled to separate TX and reactors
  - IEC 60076-25

IEC TC14 Update

- **IEC 60076-1 – Power transformers - Part 1: General**
- **MT Convener Paul Jarman (UK)**
  - Meeting virtually since 2020 which has slowed progress
  - Major update bringing specified parameters into 76-1 from 76-2 and 76-14.
  - Developing a more general approach to reference temperature to allow easier integration of new technologies and alignment with IEEE
  - First CD due imminently
  - Further W/G meetings at the end of this week

IEC TC14 Update

- **IEC 60076-1 – Power transformers - Part 1: General**
- **MT Convener Paul Jarman (UK)**
- **After CD and RR is published the UK National Committee plan is:**
  - Circulation of the CD document around the UK transformer interested groups for review and comment
  - Planning to organise a meeting to discuss the CD and agree UK comments on this
  - No venue identified so far for this, but it is likely to be central

IEC TC14 Update

- **IEC 60076-2 – Power transformers - Part 2: Temperature rise for liquid-immersed transformers**
- **MT Convener Dejan Susa (NO)**
- **This work is closely linked to that of IEC 60076-1 and meetings have been running in parallel – all virtual meetings since 2020.**
  - Specification of temperature rise limits being moved from 76-2 to 76-1
  - 76-2 then becomes a document specifically about how to test the transformer
  - Hoping that this will provide better guidance on testing, but IEC don't permit guidance in documents.
  - First CD is ready but is being held to be be issued at the same time as the CD for 76-1

IEC TC14 Update

- **IEC 60076-2 – Power transformers - Part 2: Temperature rise for liquid-immersed transformers**
- **MT Convener Dejan Susa (NO)**
- **After CD is published the UK National Committee plan is:**
  - Circulation of the CD document around the UK transformer interested groups for review and comment
  - Planning to organise a meeting to discuss the CD and agree UK comments on this
  - Meeting will probably be simultaneous with that for 76-1
  - No venue identified so far for this

IEC TC14 Update

- **IEC 60076-4 – Power transformers - Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors**
- **MT Convener Thang Hochanh (CA)**
- **This document has been in maintenance since just after the publication of IEC 60076-3 Ed 3 in 2013:**
  - Currently approved for CDV stage but CDV has not been seen yet
  - Forecast date of publishing new standard is now summer 2024

IEC TC14 Update

- **IEC 60076-5 – Power transformers - Part 5: Ability to withstand short circuit**
- **MT Convener Jean-Christophe Riboud (FR)**
- **The MT working on this has been meeting for a number of years and have had quite a lot of meetings but with not a lot of progress – however:**
  - First CD issued for circulation just before Christmas last
  - Comments are due back before 11 March – so to BSI by 4 March
  - CD comment discussions ongoing – likely to require a CD2 stage
  - Not planning on holding a meeting to discuss this one

IEC TC14 Update

- **IEC 60076-6 – Power transformers - Part 6: Reactors**
- **MT Convener Rob Verhoeven (NL)**
- **The MT working on this has met quite a few times:**
  - First CD anticipated for some time
  - UK represented by David Walker and Paul Jarman

IEC TC14 Update

- **IEC 60076-19 – Rules for the determination of uncertainties in the measurement of the losses on power transformers**
- **MT Convener Anders Bergman (SE)**
  - This is an update to IEC of a European document
  - Has been stop/ start for some time
  - CDV recently published at end of January – document available to any interested party
  - Decision in Bled to split this document into two parts, 76-19-1 for transformers and 76-19-2 for reactors, this will introduce some delays
  - But still doesn't include the biggest source of errors in loss measurement – how to determine the winding temperature!

IEC TC14 Update

- **IEC 60076-25 – Neutral Earthing resistors**
- **PT Convener Hakam El Assad (?)**
  - Development ongoing over recent years
  - Recently approved to move to FDIS stage
  - Expected publication date was October 2022 but not yet available

IEC TC14 Update

- **TC14 Plenary Meeting Decisions**
  - All inactive maintenance teams or project teams have been disbanded
  - Agreed to support IEEE with update to IEC/IEEE 60076-16 if IEEE decides to move in this direction
  - Decides to split IEC 60076-19 into two parts (as previously noted)
  - Decides to disband AHG 35 and convert this to an AG39
  - Disband participation in JMT 5 maintenance of IEC 62199 DC bushings
  - Decides to set up a new ad-hoc group to develop a TR for “Power Transformers related to energy transition systems, including PV, battery storage, EVs etc.

CIGRE UK A2|D1 Liaison

IEC TC10 GEL 10
Fluids for Electrotechnical Applications

National Committee Update

Prepared by:

Russell Martin (M&I Materials)

17/01/2023

GEL 10 (UK National Committee for TC10)

- 15 members meets 2/year
- Bruce Palavanpour was replaced as Chair by David Walker
- Bruce remains as member

GEL 10 Standards and groups under review

- IEC MT39 – updating IEC 60867 (1993) - Specifications for unused liquids based on synthetic aromatic hydrocarbons - Convenor – Jeremie Walker (Arkema)/Russell Martin
  - **Standard published 2022**

- MT36A – Updating IEC 62770 Unused Natural Esters for Electrical Equipment Convenor Russell Martin
  - **CD document produced. Ready to return to the IEC as CDV. Expected publication October 2024**

- IEC 60422 Ed. 4 "Mineral insulating oils in electrical equipment - Supervision and maintenance guidance" MT22 D.Walker
  - **The team have reviewed all the comments from the CD version and returned to Massimo for it to be issued as CDV hopefully soon**

GEL 10 Standards and groups under review

- IEC 61203 Synthetic organic esters for electrical purposes – Guide for maintenance of transformer esters in equipment. Convenor R.Martin
  - **CD draft comments still under discussion. Next meeting 11 Jan 2023**

- IEC 60599 Ed.3 "Mineral oil-filled electrical equipment in service - Guidance on the interpretation of dissolved and free gases analysis" MT20 M.Duval
  - **Standard published 2022**

- IEC 60475 Ed. 2 "Method of sampling insulating liquids". MT 20 Convenor M.Duval
  - **Published May 2022**

- Maintenance of IEC 61039:2008 Ed.2 "Classification of insulating liquids" (actual SD 2021) Russell Martin
  - **CD Produced. Now circulated to collect comments Expected publication October 2024**

GEL 10 Standards and groups under review

- Cigre JWG D1/A2 77 (Liquid Tests for Electrical Equipment – DGA in esters) Convenor Fabio Scatiggio
  - **Several web meetings held, and the team split into various TF for literature review and summarising. Draft TOC has been written**

- IEC WG 45 (Preparation of a new TR/IS on interpretation of DGA analysis in natural and synthetic esters)
  - **Convenor: Ivanka Atanasova-Hoehlein**
  - **Working closely with JWG D1/A2.77. 2 meetings (1 web, 1 F2F),**
  - **Scope & Purpose have been agreed. More meetings to come**

- MT30 IEC 60156 (2018) Insulating liquids - Determination of the breakdown voltage at power frequency - Test method
  - **Updated version nearly published**