TECHNICAL COMMITTEE REPORT 2023

Report Date: November 2023

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Report Contributors:

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Elizabeth Mackenzie	SC A2 UK Additional Regular Member
Matthew Iles	SC A3 UK Regular Member
Tony Chen	CIGRE UK TC Member
James Pilgrim	SC B1 UK Regular Member
Mark Osborne	SC B3 UK Regular Member
Dechao Kong	SC B4 UK Regular Member
James Yu	SC B4 UK Additional Regular Member
John Wright	SC B5 UK Regular Member
Ronan Jamieson	SC C2 UK Regular Member
Spyros Karamitsos	SC C4 UK Regular Member
Jun Liang	SC C6 UK Regular Member
Thomas Andritsch	SC D1 UK Regular Member
Thomas Charton	SC D2 UK Regular Member
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Contents

1 Introduction

This report summarises CIGRE UK Technical Committee (UK TC) related work conducted over 2023 and its intended recipients are the CIGRE UK members.

The report provides information on the structure of CIGRE UK TC, updated information from the lead areas within the remit of CIGRE UK TC, i.e. Technical Panels, Technical Events, Liaison activities and Session Papers. Since the concept for CIGRE UK for Technical Panels was introduced a few years ago, progress has been made in establishing a number of panels. Information with respect to the composition of these are given in the individual SC RM reports sections.

The report also contains statistical information courtesy of the Central Office with respect to the WG and their composition and outputs.

Finally, the report includes a brief update from each Regular Member (RM) representing UK in the international Study Committees.

CIGRE UK TC has a dedicated website and KMS webpage and all information relating to TC work is uploaded onto the KMS site. CIGRE UK membership can request access to the public parts of the KMS in order to keep informed on aspects of various TC works.

The report is based on information supplied by each lead within the TC and by the RMs.

2 CIGRE UK Technical Committee

CIGRE UK Technical Committee mirrors the international CIGRE Technical Council with the specific aim of serving the technical requirements of CIGRE UK. In doing so CIGRE UK TC aims:

1. to be the technical thought leader for the UK electricity supply industry
2. to support the active participation in and access into the critical technical working groups of CIGRE,
3. to provide a staircase of new talent into technical study committees and working groups as the core of future expertise for the UK electricity supply industry,
4. to leverage overall CIGRE organization by providing greater depth of technical knowledge from the UK electrical supply industry.

CIGRE UK TC works towards the achievement of the above objectives by:

1. providing leadership in the practical development of the UK transmission and distribution networks,
2. ensuring CIGRE technical activities reflect the issues of interest/concern to UK,
3. establishing closer links between UK Regular Members and all UK members using adopted communication techniques in the form of Technical Panels,
4. establishing responsibilities expected from UK Regular Members in terms of representing the UK,
5. introducing review and selection process/methods for UK papers to maximize the number and quality of papers accepted by CIGRE Technical Council,
6. ensuring UK Regular Members gain clear view of technical topics of interest/concern to UK members,
7. promoting exchange of technical information to all UK members without commercial constraints.
8. promoting joint activities across TPs/SCs, providing further support to the TPs/SCs with smaller UK members/communities.

2.1 CIGRE UK TC Structure

CIGRE UK TC is structured as shown in Figure 1. Roles and responsibilities attached to each position can be found on CIGRE UK TC KMS webpage (https://cigregroups.org/x/EAX6). In addition to the assigned roles the UK TC invites CIGRE UK Chair and Vice Chair as well as the NGN and Women's Network representatives to the UK TC meetings. CIGRE UK TC meets 4 times annually and teleconference in the meantime as necessary.

In the past year, Charlotte Higgins stepped down as the C1 RM and new RM is Dr. Bless Kuri. He had working experience in National Grid, is now the head of System Planning and Investment in SSE Electricity Transmission. We would like to thank all the outgoing members for their hardworking and contributions in serving their terms of office over the years, and wish all the new members every success in taking up the roles.

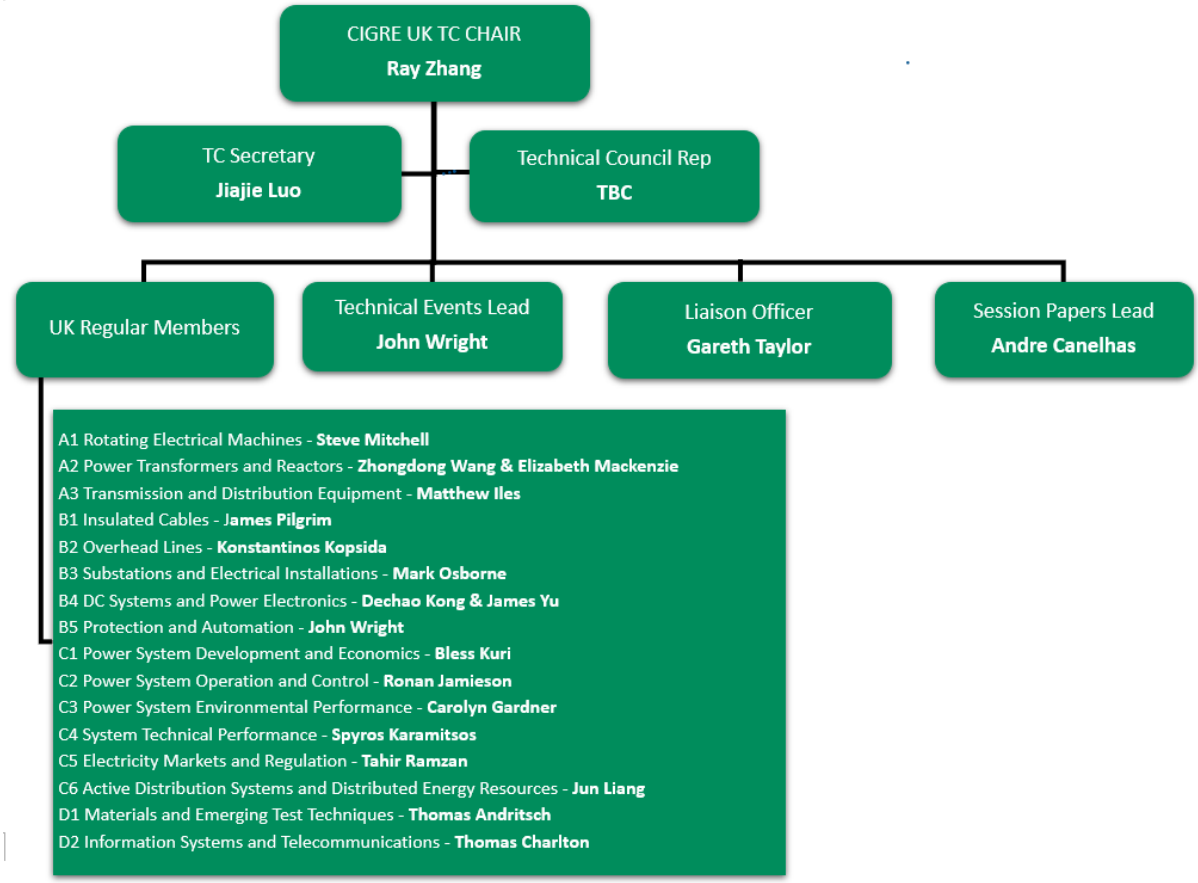


Figure 1: CIGRE UK TC structure, also available on: https://cigre.org.uk/uk-technical-committee/

2.2 CIGRE UK Regular Members

The following table shows the current UK RMs serving in Study Committees along with their contact details.

Study Committee	Regular Member/Additionmal Regular Member	Email
A1	Steve Mitchell	stevejamesmitchell@msn.com
A2	Zhongdong Wang	zhongdong.wang@manchester.ac.uk
A2	Elizabeth Mackenzie	elizabeth.a.mackenzie@btinternet.com
A3	Matthew Iles	Jonathan.Hennah@nationalgrid.com
B1	James Pilgrim	japil@orsted.co.uk
B2	Konstantinos Kopsida	K.Kopsidas@manchester.ac.uk
B3	Mark Osborne	mark.osborne@nationalgrid.com
B4	Dechao Kong	kingdc.bruce@hotmail.com
B4	James Yu	James.Yu@spenergynetworks.co.uk
B5	John Wright	john.w.wright@ge.com
C1	Bless Kuri	bless.kuri@sse.com
C2	Ronan Jamieson	Ronan.Jamieson@nationalgrideso.com
C3	Carolyn Gardner	carolyn.gardner@nationalgrid.com
C4	Spyros Karamitsos	spyros.karamitsos@ieee.org
C5	Tahir Ramzan	tahir.ramzan@live.co.uk
C6	Jun Liang	liangj1@cardiff.ac.uk
D1	Thomas Andritsch	t.andritsch@soton.ac.uk
D2	Thomas Charton	thomas.charton@nationalgrid.com

3 CIGRE-UK Technical Events

3.1 Introduction

CIGRE-UK has organised Technical Liaison Meetings, webinars, and many other events in this year. The active support of RM's, NGN and the wider CIGRE community has been greatly appreciated.
For more details, please visit CIGRE UK website:

https://cigre.org.uk/category/events/
https://cigre.org.uk/past-monthly-technical-webinars/

3.2 Technical Liaison Meetings

CIGRE UK A2/D1 Technical Liaison Meeting

17th Jan 2023

The purpose of the meeting was to bring people together in person for the first time for a few years and to provide an overview of the ongoing activities in CIGRE related to Study Committees A2 (Power Transformers & Reactors) led by UK Regular Members, Zhongdong Wang & Elizabeth MacKenzie, and D1 as relating to Transformers (Materials and Emerging Test Techniques) led by UK Regular Member, Thomas Andritsch.

CIGRE UK B1/D1 Technical Liaison Meeting

3rd Oct 2023

The annual Cigre B1 UK Technical Liaison meeting was held as a Hybrid Meeting on October 3rd. The purpose of the meeting was to provide a high level overview of the ongoing activities in Cigre related to Insulated Cables. Technical Brochures published in the last year were highlighted, along with a status update on all of the active B1 Working Groups where the UK has an interest. There was also a reminder about the latest new work items approved by the B1 Study Committee during the annual B1 Study Committee meeting, and an opportunity to provide feedback on possible work items that could be proposed by the UK in the future. In addition to information about the latest work within B1, we were joined by the UK Regular Member for D1 who provided a summary of activities relevant to the B1 audience. The event was held as a Hybrid meeting, meaning that a dial in option was available.

CIGRE UK B4 Hybrid Technical Liaison Meeting

4th Oct 2023

The purpose of the meeting was to provide a high-level overview of the ongoing activities in CIGRE related to Study Committees B4 (DC Systems & Power Electronics) led by UK Regular Members Dechao Kong and James Yu. There were keynote presentations, updates on a recent Colloquium, a review of Technical Brochures published in the last year, along with a status update on all of the active Working Groups where the UK has an interest.

CIGRE UK B5/D2 Technical Liaison Meeting

22nd Nov 2023

The purpose of the meeting was to provide a high-level overview of the ongoing activities in CIGRE related to Study Committee B5 (Protection and Automation) and D2 (Information systems and Telecommunication) led by UK Regular Members John Wright and Thomas Charton. There were keynote presentations, updates on a recent Cairns Symposium, a review of Technical Brochures published in the last year, along with a status update on all of the active Working Groups where the UK has an interest.

3.3 CIGRE-UK Webinars

Webinar Programme

Date	Title	Presenter
Jan	*Development of Grid Forming Convertors for Secure and Reliable Operations of Future Electricity systems*	Xiao-Ping Zhang, Juan Carlos Gonzales, Jiajie Luo
Feb	*Transient Stability Enhancement of Large-Scale Power Systems Using Maximum Energy Balance Control* *Integrating large scale Renewable Energy: Challenges and Opportunities.*	Henry Wu, Pingliang Zeng
Feb	*Experience and New Requirements for Transformers for Renewable Generation*	Elizabeth Mackenzie
Mar	*National Grid (NG) Innovation Programme – Secure Edge Platform (SEP)*	Sara Nichols, Ryan Vaughan
Apr	*Enabling the Transition to Net Zero*	Regina Finn, Cecile Geier, Wenjuan Song, Alejandra Giraldo
Apr	*Building the Grid of the Future Through Innovation & Collaboration*	Mital Kanabar
May	*Protection of Future Power Networks Dominated by Converters*	Qiteng Hong, Ben Marshall
July	*Report on A3/B3 Joint Colloquium*	Matthew Iles
Aug	*LV Engine: Hybrid AC-DC Networks*	James Yu, Ali Kazerooni
Sep	*Improve Operations with AI/ML Powered Analytics*	Jack Wilkins
Oct	*An Introduction to SSEN's HVDC Project Aquila and its Concepts*	Ben Marshall, Dong Chen, Perry Hofbauer

3.4 CIGRE-UK Other Events

Collaboration in the North Sea Powerhouse

This is a series of events.

The development of renewables in the North Sea is critical for accelerating clean transition and boosting energy security for the UK and our European neighbours. Offshore wind in North Sea is set to play a key role to reduce dependence on natural gas and cut carbon emissions. The UK government plans to increase capacity of offshore wind production to 50 gigawatts by the end of the decade and aims for the economy to produce net-zero emissions by 2050.

Joint B3 & A3 Colloquium

9th -12th May 2023

The CIGRE UK National Committee has invited CIGRE Study Committees B3 & A3 to hold a joint Colloquium in Birmingham between the 9th and 12th May 2023 at the IET Austin Court. This Colloquium on the theme of 'The role and impact for T&D Substations and Equipment in delivering a Net Zero Carbon Future' brings together experts and key players in the domain of Transmission & Distribution Substations & Equipment from the electric power industry, including Network Operators, Manufacturers, Consultants, Policy Makers, Regulators and Academics. The Colloquium will be a unique forum to share exciting new research, to raise issues and awareness, to discuss future directions, to show innovative solutions and to network with leading professionals.

Data Science and Next Generation Communications in Electricity Networks: Event Presentations

30th June 2023

CIGRE UK's conference on Data Science and Next Generation Communications in Electricity Networks, kindly hosted by Arup, took place on Friday 30th June in London. The event featured expert speakers who discussed the latest advancements in data science and communication technologies in the electricity industry. Attendees had the opportunity to network with other professionals in the field and learn about the latest trends and best practices. Topics covered (see programme below for details) included: the applications of Artificial Intelligence, Machine Learning, Digital Twins, Common Data Exchange, Forecasting Analysis, the Industrial Internet of Things, Applications of 5G, Future Communications Systems and last, but not least, Cybersecurity.

CIGRE UK WiE Event Refresh 2023 | Presentations, Video & Mailing list

25th Jan 2023

A discussion took place about the refresh of the CIGRE UK Women in Energy activity. An introduction and presentation were made by Biljana Stojkovska (CIGRE UK WiE Chair) and by Mandy Olson (CIGRE USA WiE Chair) who shared activities and experiences to date. There followed a general discussion by those that joined the webinar on ideas for the future.

CIGRE UK NGN Event National Grid Control Room Visit

4th Aug 2023

This was the first in-person event that the CIGRE UK NGN committee has organised, post pandemic, and was successfully delivered in collaboration with National Grid ESO. The highlight of the event was the insightful visit to the National Grid ESO's control room. This experience provided invaluable insights into the intricate workings of the ESO's role in effectively balancing and managing the electricity grid across GB.

3.5 Synopses submitted for Paris Session 2024

There are totally 52 synopses submitted from the UK for Paris session 2024, the details are shown by the table below:

Summary of Synopses Submitted				
Study Committee	**Submitted**	**Rejected**	**Withdrawn**	**Total**
A1	0	0	0	0
A2	6	1	1	4
A3	2	0	0	2
B1	5	0	0	5
B2	3	0	0	3
B3	3	0	0	3
B4	5	0	1	4
B5	6	0	0	6
C1	6	0	0	6
C2	4	0	0	4
C3	1	1	0	0
C4	8	0	0	8
C5	0	0	0	0
C6	7	0	0	7
D1	0	0	0	0
D2	0	0	0	0
Total	56	2	2	52

4 CIGRE-UK Technical Panels

More information on the UK Technical Panels is available on individual Regular Member reports Section 7 – Section 21 of this document.

5 Information from Paris Central Office

The following statistical information is based on data from the Paris Central Office relating to technical activities within CIGRE for the year 2022. Data related to 2023 will be available in 2024.

5.1 Active Working Group

- Number of total active Working Groups (WGs) and Joint Working Groups (JWGs) has changed from 266 in January 2022 to 257 in January 2023.
- Out of all active WGs, 40 are active JWG.
- Study Committees C4 and B2 have the largest number of active WGs including JWGs.
  C2 has the least number of WGs including JWGs.
  Distribution of WGs and JWGs across 16 Study Committees (SC) is shown in Figure 2.

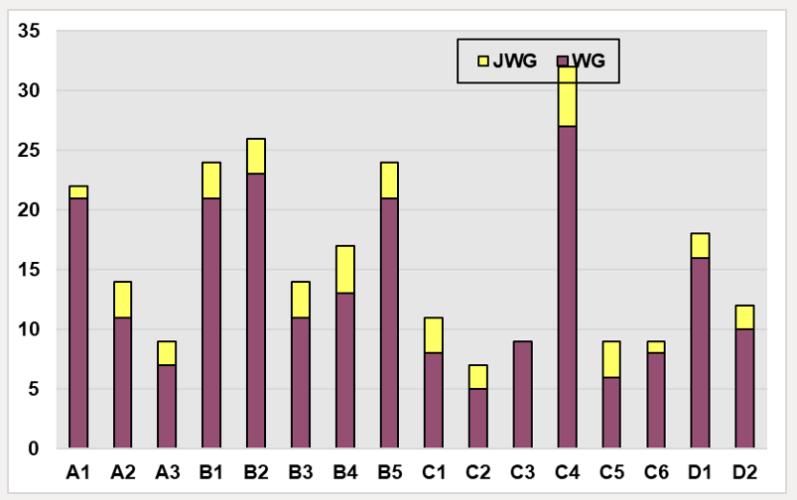


Figure 2: Distribution of WGs across 16 Study Committees

5.2 Working Group Membership

- There are total of 4838 experts from 79 different countries involving for approximately 6000 positions, across 16 Study Committees.
- Figure 3 shows the distribution of number of experts and available WG positions across 16 Study Committees. B2 has a considerable gap between the number of experts and available WG positions highlighting one expert is participating more than one WG. C2 on the other hand has a good balance between the number of experts and available WG positions.

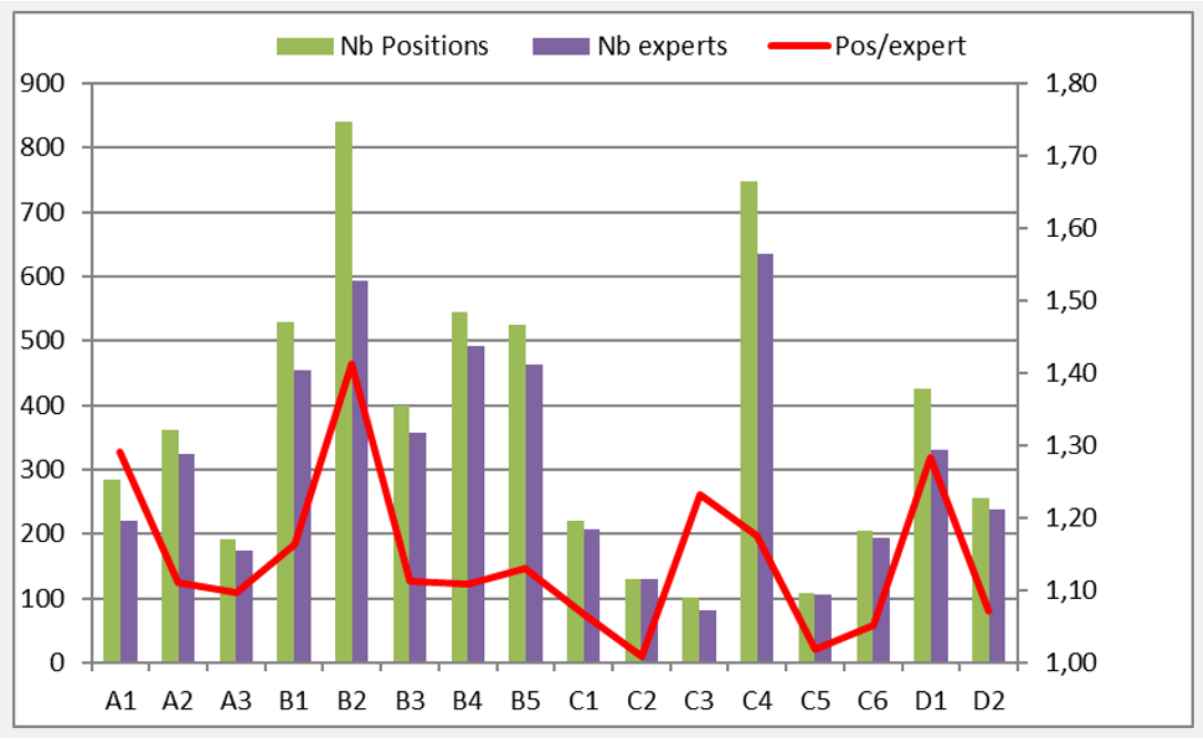


Figure 3: Number of Experts and WG Positions

- B2 has the highest number of positions and experts available and C3 has the least number of WG positions and experts.
- Figure 4 shows the number of WG positions fulfilled by experts in red and the number of experts involved in WGs in blue based on the country of origin. Only 25 countries depicted on the figure. United States had the highest number of experts and majority of the WG positions are filled by experts from United States.

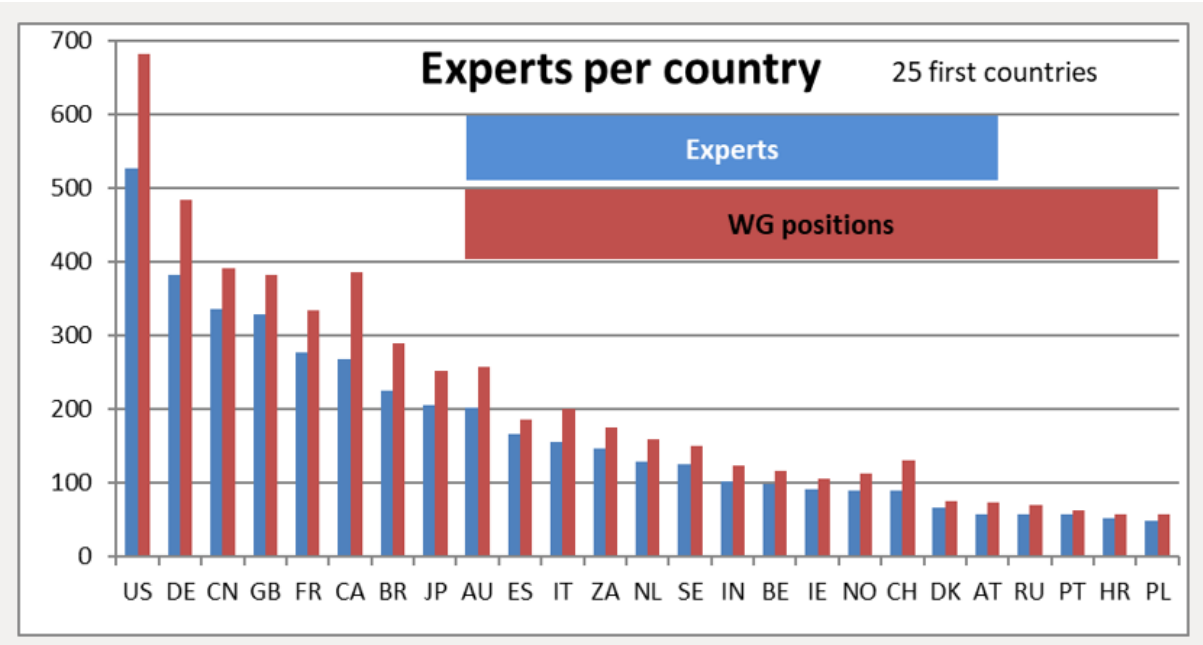


Figure 4: Number of WG positions filled by experts based on country of origin

- GB is listed fourth in the list behind United States, Germany, and China. There is a considerable gap between number of GB experts and the number of WG positions filled by a GB expert, which means one expert is participating in more than one WG.

5.3 Working Group Publications

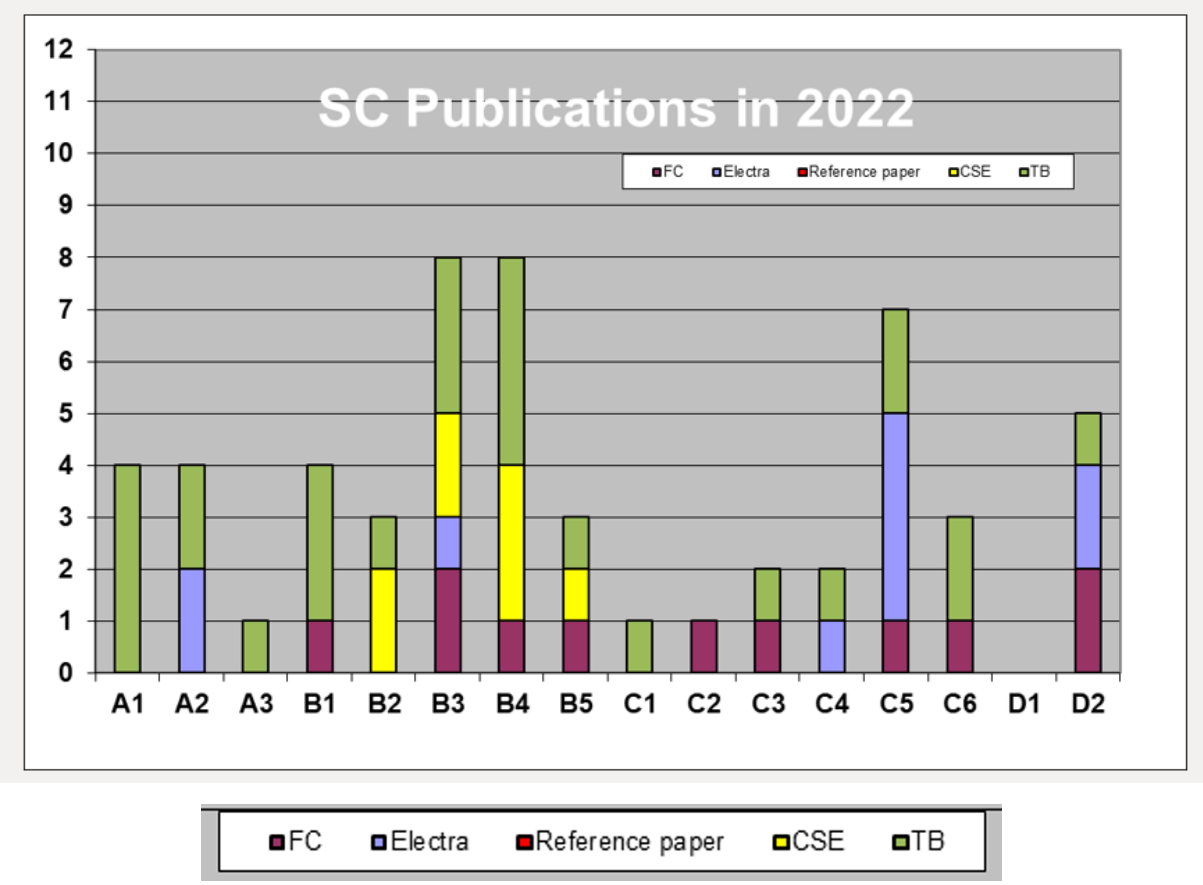


Figure 5: Study Committee Publications

- As shown in Figure 5, D1 has produced the least publication in the past year.
- B3 and B4 have the most publications in the past year combining all categories.

6 RM Report on SC A1 Rotating Electrical Machines

6.1 Study Committee Scope

SC Chair: Kevin Mayor (CH)

SC Secretary: Peter Wiehe (AU)

The scope of SC A1 is study the design, construction, operation and maintenance of rotating electrical machines. The Study committee is split into four sections; Turbine Generators, Hydro Generations, Motors and New Technologies.

6.2 Strategic Advisory Groups

Turbo Generators	Monique Krieg-Wezelenburg (NL)
Hydro Generators	Johnny Rocha
Motors	Erli F Figueiredo (BR)
New Technologies	Luis Rouco (ES)

6.3 2024 Preferential Subjects

2024 Preferential Subjects for the next Paris bi-annual meeting are as follows:

PS1 : ROTATING ELECTRICAL MACHINES AND THE ENERGY TRANSITION

- Impact of the energy transition on the role, duty and flexible operation of rotating electrical machines
- Changing requirements on rotating machines to support the evolution of smart grids
- Update of international standards for electrical machine requirements to reflect future applications

PS2 : EVOLUTION AND DEVELOPMENT

- Developments in the design of generators for new applications such as wind turbine, synchronous compensators and variable speed pump-storage
- Improvements in design, manufacture, efficiency, insulation, cooling, bearings and materials
- Enhancements in the performance, reliability and control of rotating electrical machines
- Design evolution of rotating electrical machines based on operational experience

PS 3 : KEEPING THE LIGHTS ON

- Condition monitoring, diagnosis, prognosis of rotating electrical machines including the use of artificial intelligence, deep learning techniques and digital twin concepts

- Ensuring power supply reliability by asset management of installed base and maintenance practices
- Improving performance and extending operational service life of installed base through refurbishment, replacement, and power up-rating, and methodologies to establish the sequence of machines to be refurbished/replaced

6.4 Proposed Working Groups

Proposed in 2023 session	Convener	Status

6.5 Technical Panel Meetings, Seminars &Tutorials

The following Tutorials were held within the SC A1 meeting in Japan:

- Survey on Industry Practices and Effects associated with the Cutting Out of Stator Coils in Hydrogenerators Jemimah Connie AKIROR, Secretary WG A1.59
- Renewable Power Integration - Synchronous Condenser role in Grid Stability Dhananjay CHATURVEDI, Cigre Fellow & Honorary member
- History of High Thermal Conductivity Insulation Development and Application Hiroshi HATANO, Toshiba Energy Systems and Solutions Co., Hiroshi SAKO, Mitsubishi Electric Corporation, Kazuhiro KUDO, Mitsubishi Heavy Industries

6.6 Technical Brochures

Working Group	Title	Technical Brochure
A1.	Survey on industry practices and effects associated with the cutting out of stator coils in hydogenerators	91

6.7 Last Study Committee Meeting (Highlights)

The study committee meeting was held in Doshisha University, Kyoto, Japn on the 11th and 12th of September 2023 and also via Teams online meeting. Overall the SC A1 priorities were as agreed in 2022 with the focus on the following:

- Finalise and publish back-log of completed WG work
- Improve regular communication within SCA1 community to promote timely completion of work
- Identify opportunities to increase female and younger age group membership and participation

Following the central Cigre Strategic Plan 2030 SC A1 has proposed a change in name and revision to its scope which is included below:

Study Committee A1*: **" Power Generation and Electromechanical Energy Conversion"***

Mission: *"To facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of electromechanical energy conversion realised by rotating machines and associated equipment in both power generation and consumption, by providing a full E2E forum covering all aspects of equipment lifecycle including the influence/impact of their operating environment. To add value to this information and knowledge by means of synthesizing state-of-the-art practices and developing recommendations."*

Scope: *"Study Committee A1 covers all aspects of electromechanical energy conversion equipment, rotating electrical machines for power generation, grid support, and energy conversion within industrial applications. This includes research, development, design, manufacture and testing of power generation and electromechanical energy conversion equipment and their associated auxiliaries, commissioning, operation, condition assessment, maintenance, life extension, refurbishment, upgrades, efficiency improvement, conversion, storage and de-commissioning.*
Some of the working groups have not reached their ideal size and require more members to be able to provide quality work. It is viewed that each working group requires around 15-20 members in order to obtain sufficient number of answers to validate surveys sent out."

Upcoming meetings
The Paris 2024 session, the aim for this session is to have 3 reviewers per paper, or 13 reviewers so the SC has sent out request for those willing to help.
SC A1 meeting in 2025 is scheduled to take place in Russia. However, the continuing situation in Europe will make participation difficult. The Russian National Committee has proposed that this event is postponed until 2027. Meaning that there is a need for an invitation from a different National Committee for 2025.

6.8 Current Working Groups and UK Members

WG Nr.	WG TITLE	STATUS	
A1.33	Guide For Cleanliness And Storage Of Generators	TB 860 published in e-cigre. Extract published in ELECTRA 360	
A1.42	Influence of key requirements to optimize the value of hydro generators	Draft TB available. Further review/rework required before circulation under the 6-week rule	
A1.43	State of the art of rotor temperature measurement	TB reviewed. Associated documents to be compiled for submission	
A1.44	Guideline on Testing of Turbo and Hydrogenerators	6-week review completed. TB updated. Associated documents in preparation for submission.	
A1.45	Guide for Determining the Health Index of Large Electric Motors	Need more responses to the questionnaire - recirculate	
A1.48	Guidance on the Requirements for High Speed Balancing / Over-speed Testing of Turbine Generator Rotors Following Maintenance or Repair.	6-week review completed. Documents updated and ready for submission	
A1-C4.52	Wind generators and frequency-active power control of power systems	TB in preparation	
A1.53	Guide on Design Requirements of Motors for Variable Speed Drive Application	In revision following 6-week rule feedback.	
A1.55	Survey on Split Core Stators	Pending feedback from convener	

A1.56	Survey on Lap and Wave Winding and their Consequences on Maintenance and Performance	TB prepared. To be sent for review under the 6-week rule	
A1.58	Selection of Copper Versus Aluminium Rotors for Induction Motors	Report prepared & in checking for 6-week review.	
A1.59	Survey on Industry Practices and Effects associated with the Cutting Out of Stator Coils in Hydrogenerators.	TB+Electra abstract prepared. To be sent for review under the 6-week rule	
A1.60	Guide on economic evaluation for refurbishment or replacement decisions on hydro generators	In work. TB chapters defined & allocated. Needs more WG members.	
A1.61	Survey of Partial Discharge Monitoring in Large Motors	Pending feedback from convener	
A1.62	Thrust Bearings for Hydropower - A Survey of Known Problems and Root Causes	Need more responses to the questionnaire - recirculate	
A1.63	Turbo Generator Stator Winding Bushings and Lead Connections – Field Experience, Failures and Design Improvements	Working Group re-established and in progress. Questionnaire being finalised.	
A1.64	Guide for Evaluating the Repair / Replacement of Standard Efficiency Motors	Report in preparation	
A1/C4.66	Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators	TB review under 6-week rule completed on 22 April 2022. Feedback being assessed.	Fabian Koehler (Member) Liqiu Han (Member)
A1.67	State of the Art in methods, experience and limits in end winding corona testing for Hydro Generators	Pending feedback from convener	
A1.68	Evaluating Quality Performance of Electric Motor Manufacturing and Repair Facilities	Renewed call for WG members sent out on 4 May 2022. Needs more participation from manufacturers and responses.	
A1.69	Hydro-Generator Excitation Current Anomalies	Team assembled.	
A1.70	Dielectric Dissipation Factor Measurements on Stator Windings	Questionnaire and collection of information completed; Analysis in progress.	Richard Ludlow (member) Ian Simmonds (member)
A1.71	Survey on damper-winding Concepts and its operational experience on hydro generators and motor-generators	Team assembled – start in 2022	
A1.72	Survey on multi-turn coils with dedicated turn insulation versus coils without dedicated turn insulation	Team assembled – start in Sept 2022	
A1.73	Customer Requirements for Qualification of Form Wound Stator Insulation Systems for Hydro Generators	Team assembled – start in 2022	
A1.74	Evaluating quality of large electric motors used in power generation plant	Currently has only 7 members	
A1.75	Large air-cooled turbo-generator state of the art, limits and perspectives for small modular reactors		
A1.76	Study on Eco-design, circular economy and impacts on generator production process		

A1.77	Survey on stator insulation reliability of motors	Currently only 9 members	

7 RM Report on SC A2 Transformers

7.1 Study Committee Scope

SC Chair: Pascal Müller

SC Secretary: Mark Foata

The scope of SC A2 covers:

- All kinds of power transformers, including HVDC transformers converter and phase-shifting Transformers;
- All kinds of reactors, including shunt reactors, series reactors, and HVDC smoothing reactors;
- All transformer components, including bushings, tap-changers, and other transformer accessories.

The key activities of SC A2, which cover the life cycle of a transformer, are related to the four following key domains:

- Specification, procurement and economics
- Design, manufacturing and testing
- Operation, reliability, safety and environmental impact
- Maintenance, diagnostics, monitoring and repair

Key domains (1) and (2) are associated with transformer technology, while key domains (3) and (4) are associated with transformer utilization. SC A2 will normally have activities in order to continuously cover the four key domains.

SC A2 is also moving to consider MV/LV issues.

UK representation on the committee is Prof. Zhongdong Wang (RM) and Elizabeth MacKenzie (ARM).

7.2 Strategic Advisory Groups

AG 2.3 Technology – Henk Fonk;

AG 2.4 Utilisation - Brendan Diggin;

AG 2.6 Green Book – Simon Ryder;

AG 2.7 Transformer Digitalisation – Patrick Picher;

AG 2.8 Lower Voltage Applications – Peter Werle.

7.3 Draft Preferential Subjects

The Preferential Subjects for 2024 Paris Session are:

PS 1: Design of resilient transformers

PS 2: Advances in transformer analytics

PS 3: Reliability of transformers for renewable energy

Seven UK synopses received. Synopses notification of acceptance to be informed on 6th November.

The 2023 A2 Colloquium will be held in Split, Croatia, 27 November to 1 December 2023. It is jointly organised with the 6th International Colloquium Transformer Research and Asset Management.

7.4 New Working Groups

A2.68	Failure survey of lower voltage generator step up transformers installed in wind farms and photovoltaic parks.	UK members: Elizabeth MacKenzie, Denis Nesbitt (Doble), Florian Marpaux (EdF), How Owens (EdF), Muhammed Dagrah (M&I)
A2.69	Guide for transformer maintenance – update	UK members: Allan Holton (SPEN), Paul Jarman (Manchester Univ)
A2/C3.70	Life Cycle Assessment (LCA) of Transformers	UK members: Hang Xu (IST Power) and Steven Vallance (SPEN)

7.5 Technical Panel Meetings, Seminars & Tutorials

The last UK A2 technical panel and A2/D1 liaison meeting were held in person on 17th January 2023. Over 50 attendees were present in person at the liaison meeting, and several were on-line.

The next technical panel and liaison meetings are scheduled on 9th January 2024 at the University of Manchester.

7.6 Technical Brochures published in 2023 (including late 2022)

Ref.	WG	Title
TB887	A2.55	Life extension of oil filled transformers and shunt reactors
TB900-TB904	A2/C4.52	High-Frequency Transformer and Reactor Models for Network Studies – Part A: White-Box Models Part B: Black-Box Models Part C – Grey-box models Part D: Model interfacing and specifications Part E: Measurements and transformer
Green Book GB 14	*A2.6*	*Transformer and Reactor Procurement*

7.7 Current Working Groups and UK Members

WG	Title	UK Member	Organisation
A2.56	Power Transformer Efficiency	Kevin Wilson	Wilson PS
A2.57	Effects of DC Bias on Power Transformers	Paul Jarman Dongsheng Guo	NG NG
A2.58	Installation and Pre-Commissioning of Transformers and Shunt Reactors	John Lapworth Ian Hunter	Doble Polaris
A2.59	On-Site Assembly, On-Site Rebuild, and On-Site High Voltage Testing of Power Transformers	Simon Ryder	Doble
A2.60	Dynamic Thermal Behaviour of Transformers	Muhammad Daghrah Jose Quintana Xiang Zhang	M&I Materials SPEN MMU
A2.62	Analysis of AC Transformer Reliability	Shengji Tee	SPEN
A2.63	Transformer Impulse Testing	Qiang Liu	Manchester Univ.
A2.64	Condition of Cellulose Insulation in Oil-immersed Transformers after Factory Acceptance Test	Hongzhi Ding Andrew Fieldsend-Roxburough	Doble NG
A2/D2.65	Transformer Digital Twin – concept and future perspectives	Zhongdong Wang Tim Zhao	Manchester Univ.
A2/D1.66	Breathing systems of liquid filled transformers and reactors		
A2/D1.67	Guideline for Online Dissolved Gas Analysis Monitoring	Michelle Fiddis Shuhang Shen	GE Exeter Univ.
A2.68	Failure Survey of Lower Voltage Generator Step Up Transformers installed in Wind farms and Photovoltaic Parks	Elizabeth MacKenzie Denis Nesbitt, Florian Marpaux, How Owens, Muhammed Dagrah	Consultant Doble EdF EdF M&I
A2.69	Guide for transformer maintenance – update	Allan Holton Paul Jarman	SPEN Manchester Univ
D1/A2.77	Liquid tests for Electrical Equipment	Atitila Gyore Qiang Liu Russel Martin David Walker Gordon Wilson	M&I Materials Man Univ. M&I Materials SPEN

			NG
A2/C3.70	Life Cycle Assessment (LCA) of Transformers	Hang Xu Steven Vallance	IST Power SPEN
A3/A2/A1/B1.44	Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltages		
TF WGR_310_1	Power Transformer sound level on site	Janine Dickinson	NGET
Green Book	"Guide for Transformer and Reactor Life Management".	Simon Ryder (Editor-in-chief)	Doble

Updates on working groups from the UK members are received and included as follows:

WGR_310_1 **Task Force title:** Power Transformer sound level on site, following the work left from A2.54

This working group **A2.54** Load sound power levels for specification purposes of three-phase 50 Hz and 60 Hz liquid-filled power transformers, was set up in 2016 and should complete in 2023. All meetings and all research have now completed. The technical brochure chapters have been finalised and are being complied for submission. A tutorial will take place on 29th November 2023 during the Cigre SC A2 colloquium in Split.

This task force's convenor is Janine Dickinson and secretary is Martin A. Stoessl. The Task Force started in August 2022 with an expected completion date of March 2024. The Task Force is exploring the reasons why once a transformer is installed on a substation site, sound level measurements often do not match the sound level determined during factory acceptance testing. Seven meetings have taken place via MS Teams and in person. The outline of the technical brochure has been drafted, names allocated to chapters and first drafts produced. Future meetings will take place in November 2023 and January 2024, with an estimated end date of March.

A2.55 and A2.56 and A2.57 update
According to the 2022 UK A2 report, technical brochures are expected to be ready by 2022. No brochure has been published yet.

A2.58 update

The purpose of the WG is to provide guidance on how transformers should be installed on site, commissioned and monitored during the warranty period to defect any manufacturing or design faults not detected by factory acceptance tests, but exposed by real operating conditions. The intended audience is not only the main practitioners in manufacturing, utility and service companies, but also any other interested parties, e.g. senior management, project managers, insurance companies, regulators and potential second owners (in the case of renewable assets being transferred from developer to operator). The chairman is Ross Willoughby (AU), ex GE. The UK has had three members from service companies (Doble and Polaris). There is strong representation from Europe, with manufacturer members from ABB and GE, but also utility representation from US, India and Israel.
This working group was set up in Spring 2017 and will hopefully complete in 2024. Three Task Forces were set up: 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 fortnightly virtual meetings have been held with a face-to-face meeting at the Paris 2022 Session. A large draft Technical Brochure covering the very wide scope has been produced, with detailed and comprehensive discussion of all topics. Recent discussion has included Inspection and Test Plans, Documentation, DGA and other monitoring during the warranty period, and special

considerations for new insulating fluids and offshore installation. The latest version (20) is being finalised within the WG before being submitted to SC A2 at the 2023 A2/D1 Colloquium in Split for review.

A2.59 update
According to the 2022 UK A2 report, the technical brochure is expected to be ready by 2022. No brochure has been published.

A2.60 update
The scope of this working group is to review the state-of-the-art tools and approaches to Dynamic Transformer Thermal Modelling (DTTM), and to propose suggestions for improving the standard models, with focus on the effects of using new insulating liquids and sub-zero ambient temperatures. This working group was set up in April 2019 and is expected to complete in Summer 2024. There are 5 UK members, 3 from academia, 1 from utility and 1 from manufacturer. There has been 7 plenary meetings and numerous task force meetings between plenary meetings. There are 4 task forces: TF1 Transformer Thermal Behaviour. TF2 Dynamic Transformer Thermal Modelling (DTTM) literature review. TF3 Benchmarking of dynamic transformer thermal models.TF4 Dynamic transformer thermal model applications. The working group is in the writing phase, with a structured brochure detailing the findings, scheduled for release in Spring 2024.

A2.61 update
This working group was disbanded, according to last year's report.

A2.62 update

The purpose of the working group is to conduct and analyse failure data resulting from major failures and replacement for the period 2010 to 2019 for AC power transformers of 100 kV and above. Considerations include failure rate, location, mode and cause. Hazard curves of failure and replacement will also be determined. The UK has one member in this working group. There have been 8 meetings since November 2019, with the next one scheduled for 13 November 2023. The questionnaire has been updated, with survey completed and data analysed. Drafting of the brochure is ongoing, with an estimated of 70% completion. Members are reviewing and amending key sections of the technical brochure, such as methods for improving reliability, methodology for failure data collection and results of reliability survey. The WG is due to end in 2024.

A2.63 update

The working group has moved into the stage focusing on completing the brochure. Three task forces were established. TF1 contents are almost ready. TF2 contents need some inputs from a couple of members, which will be ready soon. TF3 simulations are almost completed, results analysis and writing are ongoing. Next meeting will be held on 27&28 Nov at Split (in-person only).

A2.64 update

The scope of the WG is to address several main issues and questions about condition of cellulose insulation in oil immersed transformers after factory acceptance test. These include: (1) which insulation material parameters have a significant impact on and are relevant and representative for the long-term function of a transformer? (2) If physical cellulosic insulation samples are required, what material to use and how to get representative samples before and after the drying process? (3) what are the guidelines for acceptance criteria for the properties of the insulation system after completed Factory Acceptance Test (FAT), including repeated tests? (4) What are the guidelines for measures and compensation in case the criteria are not met? This working group was set up in October 2019 with the expected complete in 2023 that has been postponed to 2024 due to various reasons. The UK has two members in this working group, one from an operator and another from consultant. There have been one in-person meeting in October 2019 and ten online meetings during 2020-2023. Three task forces (groups) were formed to study the following three subjects: 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,

and 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. The final draft technical brochure has been completed and currently under review. The WG is now expected to have a final in-person meeting for the approval of the final draft in 2024.

A2.65 update

The WG A2/D2.65 was approved in Feb 2022. The purpose of the WG is to study the digital twin concept when applied to transformers and propose a CIGRE definition for transformer digital twin – the data, models, analytics and other aspects. The UK has two members in this working group. So far there are two meetings and several task forces meetings. An invited paper is to be presented in 2023 A2 Colloquium at Split in November and a 3rd in person WG meeting is also organized there. Through the meetings and discussion, the structure of the technical brochure (TB) was clarified. The TB was constructed with 8 chapters, including the literature review, definitions of transformer digital twin, applications and benefits, physics-based model, data-driven model, digitalization of transformer asset management, reliability of digital twins, recommendations for future developments. Specifically in the last meeting, the data, models, analytics and other aspects which need to be encompassed in a complete digital twin was discussed, as well as the framework and roadmap of the twin. The WG has a long shelf life and is due to end in 2026.

A2.66 update

It appears that no UK members are in this working group “Breathing systems of liquid filled transformers and reactors”.

A2/D1.67 update

The purpose of the WG is to create better guidelines to users of online gas analysis monitoring equipment, which are typically not covered by existing standards and guides. The deliverables for this working group include developing a technical brochure, Electra article, trade magazine article, tutorial slides and a webinar. The UK has two members in this working group, one from an online DGA manufacturer and one from an academic background focused on online DGA testing. There have been 2 online WG meetings & further task force meetings are ongoing (one task force is being led by a UK member). An in-person meeting is scheduled for the CIGRE A2 colloquium at end Nov/Dec. The outline of the technical brochure has been drafted, with names allocated to chapters. Task Forces are working on various surveys, case studies, and tasks with much debate surrounding alarm response, specification and maintenance of online DGA monitors, and interpretation of results versus available data analysis tools. The WG is due to end in 2024.

A2.68 update

The purpose of the WG is to validate by use of a survey whether or not there is a higher failure rate of windfarm and solar park transformer than the general population, and if there are common failure causes. The UK has five members in this working group, two from an operator and three from manufacturers/consultants. There have been four online meetings of this working group and one in-person meeting, all in 2023. The outline of the technical brochure has been drafted, with names allocated to chapters. The draft survey has been produced. It has been kept as simple as possible while collecting the main data of number of units, failure rate and failure causes. The survey will be tested by working group members, then a selected number of wind and solar farm operators, and it is hoped to roll out the full survey early in 2024. The WG is due to end in 2025.

A2.69 update

TB 445 Guide for Transformer Maintenance is one of the most widely downloaded Technical Brochures on the CIGRE library. WG A2.69 has been established to update the technical brochure to reflect current maintenance practices and will also update the maintenance chapters of SCA2 Green book 2. The UK has two members in this working group, one from a utility and one from academia/consultants. There have been five online meetings of this working group and one in-person meeting, in 2022 & 2023. Chapters one to four have been comprehensively reviewed and amendments agreed where appropriate

and future work identified. A transformer maintenance survey has been issued to CIGRE members with fifty-four respondents. The survey asks several questions from how often a unit is visually inspected to how often tap changer of various types are maintained. The responses to the first survey have triggered a small number of follow-on questions to be requested of the respondents. The WG is due to end in 2024.

D1/A2.77 update
This joint working group between A2 and D1 on "Liquid Test for Electrical Equipment" has UK Members of Gordon Wilson, Russell Martin, Attila Gyore, Dave Walker, and Qiang Liu. It started in Oct 2020. The Scope of Activities include: 1. Verification of Ostwald coefficients, 2. Improving interpretation models for natural and synthetic esters. 3. Recommend a data format/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. It has set up 3 task forces: TF1 – Measurement aspects, TF2 – Data handling and categorization, TF3 – Modelling and case studies. Liaison with IEC WG 45 started. Also cooperation with JWG A2/D1.67 on "Guidelines for Online DGA Monitoring" was established.

A2/C3.70 update
This is a new working group and two UK members have recently been accepted into this working group. The purpose of this WG is to establish standardized evaluations, scoring systems and Key Performance Indicators (KPI's) of the transformers' environmental impact. It will investigate and establish the influence of different technologies, manufacturing techniques, operational influence and end of life (Circularity) and best practices and/or framework for CO2 reduction. No other updates on the meetings and progress yet.

A3/A2/A1/B1.44
We are not aware that there are any UK experts recommended from A2 into this working group.

A2 Green Book update
After publishing the green book Transformer and Reactor Procurement in late 2022, AG 2.6 is now working on a second Green Book – "Guide for Transformer and Reactor Life Management". Advisory group convenor / editor-in-chief is Simon Ryder (GB). Co-editors are Luiz Cheim (US), Adesh Gupta (IN), and Tara-Lee MacArthur (AU). Tara-Lee MacArthur also acts as web-master. The advisory group includes approx. 17 further members, mainly the authors of the individual chapters. Members from the UK are Janine Dickinson, lead author of the chapter on sound levels, and Simon Ryder, editor in chief. The Green Book will include some front material (dedications, foreword, messages from important people in CIGRE) and then 25 chapters. The structure of the book will follow the life of a transformer or reactor from procurement to disposal. There is special emphasis on condition assessment. The editors now have the full text for 20 of the 25 chapters. The editors also have partial drafts for 4 of the remaining chapters. There will be a plenary meeting of the full advisory Group at the Spilt colloquium to review and discuss progress, with the aim of submitting the full text for publication by mid 2024. The Green Book will be published approx. 6 months after submission of the full text, i.e. by end 2024.

7.8 UK Members of the Technical Panel

Name	Organisation	Role/Type	W/G
Zhongdong Wang	Exeter University	Chairman	52
Elizabeth MacKenzie	Independent	Vice-chairman	
Jose Quintana	SP Energy Networks	Secretary	60
ShengJi Tee	SP Energy Networks	Events	62
David Walker	SP Energy Networks	Transmission	55

Paul Jarman	Manchester University	WG Member	57
Paul Dyer	UK Power Networks	Distribution	
Tom Breckenridge	TB TCS	Consultant	
Ian Hunter	Polaris	Contractor	Green Book
Qiang Liu	Manchester University	WG Member	58
Simon Ryder	Doble	WG Member	63, Green Book
Gordon Wilson	NGET	Transmission	
Matt Barnett	SSE Networks (SHETL)	Member	
Hongzhi Ding	Doble	WG Member	64
Martin Judd	High Frequency Diagnostics	WG Member	51
Mark Warren	Unifin Int	WG Member	54
Asim Bajwa	Doble	WG Member	55
Kevin Wilson	Wilson PS	WG Member	56
Dongsheng Guo	National Grid	WG Member	57
John Lapworth	Doble	WG Member	58
Muhammad Daghrah	M&I Materials	WG Member	60
Xiang Zhang	Manchester Metropolitan University	WG Member	60
Richard Josebury	NG	WG Member	61
Mike Munro	Polaris	WG Member	64
Andrew Fieldsend-Roxburough	NGET	WG Member	64
Wenhui Deng	GE	Manufacturer	

8 RM Report on SC A3 Transmission and Distribution Equipment

8.1 Study Committee Scope

SC Chair: Nenad Uzelac

SC Secretary: Frank Richter

The scope of SC A3 covers all kinds of transmission and distribution equipment above 1kV, including:

- All kinds switching devices, including AC and HVDC;
- All kinds of instrument transformers, including non-conventional instrument transformers for AC and HVDC applications;
- Surge Arresters for AC and HVDC applications.
- Digitization and the implications of new and emerging technologies such as digital twins, new substation functions and offshore platforms.

The key activities of SC A3 address topics throughout all life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life.

At all stages the, technical, safety, economic, environmental and social aspects are addressed as well as interactions with, and integration into, the evolving power system and the environment. Technical aspects such as performance, specification, testing and the application of testing techniques are covered as well as asset management topics such as life cycle assessment techniques, safety and risk management techniques, education and training. Some of the key topics 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.

SC A3 is also moving to consider issues of a broader voltage range by expanding preferential topics by referring to Transmission and Distribution instead of HV.

UK representation on the committee is Matthew Iles (RM).

8.2 Strategic Advisory Groups

AG 3.01 strategic planning – Nenad Uzelac;

AG 3.02 Utility Advisory board – Robert Le Roux;

AG 3.03 Green Book – Hiroki Ito;

8.3 Preferential Subjects

The Preferential Subjects during the Cairns 2023 Symposium were:

1. Learning from experiences

What can we draw from past experience to develop the end-to-end electricity system?

2. Developing practices, functionalities and applications

What are the current developments and their application for an end-to-end electricity system?

3. Towards a sustainable power system

What are the future needs and requirements of an end-to-end power system?

In all 14 reports were accepted and presented during the Symposium.

8.4 New Working Groups

New WGs:

- WG A3.49: Aging effects on accuracy class of Instrument Transformers
- WG A3.50: On-site calibration and verification of the accuracy of instrument transformers
- WG A3.51: Requirements for HV T&D Equipment operating under Abnormal Weather Conditions
- JWG C4/A3/B2/B4.75: Guide to procedures for the creation of contamination maps required for outdoor insulation coordination

WGs Disbanded:

- One working group finished their work: JWG B3/A3.59 (TB 914). A3.41 has been disbanded.

8.5 Technical Meetings, Seminars & Tutorials

The last meeting of the A3 Study Committee met on the 5th September 2023 CIGRE Symposium Cairns 2023. The meeting took place in person with some contributions via MS Teams.

There have been meetings at the Symposium in Muscat in March 2023 and at the Birmingham Colloquium in May 2023.

The next meeting of the A3 SC will be at the Paris 2024 session in August 2024.

8.6 Technical Brochures and Publications

As working group activity has been limited, technical brochures and Electra articles are still outstanding. The following table details the most recent publications, and pending publications related to SC A3.

Ref.	WG	Title
TB 914	JWG B3/A3.59	Guidelines for SF6 end-of-life treatment of T&D equipment (>1kV) in Substations
WBN041	CZC	1. The fundamentals of current interruption in SF6 and its alternatives
TB 873	JWG B4/A3.80	Design, test and application of HVDC circuit breakers
TB 871	A3.41	Current interrupting in SF_6-free switchgear
TB 830	A3.36	Application and benchmark of multi-physics simulation tools and temperature rise calculations
TB 817	A3.38	Shunt capacitor switching in distribution and transmission systems
TB 816	A3.30	Substation equipment overstress management
TB 757	A3.35	Guidelines and best practices for the commissioning and operation of controlled switching projects

TB 737	JWG A3.32/CIRED	Non-intrusive methods for condition assessment of distribution and transmission switchgear
TB 725	A3.29	Ageing high voltage substation equipment and possible mitigation techniques
TB 716	A3/B5/	System conditions for and probability of out-of-phase
Electra Paper	A3.31	Instrument transformers with digital output
TB to be published soon	A3.39	Application and field experience with metal oxide surge arresters

8.7 Last Study Committee Meeting (Highlights)

Study Committee A3 met during the Cairns 2023 Symposium on the 5th September 2023. It was chaired by Nenad Uzelac who welcomed all attendees.

The meeting agenda was reviewed and approved along with the minutes of the last meeting in 2022. Nenad then gave an overview of wider Cigre activities an upcoming IEEE event SGSMA (Smart Grid Synchronised Measurements and Analytics) being held in May 2024 and the opportunities this present with greater integration of sensors and instrumentation in primary equipment.

Matthew Iles presented an update from the Utilities Advisory Board including a plea to national RMs to speak to their contacts and try to encourage users to participate in the UAB.

Andres Laso provided a remote update on the activities of NGN and Women in Engineering.

Next Nenad opened the floor to invitations about plans for new webinars or tutorial or requests from National Committees. New proposals were presented for new working groups and liaison activities with other organizations. Several topics were discussed including temperature rise limits – a question posed by TC17. New WGs proposals on Lifecycle Assessment and Digital twin were discussed, with considerable discussion on both topics (including online discussion after circulation of a draft TOR for LCA.

There was discussion around closer working with IEEE and CIRED to ensure input and standardization across different standards bodies and outputs feed into these.

Lastly options for future meetings were discussed with possible locations being Tel Aviv or Frankfurt in 2025.

8.8 Current Working Groups and UK Members

WG/JWG	Title	Convener	Secretary	UK Participation
WG A3.39	Application and field experience with Metal Oxide Surge Arresters	R. le Roux (IE)	F. Richter (DE)	
WG A3.40	Technical requirements and field experiences with MV DC switching equipment	C. Heinrich (DE)	T. Miyamoto (JP)	
WG A3.42	Failure analysis of recent AIS instrument transformer incidents	Z. Roman (US)	Fernando Lagos (Brazil)	
JWG A3.43 /CIRED	Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems	N. Gariboldi (CH)	J. Mantilla (CH)	
JWG B4/A3.80	HVDC Circuit Breakers - Technical Requirements, Stresses and	J. Cao (CN)	J. Wang (CN)	

	Testing Methods to investigate the interaction with the system			
JWG C4/A3.53	Application Effects of Low-Residual-Voltage Surge Arresters in Suppressing Overvoltages in UHV AC Systems	J. He (CN)	-	
JWG A3/A2/ A1/B1.44	Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltages	B. Rusek (DE)	-	
WG A3.45	Methods for identification of frequency response characteristic of voltage measurement systems	E. Sperling (CH)	M. Freiburg (DE)	
WG A3.46	Generator Circuit-Breakers: review of application requirements, practices, in-service experience and future trends	P. Novak (DE)	-	
JWG B4/A3.86	Fault Current Limiting Technologies for DC Grids	Z. He (CN)	-	
JWG B3/A3.59	Guidelines for SF6 end-of-life treatment of T&D equipment (>1kV) in Substations	M. Hyrenbach (DE)	-	
JWG B3/A3.60	User guide for non-SF6 gases and gas mixtures in Substations	K.P. (Piet) Knol (NL)	-	
WG A3.47	Lifetime Management of Medium Voltage Indoor Switchgear	A. Maheshwari (AU)		Ian Naylor
WG A3.48	4th CIGRE reliability survey on transmission and distribution equipment	H.Ito (Japan)		Matthew Iles
WG A3.49	Aging effects on accuracy class of Instrument Transformers	Roberto Tinarelli (Italy)		
WG A3.50	On-site calibration and verification of the accuracy of instrument transformers	Paolo Mazza (Italy)		
WG A3.51	Requirements for HV T&D Equipment operating under Abnormal Weather Conditions	Dr. Santosh Kumar Annadurai (India)		
JWG C4/A3/B2/B4.75	Guide to procedures for the creation of contamination maps required for outdoor insulation coordination			

Updates on working groups:

A3.39 Update

In the past 2 years meetings have been held on Teams and in person to finalise the last chapters, namely the introduction and conclusion. The conclusion should be completed by early October along with reviewing of the HVDC chapter and introduction. The draft TB is to be circulated for final review of all members to allow a clean version to be handed over to the SC for comments?

A3.40 Update

Work is ongoing with the last meeting held in Darmstadt in February 2020. There is good liaison with C6/B4.37, C6.31, A3/B4.34, B4/A3.80 and CIRED through the WG members. The focus has been on

applications, projects, switching equipment in general, products and testing. Field experience has been removed from the scope due to limited real projects in application. The Technical Brochure draft was circulated in September 2023 for comment. An Electra article was published in February 2022.

A3.42 Update

Both the convenor and secretary resigned in 2020 so a new convener and secretary took up position. 5 virtual meetings have been held since December 2021 with a hybrid meeting during Cigre 2022 in Paris on Wednesday August 31. Many studies have been presented, primarily relating to VFTO and tasks have been distributed among members, but there is very little written text for the actual document.

A3.43 Update

There have been 4 meetings of the WG wince December 2021 with 2 held in person. 2 more meetings are planned in November 2022 and March 2023. The working group is still facing travelling difficulties with only 3 people attending the meeting in Sweden in person with others joined remotely. This diluted the expected positive effect of in person meeting. Despite this plenty of material is now available and is now being consolidated to prepare a final draft TB for SC review in December 2022. The move from KMS into Draft in MS Word TB template is going slower than expected.

A3.45 Update

The working group is structured with main meetings quarterly and sub team (TF) meetings held individually. There have been 2 physical and 4 virtual meetings of the of the main group, and 1 physical and 15 virtual meetings of different groups. Work is progressing in drafting the technical brochure with between 0% and 80% of each of the 6 chapters complete. Knowledge transfer in short virtual sessions is limited with only to maximum 2-3 hours only (ineffective) in each session (due to time zones of members), leading to the feeling of lonely working and challenges with developing personal relationships. Motivation of members is between high and low, it is easy to excuse in virtual formats compared with being in physical meetings, similarly some members are not responding to emails. Despite the challenges the draft TB is planned to be ready for study committee review in December 2023.

A3.46 Update

Since starting in 2020 there have been multiple remote meetings with on 2 in person meetings held recently. There has been good discussion with examples of considerably higher than 1PU peak currents with degrees of asymmetry approaching 200% depending on the power factor. The structure and progress of the technical brochure is going well.

A3.47 Update

Work has just started with a kick-off Workshop taking place at Palais des Congrès on 20 August 2022. 05 Members attended in person and 04 members atteded via web link with good discussion on scope, approach, challenges & brochure structure. There are now 16 members in the WG and there is a call for more users or utilities, althoguh the only recent inclusion of MV has been recognised as a limitation for attaracting participants. There has been recognition of alignment needed with WG A3.43 and A3.48. The meeting continued on 01 September 2022. The draft TC is scheduled to be ready for SC review by August 2024.

A3.48 Update

Created in 2022 the inaugural meeting was held during the Paris 2022 session with numerous in person and virtual meetings since. This is the 4th survey to collect reliability data from equipment in service in 2014-2017 including performance of ageing equipment which has been in service for more than 35 years. The UK submitted a late response to the survey and the results are being included, nevertheless a huge amount of analysis of the survey results returned has already been completed with Chapter 1 through 7 already prepared and several circulated for member comments. Considerations,

conclusions and references are the main TB sections remaining with a planned publication date of March 2024. The next planned reliability survey will be on equipment in service from 2024 to 2027 and discussions have been ongoing within the WG and SC as to the scope and how to improve the number of responses which has reduced with each subsequent survey.

A3.49 Update

Created in 2023, the call for members went out in January 2023.

A3.50 Update

Created in 2023, the call for members went out in October 2023.

A3.51 Update

Created in 2023, the call for members went out in October 2023.

B3/A3.59 Update

Technical brochure 914 was published in 2023.

B3/A3.60 Update

The first meeting was on 10th September 2021 with further web meetings in November, March 2022 and August (during Paris session). The TB will provide guidance on handling, with a focus on achievable filling accuracy and maintainability, gas measurement guide according to TB 723, tightness guide and requirements, and environmental, health and safety aspects. Publication is planned in 2024.

8.9 New Working Group Proposals

New WGs were proposed during the SC meeting at Cairns 2023 symposium:

- Lifecycle analysis for substation (switchgear) considering the carbon footprint evaluation of options. The purpose of this WG would be to evaluate current GHG practices and establish a simplified carbon footprint assessment methodology applicable to the full life cycle of existing substations. The method should indicate where and when to act during the life cycle of the equipment. During the meeting there was consensus that this would be a useful tool there was broad support for this. Subsequent discussion on the circulated draft ToR however has generated a lot of debate on the scope of the LCA tool and what should and should not be included.

- There was discussion about how digital twins could be used and the opportunities they provide. A draft ToR is being prepared.

9 RM Report on SC B1 Insulated Cables

9.1 Study Committee Scope

SC Chair: Geir Clasen, NO
SC Secretary: Matthieu Cabau, FR

9.2 Strategic Advisory Groups

There are now four advisory groups in the B1 SC

- Strategic Advisory Group (Chair: Geir Clasen, NO).
- Tutorial Advisory Group (Chair: Luigi Colla, IT)
- Customer Advisory Group (Chair: Carla Damasceno)
- Reliability Advisory Group (Chair: Russell Wheatland, AU)

The Reliability Advisory Group was launched with effect from September 2022 on the topic of Cable System Statistics (Every Two Years). The Advisory Group was created based on the recommendations of TF B1.81 (How to have statistics every two years) and is focused on capturing the service experience of insulated cable systems on a more frequent basis. The introduction of a permanent Advisory Group (rather than ad-hoc Working Groups) will provide more stability to the process of collecting the service experience data, which is very widely used across the industry. The new Advisory Group will implement a revised data collection process which, it is hoped, will improve the range of information collected. Although some data has been contributed from the UK, the large number of organisations owning cable assets has made it difficult to ensure a full contribution.

9.3 Draft Preferential Subjects

The Draft Preferential Subjects for 2024 Paris Session are:
PS 1: Learnings from experiences

- Design, manufacturing, installation techniques, maintenance and operation
- Quality, monitoring, condition assessment, diagnostic testing, failure location, upgrading methodologies and relevant management
- Lessons learnt from permitting, consent and safety issues from design to implementation

PS 2: Future functionalities and applications

- Innovative cables and systems, exploring the limits of both land and submarine cables
- Roles and requirements of power cables in tomorrows grids
- Prospective impacts from the Internet of Things, Big Data, Industry 4.0 and Robotics on power cable systems

PS 3: Towards sustainability

- Experience with environmental challenges in current and future cable systems
- Impact of recycling, roadmap to net zero, life cycle of system with upgrading and uprating
- Projects and initiatives to promote access to affordable, reliable, sustainable distribution and transmission cable lines for all

9.4 New Working Groups

Working Groups (WG) normally take 3 years to complete and the deliverable is a Technical Brochure with recommendations based on Terms of Reference (ToRs) developed by a Task Force. At the time of writing, the formal ToR for these groups has not been approved by the Technical Council but the activities were approved by the B1 Study Committee.

Note that the B1.92 activity was proposed by the UK, it was accepted as a Task Force in 2022 before being approved to proceed to a full Working Group at the Study Committee meeting in September 2023. At present the UK members for the new working groups are unconfirmed and the final Terms of Reference have not been circulated.

Number	Title	UK Member
B1.92	Recommendation for additional testing of submarine cables (update of TB 722) (Conv: TBC. Convener of TF was James Pilgrim, UK)	TBC

The TF B1.93 on Robotic Supervision of Cable Tunnels did recommend that the work continue to a full working group. Unfortunately the proposal did not get enough votes during the study committee meeting and therefore does not proceed this year. It can be re-submitted for the vote next year.
New Task Forces are shown below. The UK intends to appoint a member to both proposed TF.

Number	Title	UK Member
B1.94	Grid operations (switching etc …) and Transient voltages in XLPE insulated cable systems possibly causing accelerated failure modes	TBC
B1.95	Mechanical performance and limits of submarine cables – modelling and testing	TBC

9.5 Technical Panel Meetings, Seminars & Tutorials

A hybrid Technical Liaison meeting was held on 3rd October 2023, with attendance of approximately 30 persons in person and around 35 online. The meeting was again held jointly with the D1 UK group, and the D1 RM Thomas Andritsch presented a summary of B1-relevant material to the group.

9.6 Technical Brochures

The following TBs have been published since November 2022:

TB883 Installation of Submarine Cables

TB889 Installation of Underground HV Cables

TB899 Recommendations for the use and testing of Fibre Optic Cables used in Land Cable Systems

TB908 Losses in Armoured Three Core Power Cables

TB912 Condition Evaluation and lifetime strategy of HV cable systems

9.7 Last Study Committee Meeting (Highlights)

The B1 Study Committee meeting was held in connection with the Cairns Symposium and was a hybrid meeting. Although hybrid meetings are not usually initiated for this purpose, it was a practical option given that many WG conveners from Europe were unable to justify such a long travel for a 2 day meeting.

The new WG and Task Forces were the subject of spirited discussion. The UK chose not to submit a request for new work, other than to request the continuation of B1.92 from a Task Force to a full Working Group. This request was granted. The UK was also invited to give input to the proposed scope on mechanical issues which was initiated from Denmark. This topic was also approved.

Many WG have been delayed due to the impact of the COVID pandemic and restrictions on physical meetings. It is notable that many of the delayed groups are now struggling to make progress even though all COVID related restrictions have been lifted for some time. Despite this, it is interesting to note that one WG has now been completed, ahead of schedule, using only virtual meetings. This lays down a challenge for all remaining WGs!

9.8 Current Working Groups and UK Members

Note: although the final publications of B1.54 and B1.58 are not yet available, the work is understood to be completed and the WG are effectively closing – hence they are not mentioned here.

Number	Title	UK Member
WG B1.67	Loading pattern on cables connected to windfarms	Ross Wilson (UK)
WG B1.68	Update of TB 358 'Remaining Life Management of Existing AC Underground Lines'	Stelios Christou (UK)
WG B1.70	Recommendations for the use and the testing of optical fibres in submarine cable systems	Roman Svoma (UK, Convener), Jingyi Wan (NGN)
WG B1.72	Current rating verification (Part 2)	James Pilgrim (UK), Kenneth Benton (NGN)
JWG B1/B3.74	Recommendations for a performance standard of insulated bus-bars	Ian Johnstone (UK)
JWG B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC application	Thomas Andritsch (UK)
WG B1.76	Increasing the role of quality assurance and quality control to reduce the cable failure possibility	Roman Svoma (UK)
JWG B1/B3/D1.79	Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends	Drew Boa (UK), Jack Stride (NGN)
WG B1.80	Guidelines for Site Acceptance Tests of DTS and DAS Systems used for Cable Systems Monitoring	Matthew Connell (NGN)
WG B1.82	MVDC Cable system requirements	Leigh Williams
WG B1.83	Grounding aspects for long HVDC land cable connections	Dongsheng Guo
JWG B1/C3.85	Environmental issues of decommissioning	None
WG B1.86	Assessment, Prevention and Mitigation of Safety Risk in Cable Systems	Christopher Donaghy-Spargo
WG B1.87	Finite Element Analysis for Cable Rating Calculations	James Pilgrim (Conv), Venkata Chalapathi (UK), Hugo Hui (NGN)
WG B1.88	Recommendations regarding the use of non SF6 gases in cable systems	Manu Haddad
JTF B4/B1.88	Insulation coordination procedure for DC cable systems in HVDC stations with Voltage Source Converters (VSC)	Rosemary Urban (UK)

WG B1.89	Guidance for conducting cable systems failure analysis	Ross Wilson (Conv), Raed Ayoob (UK)
WG B1.90	Cable systems electrical characteristics (Update to TB 531)	Tanmay Joshi (UK), Sara Anild (NGN)
WG B1.91	Transient thermal modelling of power cables	Ahmed Badawi (UK)
TF B1.92	Qualification of Lead Free Submarine Cables at 72.5kV < Um < 170 kV	James Pilgrim (Conv), Phil Miller (UK)
TF B1.93	Application of robotics in power cable operation and maintenance	Chanditha Udalgama (UK)
JWG D1/B1.75	Mechanism for corrosion and how to monitor it	Tom Cartwright (UK D1)

NOTE: UK denotes the UK member, IE denotes Invited Expert, NGN denotes Next Generation Network member.

9.9 UK Members of the Technical Panel

As the B1 liaison meetings are quite popular (40+ applications/attendees) it would be difficult to have this number of people in the panel.
In the past there has been one meeting per year in the summer before the SC B1 meeting. No meeting has yet been held in 2023 due to the need to revise the panel membership, and the lack of volunteers to date. The intention is to set up a panel with representation for the following sectors:

- Panel Chair (Regular Member)
- Panel Secretary
- Member from TSO
- Member from DNO
- Member from Manufacturer
- Member from Offshore Wind
- Member from Consultancy
- Member from Academia
- Previous Regular Member

Volunteers will be sought to start the panel from 2024, anyone interested should contact James Pilgrim via japil@orsted.com

10RM Report on SC B2 Overhead Lines

No information was provided by the Regular Member by the time the report is written.

11RM Report on SC B3 Substations and Electrical Installations

11.1 Study Committee Scope

SC Chair: Koji Kawakita (JP)

SC Secretary: Samuel Nguefeu (FR)

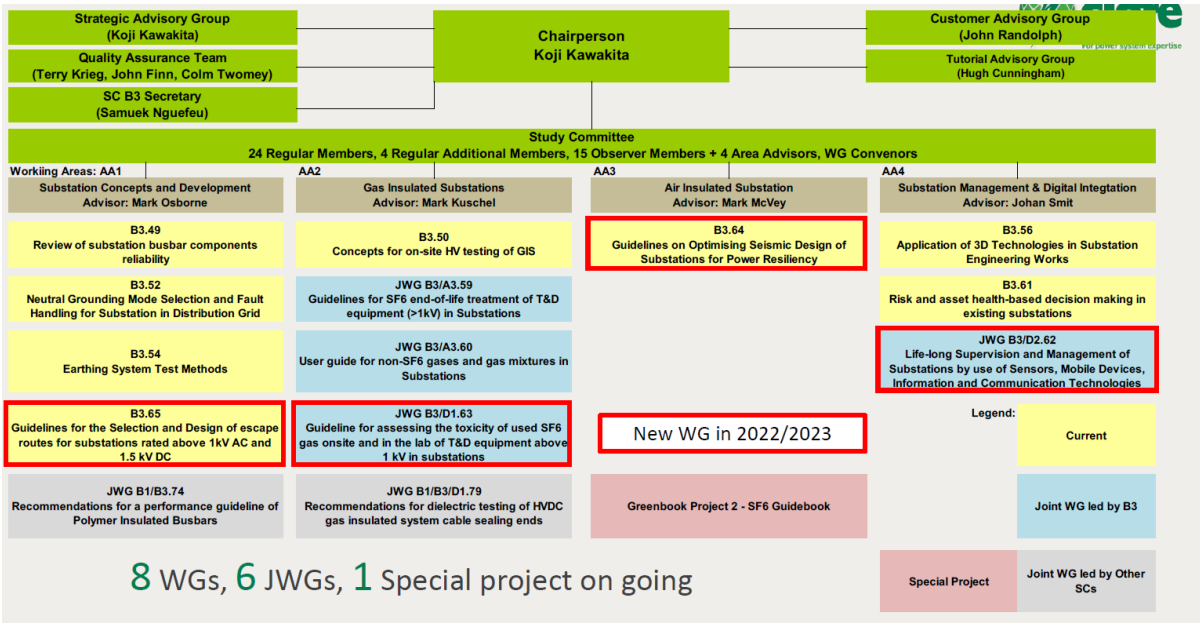
The scope of Study Committee (SC) B3 addresses topics throughout the asset management life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life. At all stages, technical, safety, economic, environmental and social aspects are addressed 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 strategic directions

- New substation concepts
- Substation ownership issues
- Life-cycle management
- Integration of intelligence for digitalization on substations



11.2 Strategic Advisory Groups

- Strategic Advisory Group (SAG) – Koji Kawakita (JP)

- Customer Advisory Group (CAG) – John Randolph (US)
- Tutorial Advisory Group – Piet Knol (NE)
- AA1 - Substation concepts & developments – Mark Osborne (UK)
- AA2- Gas Insulated Switchgear (GIS) Substations – Mark Kuschel (GE)
- AA3 - Air Insulated Switchgear (AIS) – Mark McVey (US)
- AA4 - Substation Management – Johan Smit (NE)

11.3 Draft Preferential Subjects

2024 Paris Session B3:

PS1 Challenges & new solutions in T&D substation design and construction for energy transition:

- Design impacts on substations from on-offshore wind, PV, hydrogen, small modular reactors, EV charging infrastructure etc.
- New functions in substations (energy storage, synchronous compensators, etc.).
- HV-MV DC substation and GIS/GIL application for a DC network.

PS2: Return on operational experiences for substation management:

- Challenges of managing assets: Initiatives to strengthen resilience, reliability and security, best practice and end-of-life management considering sustainability aspects.
- Lessons learned from operational experience from SF6 alternatives solutions, digital transformation solutions and digital substation.
- New competencies for new technologies, knowledge transfer methods and high standards of education in engineering skills.

2025 Colloquium – Kyoto, May 2025
Draft

- Carbon Neutrality
- Energy Transitions
- Digital Transformation

2025 Symposium – Trondheim, Norway
NRCC Symposium - led by B5, Sept 2025. Focus on changes required in the power system for the energy transition – Preferential subjects still under agreement, likely to focus on system dynamics, AC onshore and Offshore, Power to X.

11.4 New Working Groups

Number	Title	UK Member
B3.64	Guidelines on Optimising Seismic Design of Substations for Power Resiliency	TBC

B3.65	Guidelines for the Selection and Design of escape routes for substations rated above 1kV AC and 1.5 kV DC	TBC
JWG B3/A2/A3/C3/D1.66	Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation	TBC

11.5 Technical Panel Meetings, Seminars & Tutorials

Cigre UK B3/A3 Colloquium 'The Role and Impact for Electricity Transmission & Distribution (T&D) Substations and Equipment in Delivering a Net Zero Carbon Future' – 9-12 May 2023, Birmingham. See details in the Appendix:

CIGRE Symposium – Cairns 4-7th September

- Transitioning the electricity industry to a lower carbon future. 1300 attendees, 400+ from overseas, 40 countries, 11 Study Committee meetings. 69 exhibitors, 20 parallel events (CIDRE, SEAPAC etc..)
- End to End Energy Transfer - towards a Carbon Free Age - not just Carbon Neutral or Net Zero
- CIGRE B3 60th Annual **Study Committee Meeting** – 51 attendees; 21 of 43 members; including 8 on-line participants
- **Tutorial** "Knowledge Transfer of Substation Engineering and Experiences"; 120 attendees
- **Tutorial** "Air Insulated Substation Design for Severe Climate Conditions" 140 attendees
- Technical session presentations – 15 papers 300 attendees at Auditorium

Points of note.

Australian Issues

- National Policy focus F-Gas Regs - no current Australian legislation
- Resources – massive need to Train and Retain – 200,000 required
- Weather related impact on the networks
- Expanding an ageing infrastructure
- Network harmonics and voltage rise - series capacitors in VSCs contribution
- Low SCL networks (typically 1.8-2.4) coupled with high Impedance transformers
- EV charging out stripping network reinforcement
- Rolling out 500kV - closing resistors and point on wave switching required
- Vandalism of remote assets

Small Modular Reactor (SMR)

- Modular nuclear design for Energy provision & Hydrogen Electrolysis.
- Typically 50MW units which can be combined into larger groups e.g. upto 300MW.
- Commercialised brought to site on a truck/boat
- 50yr lifetime, small carbon footprint. Can provide system inertia and stability
- Substation requirements - essentially a generator, but with electrolysis facilities.

Energy Islands - Denmark

- Typically 3GW AC on the island and then DC interconnection.
- Island to produce Hydrogen. Bornholm multiterminal DC new 400kV substation.
- Environmental compatibility - physical appearance.
- Concern around increases in SCL required from 40kA to 63kA – even up to 80kA.

11.6 Technical Brochures Published 2022-23

TB number	Title	WG
TB 914	Guidelines for SF6 end-of-life treatment of T&D equipment (>1kV) in Substation.	B3/A3.59
TB 907	Mobile Substations Incorporating HV GIS – *(UK WG Convenor Paul Fletcher)*	B3.41
TB 898	Knowledge transfer of substation engineering and experiences *(Dedicated to John Nixon, was the original WG convenor, who unfortunately we lost in 2022)*	B3.58
TB 895	Impact on Engineering and Lifetime management of Outdoor GIS	B3.57
TB 886	Guidelines for Fire Risk Management in Substations	B3.53

11.7 Last Study Committee Meeting (Highlights)

The 2023 Study Committee B3 meeting was held in Cairns on 05/09/2023.

- The B3 Annual report is published in the June 2023 edition of Electra (#328)
- New Strategic Plan towards 2030 (led by Marcio Szechtman—TC Chair) “Energy Transition”: reviewed Short-Term Actions, Medium/Long Term Actions, and Next Steps
- CIGRE Women in Energy. CIGRE is looking to expand opportunities to combine activities in the substation arena. Please contact me with any ideas.
- Ambition for expansion of Global CIGRE Active membership

- Evolving cooperation with International Energy Authority (IEA) as the energy transition grows
- Adapting names of A1, C3 and D2 to reflect more
- Longer term coordination with End to End Energy Transition work

New B3 WG Terms of Reference under development;

AA1– Substation Concepts

- Guidelines for Managing Black Start Resilience in substations (possible Crina Costan)
- Offshore Substation Operational Experience (proposal Simon Waddington)
- Earthing system design guidelines for high voltage systems (possible Stephen Palmer)
- Harmonization of voltage designations and definitions across different HVDC component technologies (convenor Bruno Bisewski)

AA2– GIS, GIL, SF6 and Alternative Gases (Mark Kuschel)

- Operational safety of Medium Voltage GIS in case of abnormal leakage (Maik Hyrenbach)
- Temperature rise limits increase for lighter products (proposal Sergio Feitoza Costa)
- Guidelines for end-of-life treatment for substations > 1 kV (by JWG B3/A3.59 done)
- Return of operational experiences of SF6 free equipment (after JWG B3/A3.60)
- SF6 Green Book – Daniel Staiger; draft expected 2024

AA3– Air Insulated Substations (Mark McVey)

- Process Requirements for Commissioning and Inspecting Substations

AA4– Substation Management (Johan Smit)

- Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation (proposal new ToR—Akshaya Prabakar)

B3 recognition for contributions to CIGRE
The Outstanding service Award (used to be called distinguished award) for contribution in various ways to the success of CIGRE;

- Jeff Camden (US)
- Tony Lujia Chen (UK)

Next SC meeting will be on the 22 August 2024, in Paris.

11.8 Current Working Groups and UK Members

Number	Title	UK Member
B3.49	Review of substation busbar component reliability	Sadiq Siddiqui

D1/B3.57	Di-electric testing of gas insulated HVDC system	TBC
B3.50	On-site testing of HV GIS after installation, extension, repair or maintenance	TBC
B3.51	Service continuity guide for maintenance repair and extension of HV GIS	TBC
B3.52	Neutral grounding method selection and fault handling for substations in the distributed grid	Tony Yip (Secretary)
B3.54	Earthing System Test methods	Stephen Tucker, Dongsheng Guo, Mark Osborne AA1 advisor
B3.56	Application of 3D technologies in substation engineering works	Marcin Mroz
JWG B1/B3/D1.79	Recommendations for dielectric testing of HVDC GIS cable sealing ends	TBC
B3/A3.59	Guidelines for SF6 end of life treatment and T&D equipment (>1kV) in Substations	Adam Green
B3/A3.60	User guide for non SF6 gases and gas mixtures in substations	Mark Waldron
B3.61	Risk & Asset Health based decision making in existing substations	Dawn O'Brien
B3/D2.62	Life-long Supervision and Management of Substations by use of Sensors, Mobile Devices, Information and Communication Technologies	Call out
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.	Call out
B3.64	Guidelines on Optimising Seismic Design of Substations for Power Resiliency.	Call out
B3.65	Escape routes from Substation rated above 1kV AC and 1.5 kV DC. (Draft TOR)	TBC

11.9 UK Members of the Technical Panel

Delivered Technical Webinar
July Webinar - Mat Iles, presented a summary of the UK Colloquium 'The Role and Impact for Electricity Transmission & Distribution (T&D) Substations and Equipment in Delivering a Net Zero Carbon Future' held the previous month.

The UK liaison meeting
The B3 meeting will be jointly held with A3 on the 7/8th February 2024, in Manchester
We will aim to have presentations on UK specific issues regarding the SF6 and wider Net zero challenges affecting B3 and A3 activities.

11.10 Appendix

B3 2023 Colloquium in UK 'The Role and Impact for Electricity Transmission & Distribution (T&D) Substations and Equipment in Delivering a Net Zero Carbon Future'

Study Committees B3 (T&D Substations) and & A3 (HV Equipment) combined their resources to establish a fertile environment to discuss the impact that addressing Net Zero will have on the substation sector. The event was held in Birmingham, England between the 8th and 12th May 2023 at the Institute of Engineering & Technology's Austin Court.

The 4 day event brought together over 160 participants including international experts from 24 countries. This included key stakeholders in the domain of transmission and distribution substations and HV equipment from across the electric power industry, including System Operators, Manufacturers, Engineers, Policy Makers, Regulators and Academics.

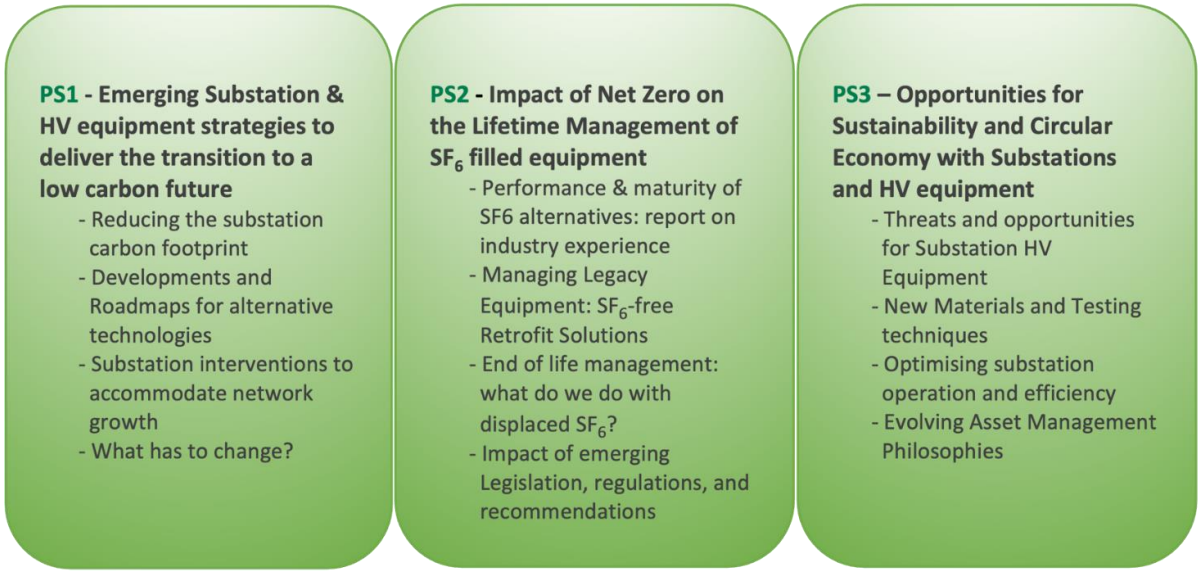
The Colloquium provided a unique forum to share ideas regarding the management of Net Zero, including:

- The latest thinking and developments in SF_6 and its alternatives, both for new products and management of existing populations
- Keynote presentation from Alice Delahunty, President of National Grid Electricity Transmission (NGET), the Transmission utility for England and Wales, outlining key advances of NGET in this sector.
- A plenary session which discussed the future outlook of SF_6 and its alternatives for the T&D sector.
- 5 Tutorials held by world leading experts on developments of alternative materials to SF_6, asset management and GIS service experience.
- 9 Working Groups
- 2 Training courses led by world leading experts introducing key aspects of GIS substation design and substation asset management.

The theme “Net Zero challenge” is a popular and important topic across the power electric industry globally. The particular resonance for our sector is the challenge around reducing and managing our dependence on SF_6, so with this in mind the following questions are being asked within our community;

- The impact of delivering Net Zero for Substations and HV Equipment - is it all about SF_6 alternatives?
- What is the role for the Circular Economy on Substations and HV Equipment in a Net Zero Future?

These questions established the 3 preferential subjects for the event, listed in figure below.



Summary

Networks are expanding at a greater rate than ever

- Introducing more renewables
- Facilitating a transition to electrification.
- Utilities cannot keep installing new SF6 equipment, if we are to reduce CO2e emissions.

Currently two main SF6 alternatives.

- Switchgear utilising fluoronitriles and fluoroketones (F-gas),
- Vacuum (interruption) and “Natural Origin Gas” (insulation)

Proposed legislation may limit growth and development of alternative F-gas technologies.

- New F-gas legislation may restrict or prevent use of alternative F-gas with GWP >10
- PFAS legislation may prevent use of PTFE e.g. circuit breaker nozzles & insulation components
- Research into alternatives is underway, but currently no available alternatives.

Need to consider the whole lifecycle environmental cost

- Its not just about SF6, but it is a major issue for our industry
- Construction and operation particularly energy inefficiency
- Opportunities for re-use and more sustainable activities.

12RM Report on SC B4 HVDC and Power Electronics

12.1 B4 Study Committee Scope

The scope of SC B4 covers High Voltage Direct Current systems and power electronic equipment for AC systems. The study committee also covers DC systems and equipment and Power Electronics for other applications such as distribution, and Power Quality improvement. Overhead lines or cables, which may be used in DC systems are not included in the scope of SC B4. DC converters for energy storage are part of the activities of SC B4.

The members of SC B4 come from manufacturers, utilities, transmission system operators (TSOs), distribution system operators (DSOs), consultants and research institutes. SC B4 is active in recruiting young engineers to participate in its activities.

SC B4 is also expanding its activities to cover DC and power electronics applications in distribution systems.

12.2 CIGRE B4 SC - Strategic Advisory Groups

SC B4 Chair: Joanne Hu (Canada); SC B4 Secretary: Rebecca Ostash (Canada)

Number	Title	Convenor	Secretary
AG01	Strategic Advisory Group	Joanna Hu	Rebecca OSTASH
AG02	B4 Newsletter	Hani Saad (FR)	
AG03	Communication and Website	Silvia Sanz Verdugo (ES)	
AG04	HVDC/FACTS System Performance	Lyle Crowe (CA)	Phaedra Taiarol (CA)
NGN	B4 NGN Group	Yuebin Zhou (CN)	
WiE	B4 Women in Energy	Rebecca Ostash	

12.3 CIGRE B4 UK Members of the Technical Panel

Dechao KONG	Chair and Regular Member	TSO
James YU	Additional Regular Member	TSO
Chidinma AGWU	Secretary	Developer
Paul JUDGE	Webmaster	Academia

Other Panel Members:

Mike Barnes	Academia
Jun Liang	Academia
Tim Green	Academia
Norman MacLeod	Consultant
Andre Canelhas	Consultant
Christopher Smith	Consultant
Carl Barker	Supplier
Nigel Shore	Supplier
Benjamin Marshall	TSO/Test Centre

Note: Current list of members on the 05/11/2023. It can be evolved in future.

12.4 B4 Colloquium 2023

- **SC B4 Working Group/Task Force Meetings on 9-10, September 2023 for**

- WG B4.79: Hybrid LCC/VSC HVDC Systems (Convenor: Hong Rao)
- JWG B4/A3.86: Fault current limiting Technologies for DC grids (Convenor: Zhiyuan He)
- WG B4.81: Interaction between nearby VSCHVDC converters, FACTs devices, HV power electronic devices and conventional AC equipment (Convenor: Kamran Sharifabadi)
- WG B4.87: Voltage Source Converters (VSC) HVDC responses to disturbances and faults in AC systems which have low synchronous generation (Convenor: Carl Barker)
- WG B4.89: Condition health monitoring and predictive maintenance of HVDC converter stations (Convenor: Nadine Chapalain)
- WG B4.90: Operation and maintenance of HVDC and FACTS facilities (Convenor: Les Brand)
- JWG B4/C4.93: Development of grid forming converters for secure and reliable operation of future electricity systems (Convenor: Dechao Kong)
- WG B4.94: Application of VSC-HVDC in a system black start restoration (Convenor: Arash Fazel Darbandi)
- Joint Task Force B4/B1/B3/C4/D1.95: Harmonization of voltage designations and definitions across different HVDC component technologies (Convenor: Bruno Bisewski)

- **SC B4 Study Committee Meeting on 11 September 2023 mainly including:**

- Paris Session 2024
- Updates from Advisory Groups
- Updates from Advisory Groups and On-going Working Groups
- New Working Group Proposals

- **CIGRE 2023 Colloquium with several topics on 12-13 September 2023:**

- VSC-Design
- VSC-Technologies
- VSC-Performance
- STATCOM/DC Equipment
- Grid Forming
- DC Grid
- DC/PE-Panning, Operation & Maintenance

- **READY4DC & InterOPERA Workshop on 13 September 2023**

- **Tutorial on 14 September 2023**

- Solid state transformer (Markus Makoschitz)
- B4.84: Feasibility study and application of electric energy storage systems embedded in HVDC systems (Hani Saad)
- B4.87: Voltage Source Converters (VSC) HVDC responses to disturbances and faults in AC systems which have low synchronous generation (Carl Barker)
- B4.81: Interaction between nearby VSCHVDC converters, FACTs devices, HV power electronic devices and conventional AC equipment (Kamran Sharifabadi)

For more details of this event, pls see the URL: https://cigre-b4-vienna2023.at/

12.5 CIGRE B4 UK Events

- The 2023 Cigre UK B4 SC Liaison meeting was held on 4 October 2023 (Virtual Event chaired by Dechao Kong)
- JWG C6/B4.37 - Medium voltage DC distribution system webinar in October 2022: James Yu (Convenor) and Jun Liang (Secretary)
- CIGRE UK Technical Webinar for JWG B4/C4.93 – Development of grid forming convertors for secure and reliable operation of future electricity systems in January 2023: Xiao-Ping Zhang (JWG Secretary); Jiajie Luo (NGN)
- CIGRE UK Webinar LV engine - Smart energy hub providing hybrid LVDC/LVAC networks in August 2023: James Yu and Ali Kazerooni

For event materials, please see https://cigre.org.uk/category/b4-zone/

12.6 Working Groups

- Current and newly established B4-related working groups:

Table 1: Current and newly established working groups

Number	Title
JWG C2/B4.43	The impact of offshore wind power hybrid AC/DC connections on system operations and system design

JTF B4/B1/B3/C4/D1.95	Harmonization of voltage designations and definitions across different HVDC component technologies
JWG C4/B4.72	Lightning and switching induced Electromagnetic Compatibility (EMC) issues in DC power systems and new emerging power electronic-based DC equipment
C4/A3/B2/B4.75	Guide to procedures for the creation of contamination maps required for outdoor insulation coordination
C1/B4.49	Offshore transmission planning
WG B4.100	Dynamic active and reactive power supporting devices for VSC HVDC systems
WG B4.98	Design considerations in integration of DC systems to meshed DC/AC transmission networks
JWG B4/C4.97	Benchmarking of simulation models for control interaction in meshed AC networks with multiple converters
WG B4.96	HVDC connection of power system with high proportion of photovoltaic (PV) generation
WG B4.95	Developments in power semiconductor technologies and applications in HVDC/FACTS
WG B4.94	Application of VSC-HVDC in a system black start restoration
JWG B4/C4.93	Development of grid forming converters for secure and reliable operation of future electricity systems
WG B4.92	STATCOMs at Distribution Voltages
WG B4.91	Power electronics-based transformer technology, design, grid integration and services provision to the distribution grid
WG B4.90	Operation and Maintenance of HVDC and FACTS Facilities
WG B4.89	Condition health monitoring and predictive maintenance of HVDC converter stations

JTF B4/B1.88	Insulation coordination procedure for DC cable system in HVDC stations with Voltage Source Converters (VSCs)
WG B4.87	Voltage Source Converters (VSC) HVDC responses to disturbances and faults in AC systems which have low synchronous generation
JWG B4/A3.86	Fault Limiting Technologies for DC Grids
WG B4.85	Interoperability in HVDC systems based on partially open-source software
WG B4.84	Feasibility study and application of electric energy storage systems embedded in HVDC systems
WG B4.82	Guidelines for use of real code in EMT Models for HVDC, FACTS and inverter-based generators in power systems analysis
WG B4.81	Interaction between nearby VSC-HVDC converters, FACTS devices, HV power electronic devices and conventional AC equipment
WG B4.79	Hybrid LCC/VSC HVDC systems
JWG B4/B1/C4.73	Surge and extended overvoltage testing of HVDC cable systems
WG B4.71	Application guide for the insulation coordination of Voltage Source Converter HVDC (VSC HVDC) stations
WG B4.69	Minimizing loss of transmitted power by VSC during overhead line fault
WG B4.64	Impact of AC system characteristics on the performance of HVDC schemes

For more details, please see URL: https://www.cigre.org/article/home/cigre-active-working-groups--call-for-experts

- Completed working groups and acknowledgement of UK members' contribution:

Table 2: Completed working groups with TB as published so far in 2023 and UK members for contribution

Number	Title	UK Member for Contribution
JWG C6/B4.37 (TB875)	Medium voltage DC distribution systems	James Yu (Convenor) Jun Liang (Secretary)

		Andrew Moon Gen Li Norman Macleod Samuel Jupe Tibin Joseph Wei Liu
JWG C4/B4.52 (TB 909)	Guidelines for sub-synchronous oscillation studies in power electronics dominated power systems	Afshin Pashaei Elisabetta Lavopa
JWG B4/A3.80 (TB 873)	Design, test and application of HVDC circuit breakers	Dragan Jovcic

13RM Report on SC B5 Protection and Automation

13.1 Study Committee Scope

SC B5 Chair: Rannveig Løken (Norway)
SC B5 Secretory: Richard Adams (UK)
The scope of SC B5 is to facilitate and promote engineering development and knowledge exchange in the field of protection and automation by means of "synthesizing" the best practices and recommendations. It covers principles, design, applications, coordination, performance, and asset management of "Light Current" systems and equipment. All technical, organisational, and economical aspects are considered including staff education and training.

13.2 Strategic Advisory Groups

SAG Convenor, Rannveig Løken (Norway)
Substation Automation (TG.51), Volker Leitloff (France)
Protection & Monitoring (TG.52), Cedric Moors (BE)
New Network Requirements (TG.53), Nirmal Nair (NZ)
Tutorial/IEC Liaison, K-P. Brand (Switzerland)
IEEE Liaison, Richard Hunt (US)
Communication Officer, A. Apostolov (US)

13.3 B5 2023 Symposium - Australia

From the 4th to 7th September 2023 the B5 Symposium was combined with the South East Asia Protection Automation Conference (SEAPAC).

Topics:

- Application of IEC61850 in protection and automation systems
- Metering systems
- Special protection systems & wide area protection
- Training engineers and technicians for technology transition
- Time in protection applications - Time sources & distribution applications
- Leveraging PMU data for better system protection
- Future technologies for Inter substation protection communication.
- Standardizing and updating protection with the need consider a greater number of hardware/firmware changes.
- Modelling protection systems
- Safety by design for Protection
- Protection challenges highlighted by power system events.

13.4 New Working Groups

Number	Title	UK Member

B5.81	Obsolescence Management for Protection, Automation and Control Systems	CONV: John Wright RM: Ryan Murphy CM: Angela PP CM: Andrew Mills / Philip Carss / Jesudoss Savarimuthu
B5.82	Education, Qualification and Continuing Professional Development of Engineers in Protection, Automation and Control	CM: Beatrice Chong CM: David Meadows
B5.83	Protection for modern distribution networks	RM: Himanshu Bhatia CM: Deepa Shaji Kumar

13.5 Technical Panel Meetings, Seminars & Tutorials

- Liaison Meeting Nov 22– combined with D2
- Nov 2022 – Cigre UK AGM - Venkatesh Chakrapani - Enhanced Distance Relay To Meet The New Challenges From Inverter Based Resources
- April 2023 – Cigre UK Webinar Series – Mital Kanabar - Building the Grid of the Future Through Innovation & Collaboration
- May 2023 – Cigre UK Webinar Series – Ben Marshall / Qiteng Hong – Protection and Future Networks Dominated by Converters: Recent Learnings on Challenges and Potential Solutions
- B5 Technical Panel Meeting – Oct 23
- B5 Liaison Meeting Nov 23– combined with D2
- AGM Nov 23 – Protecting the Grid of the Future – John Wright

13.6 Technical Brochures

Reference	Working Group	Title
884	JWG B5/D2.67	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods
891	WG B5.60	Protection, Automation and Control Architectures with Functionality Independent of Hardware
896	WG B5.48	Protection for developing network with limited fault current capability of generation

13.7 Last B5 Study Committee Meeting (Highlights)

SC B5 has LinkedIn, Twitter and Facebook accounts which members can join

The meeting included the discussion of strategic directions, future events & activities, review of on-going WGs, Green Book development as well as Communications and Liaison with other technical bodies such as IEC, IEEE etc. At the meeting, the following 3 new working groups were selected for 2023:

- **New WG1** – PACS interfaced asset management and condition monitoring using innovative technologies.
- **New WG2** – Recommendations and constraints for development and interfacing of virtual IED implemented in PACS.

- **New WG3** – Protection, Control and Monitoring principles of synchronous condenser and generation with fly wheel

The invitation for nominating new members will be circulated in due course once the Terms of References for the new WGs are finalised by the study committee.

Next Event: Paris 2024 – 25th – 30th August

Preferential Subjects are as follows:

PS1 - Practical experiences and new developments of process bus

PS2 – Acceptance, commissioning and field testing for protection automation and control systems

13.8 Awards

- No UK Awards for B5

13.9 Current Working Groups and UK Members

Country Member	Type ○ Tx Utility ○ Dx Utility ○ Gx Utility ○ Vendor ○ Consultant ○ University ○ Other	WG Member (WG-___(R)/(C) (R) - regular (C) – corresponding
Ray Zhang	Consulant	JWG B5/C4.61 Convener
V. Terzija	Other	JWG B5/C4.61 WG B5.55 WG B5.57
Peter Crossley,	University	WG B5.55 Convener WB B5.82 (R)
Peter Watson	Consultant	WG B5.56 (R) WG B5.72 (R)
John Wright	Vendor	WG B5.59 (R) WG B5.63 (R) WG B5.81 (Convener)
Bojana Djukic	Tx Utility	WG B5.57 (C) WG B5.78 (C)
Abraham Varghese	Vendor	WG B5.58 (R)
Thomas Charton	Tx Utility	WG B5.64 (R) WG B5.69(R)
Steven Blair	Other	WG B5.64 (C)

Country Member	Type ○ **Tx Utility** ○ **Dx Utility** ○ **Gx Utility** ○ **Vendor** ○ **Consultant** ○ **University** ○ **Other**	WG Member **(WG-___(R)/(C)** **(R) - regular** **(C) – corresponding**
Veronika Koseleva	Consultant	
Colin Scoble	Dx Utility	WG B5.65 (R)
Dave York	Vendor	WG B5.70 (C)
Dave Hewings	Other (Network Rail)	WG B5.65 (C)
Chee-Pinp Teoh	Vendor	WG B5/D2.67 WG B5.77 (C)
Rasoul Azizipanah	Tx Utility	JWG B5/C4.61 (C) WG B5.74 (C)
Raju Paidi	University	JWG B5/C4.61 (C)
Chen, Linwei	Tx Utility	WG B5.68
Stockton, Mark	Tx Utility	WG B5.68 (C) WG B5.71 (R)
Jason Vieira Ferreira	Vendor	WG B5.69 (C)
Hengxu Ha	Vendor	WG B5.70 (C)
Shimeh Jahangiri	Vendor	WG B5.71 (C)
Dr Jianing Li	University	WG B5.72 (C)
Dr. Daniel Gheorghe	Consultant	WG B5.72 (C)
Joao Pestana	Vendor	WG B5.73 (R)
Saurabh Makwana	Vendor	WG B5.73 (C)
Yasemin Baygar	Vendor	WG B5.73 (C)
Mohseen Mohemmed	Tx Utility	WG B5.74 (R)
Robert Leone	Vendor	WG B5.74 (C)
Piotr Sawko	Vendor	WG B5.75 (C)
Ian Nicoll	Other	WG B5.76 (R)
Jesus Joao	Vendor	WG B5.76 (C)
Daniel Dantas	Utility	WG B5.75 (C) WG B5.77 (C)
Conor Shore	Vendor	WG B5.77 (C)

Country Member	Type ○ Tx Utility ○ Dx Utility ○ Gx Utility ○ Vendor ○ Consultant ○ University ○ Other	WG Member (WG-___(R)/(C) (R) - regular (C) – corresponding
Simanand Gandhi-Jeyaraj	Other	WG B5.77 (C)
Haiyu Li	University	WG B5.78 (R)
Ricardo Bouchet	Vendor	WG B5.78 (C)
Jesus Valdivieso	NGN	WG B5.78 (C)
Venkatesh Chakrapa	Vendor	WG B5.79 (R)
Ryan Young	Gx	WG B5.79 (C)
Adam Dysko	University	WG B5.79 (C)
Ryan Murphy	Vendor	WG B5.81 (R)
PP Angela	TSO	WG B5.81 (C)
Andrew Mills	Vendor	WG B5.81 (C)
Philip Carss	Other	WG B5.81 (C)
Jesudoss Savarimuthu	Gx	WG B5.81(C)
Beatrice Chong	TSO	WG B5.82 (C)
David Meadows	Vendor	WG B5.82 (C)
Himanshu Bhatia	Vendor	WG B5.83 (R)
Fainan Hassan	Other	WG B5.83 (C)
Deepa Shaji Kumar	University	WG B5.83 (C)

13.10 Notable Industry Activities, Highlighting Positive Issues And Difficulties

There is considerable interest in the industry around the following topics:

Operation of distance protection with the increase on REN continues to dominate the transmission sector - The traditional algorithms are not responding correctly in certain situations. Vendors are having to modify them. Additional challenge is how to deal with the installed base of distance protection as we move towards net zero.

Impact of Cyber Security on PAC`s – evolution of standards required.

Virtualised protection is gaining momentum.

Interoperability and IEC61850 development continue to improve flexibility. Impact of 2.1, vendor agnostic tools, top-down engineering etc.

Increased move to standard designs and focus on asset / obsolescence management. This is driven by lack of PAC Engineers and the need to train the existing ones on the new and fast evolving technology.

Edge technology and its use / advantages in zonal control to improve grid resilience and flexibility with increased penetration of REN. Looking at a systems approach to PAC interacting at all voltages levels – communications and latency becoming more important.

13.11 UK Members of the B5 Technical Panel

Chairman: John Wright
Secretary: Ryan Murphy

- Academia by Haiyu Li / Xiao-Ping Zhang
- Transmissions by Mark Stockton / Thomas Charton / Craig McTaggart
- Distributions by Sean Stack / Colin Scoble
- Manufacturers (OEMs) by Robbie Smith / Dave York
- Consultancies/Contractors by Peter Watson
- Others/Rail by Dave Hewings
- NGN : Zhenkun Yang
- Women’s Network : Bojana Djukic / Anis Yaakob
- Testing – Ali Abdulla - Omicron

14RM Report on SC C1 System Development and Economics

No information was provided by the Regular Member by the time the report is written.

15RM Report on SC C2 System Operation and Control

15.1 Study Committee Scope

SC Chair: **Jayme Darriba Macedo**

SC Secretary: **Flavio Alves**

UK Regular Member – **Ronan Jamieson**

The scope of C2 covers the technical, human resource and institutional aspects and conditions for the secure and economic operation of power systems under security requirements against system disintegration, equipment damages and human injuries and security of electricity supply.

15.2 Strategic Advisory Groups

TD 1: Real-time System Operation and Control
TD 2: System Operational Planning and Performance Analysis
TD 3: Control Centre Infrastructure and Human Resources for System Operation

15.3 Preferential Subjects

The Paris 24 Session has the following preferential subjects on

PS1: Create operational resilience to extreme/unpredictable events

- Natural phenomena forecasting applied to operation planning studies & real time decision support.
- Threats and hazards from other systems that affect supply/demand of electricity.
- Lessons learned & best practices to deal with high impact/low probability events on system operation.

PS2: Changes on system operation and control considering the energy transition

- Disturbances and system restoration in power systems with a high share of inverter-based resources.
- Flexibility and ancillary services for high RES share environments.
- Power system operation strategies & operation planning studies considering a high share of RES.

15.4 New Working Groups

Number	Title	UK Member
WG C2.4	Estimation, evaluation and provision of power system inertia in networks with a high share of renewable generation – convener Yaran Li	TBC

New potential WGs:

- System Operational Resilience Indexes
- ✓ Digitalization

New potential JWGs:

- System Operation & Cybersecurity (JWG w/ D2?)
- Influence of Changing Climate Policies on System Operation (JWG w/ C3?)
- System Integrity Protection Schemes (JWG w/ B5?)
- Changes in Control Centers due to technology changes and new functionalities available in Distribution Management Systems

New JWGs:

- C2/C5.06 - The Impact of Market Interventions by System Operators during emergency situations
- C2/B4.43 The Impact of offshore wind power hybrid AC/DC connections on system operations and system design

15.5 Technical Panel Meetings, Seminars & Tutorials

- **01 September 2023**, Michael Power, convener of WG C2.40, and Tony Hearne, delivered a tutorial titled "TSO-DSO Co-Operation – Control Centre Tools Requirements"
- **Cairns 2023 – International Symposium**: Titled "The End-to-End electricity system: transition, development, operation and integration"
    - Franco Crisci and members of WG C2.24 presented the tutorial titled "Mitigating the risk of fire starts and the consequences of fires near overhead lines for system operations" during the 2023 CIGRE Symposium in Cairns, Australia, in September 2023.
    - Babak Badrzadeh and members of WG C2.26 presented the tutorial titled "Power system restoration accounting for a rapidly changing power system and generation mix" during the 2023 CIGRE Symposium in Cairns, Australia, in September 2023.

15.6 Technical Brochures

TB 911 Power System Restoration Accounting for a Rapidly Changing Power System and Generation Mix (WG C2.26)
The following WG are finalizing their Technical Brochures, which are expected to be published in 2023
C2.18 - Wide Area Monitoring Protection and Control Systems – Decision Support for System Operator
C2.39 - Operator Training in Electricity Grids at Different Control Levels and for Different Participants/Actors in the New Environment
Joint Working Group C2/C5.06 - The Impact of Electricity Market Interventions by System Operators during Emergency Situations
Published Reference Paper – refer to Cigre Paris session as too many to list here

15.7 Last Study Committee Meeting (Highlights)

Cairns Session 2023 - A summary of the sessions

The central theme running through both the papers and the presentations were novel approaches and techniques need to be considered, tested and if successful then rolled out. The challenges that low inertia and growth of renewable generation can be assisted by using modern computing techniques (parallel and high performance) to break the problem space to manageable regions. New techniques to highlight areas of low system strength need to be adopted and automatic load management schemes installed to assist in controlling these regions. Also returning to understanding the different elements involved in the challenges in Unit commitment of renewable generation to test and develop new approaches can provide improvements and increased efficiency in the solution space.
In conclusion the papers aligned to the overall theme of the end-to-end electricity system and aligned with the opening ceremony presentations which examined the magnitude of the journey to net zero (from a Queensland perspective) and the need to do things different to achieve the net zero goals (the use of standardization to simplify some of the supply chain challenges). We cannot meet the global ambition of a net zero carbon energy system by 2035 by doing what we have been doing to date and we need to find new approaches to addressing the challenges of a low inertia system with a wide range of different source of energy at different voltages with the whole energy system.

UPCOMING EVENTS

- C2 paper sessions – Paris 2024
- Large Disturbances Workshop – Paris 2024.
- Tel Aviv Symposium (April/May, 2025)
- Trondheim Symposium (September, 2025)
- Montreal Symposium (September/October, 2027)

15.8 Current Working Groups and UK Members

Number	Title	UK Member
WG C2.26	Power system restoration accounting for a rapidly changing power system and generation mix	Dan Auty
WG C2.39	Operator Training in Electricity Grids at Different Control Levels and for Different Participants/Actors in the New Environment	Dozie Nnabufie
WG C2.42	The Impact of the growing use of machine learning/Artificial Intelligence in the operation and control of Power Networks from an Operational perspective	Ewa Krywkowska
WG C2.44	Operational strategies to manage power system minimum operating conditions	Ramana Budha

15.9 UK Members of the Technical Panel

RM – Ronan Jamieson (Baringa)

16RM Report on SC C3 System Environmental Performance

No information was provided by the Regular Member by the time the report is written.

17RM Report on SC C4 System Technical Performance

17.1 Study Committee Scope

SC C4 Chair: Marta Val Escudero (IE)

SC C4 Secretary: Dr Genevieve Lietz (DE)

The main mission of Study Committee (SC) C4 is to facilitate and promote the progress of power systems engineering and the international exchange of information and knowledge in the field of system technical performance and to add value to this information and knowledge by means of gathering state-of-the-art practices from around the world and developing recommendations.

The scope of SC C4 is the development and review of methods and tools for analysis related to power systems, with reference to dynamic and transient conditions and the interaction between the power system and its apparatus/subsystems, as well as between the power system and external causes of stress and other installations. Specific issues related to the design and manufacturing of components and apparatus are not in the scopes of SC C4, nor are those specifically related to planning, operation, and control, apart from those cases in which a component, apparatus, or subsystem behaviour depends on, or significantly interacts with the performance of the nearby power system. Thus, the scope of SC C4 is quite broad and covers all aspects of the technical performance of large power systems across the entire range of phenomena and time frames, the continuum of which is shown in Figure 17.1.

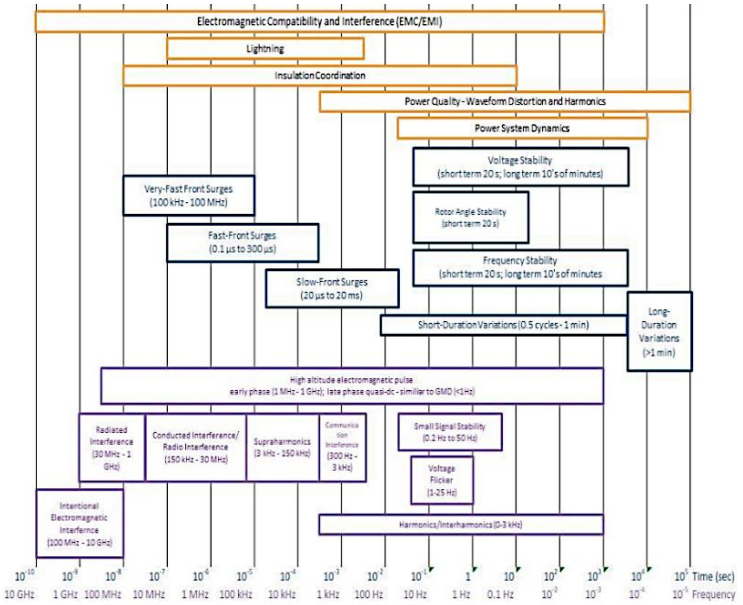


Figure 17.1: Time Frame with the Range of Phenomena Investigated by SC C4.

To better define the scope of SC C4, the following broad topics of interest are covered:

- Power Systems Stability & Dynamics – Performance, Models and Numerical Analysis (PMNA)
- Power Quality (PQ)
- Electromagnetic Compatibility and Interference (EMC/EMI)
- Insulation Coordination (IC)
- Lightning (L), Switching

The common theme among these broad topics is the investigation and development of new tools, models, analysis methods and techniques for the assessment of such phenomena. The list provided above also relates to the emerging smart grid, microgrid and distributed and renewable energy resource technologies (such as wind and solar), with emphasis concerning power quality and advanced tools for the analysis of electromagnetic and electromechanical transients and dynamic performance.

Due to its wide remit, SC C4 alone cannot investigate all technical performance issues without being in close cooperation with other CIGRE SCs that deal with equipment, system planning and operations, distribution networks, materials and testing, and environmental aspects of the power system.

17.2 Structure and Strategic Advisory Groups

The membership of SC C4 presently encompasses 43 countries. At the 2023 SC C4 meeting on Thursday, September 7th, Cairns Convention Centre, Cairns, Australia, the composition of the SC was confirmed as follows (https://c4.cigre.org/GB/about-sc-c4/our-members):

- Chair: Marta Val Escudero (MVE)
- Secretary: Dr Genevieve Lietz
- 24 Regular Members and 2 Additional Regular Members
- 18 Observer Members

Figure 17.2 shows the organisational structure of the CIGRE SC C4. It comprises 3 Advisory Groups (AGs), as follows:

- Strategic Directions AG C4.1 (SAG) – AG1 also includes liaisons with IEC and IEEE; it will be disbanded, and membership may change at the discretion of the new SC C4 Chair
- Customers AG C4.2 (CAG) – Convenor: Dr Filipe Faria da Silva (DK)
- Tutorials & Conferences AG C4.3 (TAG) – Convenor: Marta Val Escudero (IE)

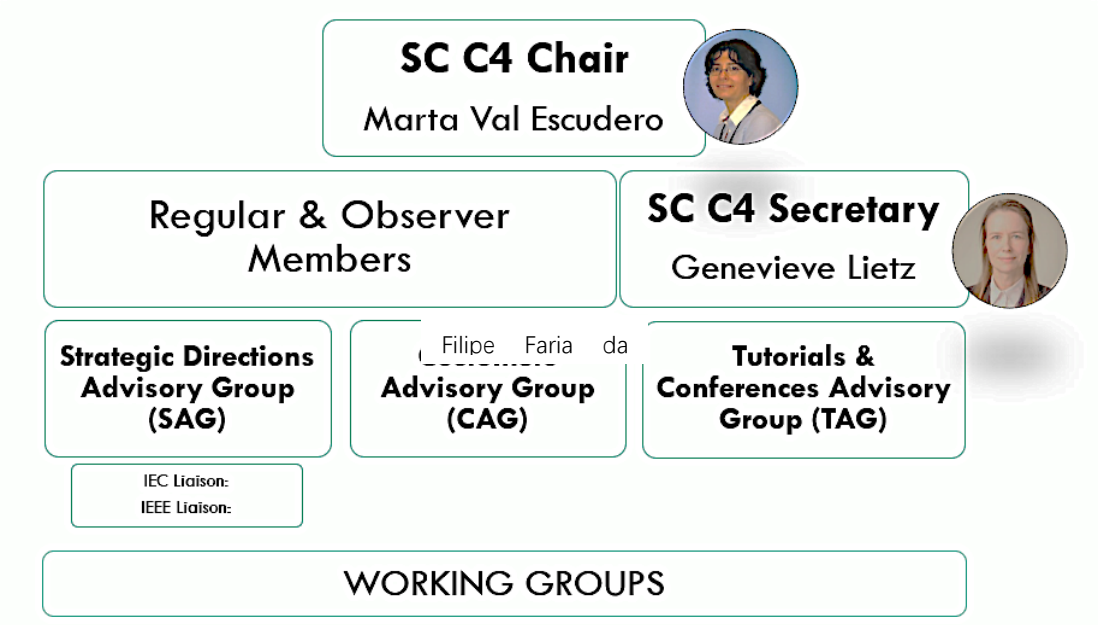


Figure 17.2: Organisational Structure of SC C4.

Awards

The following individual associated with SC C4 works was recognised with a CIGRE award:

- Yicheng Liao: Thesis Award; PhD thesis: “Impedance-Based Analysis for Power Electronics-Based Systems”

17.3 CIGRE SESSION 2024 – Preferential Subjects

The Preferential Subjects (PS) for the CIGRE 2024 Paris Session have been finalised:

PS1: Power system dynamic analysis in the energy transition: challenges, opportunities and advances

- Methodologies including modelling tools and techniques, model validation, metrics and data analytics.
- Technologies including storage, large scale electrification and advanced control methods.
- Phenomena including control interactions, system needs and required equipment capabilities for planning and operation of secure power systems.

PS2: Power quality (PQ) and electromagnetic compatibility (EMC) analysis in the energy transition: challenges, opportunities and advances

- New tools and methods for the assessment and the mitigation of PQ issues for low-carbon grids.
- EMC related challenges arising from large penetration of renewable energy plants and electric vehicles (EV) charging networks.
- Evaluation and mitigation of high-altitude electromagnetic pulse (HEMP), intentional electromagnetic interference (IEMI) and geomagnetically induced current (GIC) in modern power systems.

PS3: Insulation co-ordination and lightning interference analysis: challenges, opportunities and advances

- Overvoltage stress of future HVDC and HVAC transmission and distribution systems, including new characteristic waveforms.
- Advancements in lightning detection systems and lightning performance assessment methods including advanced data analytics of AC and DC high voltage, medium voltage, hybrid overhead lines and other exposed structures.
- Impact of extreme weather events, such as wind, fires, flooding, lightning, icing, snow, etc, on insulation co-ordination including practical solutions.

17.4 Current Working Groups and UK Members

SC C4 presently consists of some 44 active (J)WGs performing highly technical work aligned with its strategic fields. These WGs are composed of over 600+ individual technical experts from 60+ countries around the world, some serving in more than one WG. The number of active WGs by topic is as follows:

Number	Title (RAG Status)	UK Member

WG C4.36	Winter Lightning – Parameters & Engineering Consequences for Wind Turbines	
JWG C1/C4.36	Review of Large City & Metropolitan Area Power System Developments - New Generation, Grid & Information Technologies.	
JWG C4.40/CIRED	Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14	Emin, Zia Foster, Sarah Koo, Leong Thomas, Dave Djokic, Sasa Vujatovic, Davor
JWG C4.42/CIRED	Continuous assessment of low-order harmonic emissions from customer installations	Djokic, Sasa Moore, Fabian
WG C4.43	Lightning problems and lightning risk management for nuclear power plants	Siew, Wah-Hoon Knott, Robert
WG C4.44	EMC for Large Photovoltaic Systems	Siew, Wah-Hoon
JWG C1/C4.46	Optimizing power system resilience in future grid design	Panteli, Mathaios
WG C4.47	Power System Resilience (PSR WG)	Rapier, Aisling Panteli, Mathaios Skarvelis-Kazakos, Spyros Strbac, Goran Zhou, Yutian
WG C4.49	Multi-frequency stability of converter-based modern power systems	Mills, David Ding, Xiaoling Shore, Nigel Emin, Zia
WG C4.50	Evaluation of Transient Performance of Grounding Systems in Substations and Impact on Primary & Secondary System	Negi, Himanshu
WG C4.51	Connection of Railway Traction System to Power Network	Vujatovic, Davor-Convenor Emin, Zia Ghassemi, Forooz
JWG A1/C4.52	Wind generators and frequency-active power control of power systems	
JWG C4/A3.53	Application Effects of Low-Residual-Voltage Surge Arresters in Suppressing Overvoltages in UHV AC Systems	Haddad, Manu
WG C4.54	Protection of high voltage power network control electronics from the High-altitude Electromagnetic Pulse (HEMP)	Hoad, Richard
WG C4.55	EMC related very-fast transients in gas-insulated substations - EMI, measured characteristics, modelling and simulations	James, Jonathan Haddad, Manu
WG C4.57	Guidelines for the Estimation of Distribution OHL Lightning Performance and Application to Lightning Protection Design Scope	Haddad, Manu
JWG C4/C2.58/IEEE	Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems	Awadallah, Selma
WG C4.59	RT Lightning Protection of the Electricity Supply Systems of the Future	
WG C4.60	Generic EMT-Type Modelling of Inverter-Based Resources for Long Term Planning Studies	Li, Rui Vozikis, Dimitrios Nieto Calvo, Alejandro Larkins , Andrew Vaheeshan,Jeganathan Abiri Jahromi, Amir
WG C4.61	Lightning transient sensing, monitoring and application in electric power systems	Siew, Wah-Hoon
JWG B5/C4.61	Impact of Low Inertia Network on Protection and Control	Zhang, Ray - Convenor

JWG: C4/C2.62/IEEE	Review of Advancements in Synchrophasor Measurement Applications	Blair, Steven Clark, Stuart Simmons, Clarke Li, Yun Cowan, Ian L Shams, Negar
WG C4.63	Harmonic power quality standards and compliance verification – a comparative assessment and practical guide	Emin, Zia Shore, Nigel – Convenor Koo, Kah-Leong Pampana, Ramesh Blair, Steven Ghassemi, Forooz
WG C4.64	Application of Real-Time Digital Simulation in Power Systems	Ponnalagan. Bharath Wijesinghe, Sarath
WG C4.65	Specification, Validation and Application of Harmonic Models of Inverter Based Resources	Pampana, Ramesh Monteiro, Jose
WG C4.66	New concept for analysis of multiphase back-flashover phenomena of overhead transmission lines due to lightning	Nurashikin, Jamil
WG C4.67	Lightning Protection of Hybrid Overhead Lines	
WG C4.68	Electromagnetic Compatibility (EMC) issues in modern and future power systems	Ragusa, Antonella Frosinou, Asimina
WG C4.69	Quantifying the lightning response of tower-footing electrodes of overhead transmission lines: methods of measurement	Fabian Koehler
JWG B1/C4.69	Recommendations for the insulation coordination on AC cable systems	
WG C4.70	Application of space-based lightning detection in power systems	Fabian Koehler
WG C4.71	Small signal stability analysis in IBR dominated power system	Tatiana Assis Can Li
JWG C4/B4.72	Lightning and Switching Induced Electromagnetic Compatibility (EMC) issues in DC power systems and new emerging power electronics-based DC equipment	Oheidhin, Gearoid
JWG B4/B1/C4.73	Surge and extended overvoltage testing of HVDC Cable Systems	
JWG B2/C4.76	Lightning & Grounding Considerations for Overhead Line Rebuilding and Refurbishing Projects, AC and DC	
WG C4.73	Insulation Coordination of HVDC Overhead Lines	
WG C4.74	Accurate Line and Cable Models for Steady-State and Transient Studies	
JWGC4/A3/B2/B4.75	Guide to Procedures for the Creation of Pollution Maps Required for Outdoor Insulation Coordination	
WG C4.76	Protection in Switching Inductive Devices with Vacuum Circuit Breaker	
JWG B5/C4.79	Protection Roadmap for Low Inertia and Low Fault Current Networks	
JWG B4/C4.93	Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity System	Dechao Kong – Convenor Peng, Jinsheng
JWG B4/C4.97	Benchmarking of simulation Models for control interaction in meshed AC networks with multiple converters	

The number of the above-mentioned 44 active (J)WGs by topic is as follows:

- Power Systems Performance Models and Numerical Analysis (PMNA): 16 (J)WGs
- Power quality (PQ): 5 (J)WGs
- EMC/EMI: 5 (J)WGs
- Insulation Coordination (IC): 8 (J)WGs

- Lightning (L): 10 (J)WGs

17.5 New Working Groups

Following the 2022 Annual SC C4 6 **new WGs** were formed in SC C4 as listed below, while there is further work in progress to propose new WGs:

- **WG C4.73:** "Insulation Coordination of HVDC Overhead Lines"
- **JWG B5/C4.79:** "Protection Roadmap for Low Inertia and Low Fault Current Networks"
- **JWG B4/C4.93:** "Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity Systems"
- **WG C4.74:** "Accurate Line and Cable Models for Steady-State and Transient Studies"
- **JWG C4/A3/B2/B4.75**: "Guide to procedures for the creation of contamination maps required for outdoor insulation coordination"
- **JWG B4/C4.97:** "Benchmarking of simulation models for control interaction in meshed AC networks with multiple converters"

New working group proposals are welcome. Invitations for nominating new WG members will be circulated in due course once the Terms of References for any new WGs are finalised and accepted.

17.6 Technical Brochures

The following **Technical Brochures (TBs) have been published** since October 2022 as a result of work done by SC C4 WGs and JWGs:

- **TB-881: "**EMT simulation models for large-scale system impact studies in power systems having a high penetration of IBR", WG C4.56, 2022.
- **TB-885:** "Guide on Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low/Zero Inertia Generators", JWG A1/C4.66, 2022.
- **TB-900, TB-901, TB-902, TB-903, TB-904: "**High-frequency transformer and reactor models for network studies", JWG A2/C4.52, 2022 – UK C4 Members: Vujatovic Davor, Jamil Shakin.
- **TB909: "**Guidelines for Subsynchronous Oscillation Studies in Power Electronics Dominated Power Systems", JWG C4/B4.52, 2022 – UK C4 Members: Lapova Elisabetta, Pashaei Afshin.
- **TB913:** "Evaluation of Temporary Overvoltages in Power Systems due to Low Order Harmonic Resonances", WG C4.46, 2023 – UK C4 Members: Mills David, Munji Kiran, Peng Jinsheng.

The following **TBs are expected to be finalised** and submitted for publication in 2023/2024:

Already reviewed by SC C4. Waiting for final TB version:

- JWG C4.42/CIRED Continuous assessment of low-order harmonic emissions from customer installations
- JWG C4/A3.53 Advanced metal-oxide varistors for surge arresters with better protection properties
- JWG C4/C2.58/IEEE Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems
- WG C4.49 Wideband stability of grid-tied converter-based modern power systems

Draft TBs currently under review by SC C4:

- WG C4.59 Real-time Lightning Protection of the Electricity Supply Systems of the Future
- JWG B4/B1/C4.73 Surge and extended overvoltage testing of HVDC Cable Systems
- WG C4.61 Lightning transient sensing, monitoring and application in electric power systems

Draft TBs expected in Q3 or Q4 2023, to be reviewed by SC C4:

- WG C4.36 Winter Lightning - Parameters and Engineering Consequences for Wind Turbines
- WG C4.43 Lightning problems and lightning risk management for nuclear power plants
- WG C4.44 EMC for Large Photovoltaic Systems
- WG C4.47 Power System Resilience
- WG C4.50 Evaluation of Transient Performance of Grounding System in Substation and Its Influence on Secondary System
- WG C4.55 EMC-related very-fast transients in gas-insulated substations
- WG C4.60 Generic EMT-Type Modelling of IBR for Long Term Planning Studies
- JWG B5/C4.61 Impact of Low Inertia Network on Protection and Control
- JWG B2/C4.76 Lightning & Grounding Considerations for Overhead Line Rebuilding and Refurbishing Projects, AC and DC
- JWG C1/C4.46 Optimising power system resilience in future grid design
- JWG B1/C4.69 Recommendations for the insulation coordination on AC cable systems
- JWG C4/C2.58/IEEE Evaluation of Voltage Stability Assessment Methodologies in PS
- JWG A1/C4.66 “Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators”

SC C4 has also produced in **CIGRE Science & Engineering Journal (CSE)** since October 2022:

- **Best Of Papers CIGRE Paris 2022 Session** (January 2023 edition): “Taking advantage of grid- forming BESS behaviour during major outages: contribution to improve the share of renewable energy in French isolated power systems”, G. Santos Pereira, G. Prime, F. Benavent, J. Witkowski
- **CIGRE Thesis Award 2023** (June 2023 edition): “Impedance-Based Analysis for Power Electronics- Based Systems”, Y. LIAO
- **CSE-029**: “Weak Grid Analysis for Interconnecting Inverter-Based Generation – Ireland Case Study”, G. Misyris, D. Ramasubramanian, M. Val Escudero, T. Kërçi, s. Murray
- **CSE-028:** “Stability of inverter-based resource (IBR) dominated systems with different types of local loads”, P. Mitra, l. Sundaresh, D. Ramasubramanian
- **CSE-028:** “The impact of adoption of variable frequency drives on the bulk power system”, L. Sundaresh, P. Mitra, D. Ramasubramanian
- **CSE-028:** “Oscillatory Interaction Between Large Scale IBR and Synchronous Generators in the NEM”, E. Farahani, P. F. Mayer, J. Tan, F. Spescha, M. Gordon

SC C4 embarked on a new **Green Book** on “**Power system dynamic modelling and analysis in evolving networks**”, co-edited by Dr Babak Badrzadeh and Dr Zia Emin. Various chapters within the book will be led by SC C4 experts. It will:

- Provide information about all aspects of contemporary PS dynamic modelling and analysis Provide information about all aspects of contemporary power system dynamic modelling and analysis in a rapidly changing power system with increasing uptake of IBR.
- Provide a comparison of changes occurring between conventional power systems with the dominance of synchronous generators and an evolving power system with high share of grid-connected and distributed inverter-based resources in terms of dynamic phenomena experienced, analysis methods and simulation tools required, and enablers to achieve this.
- Describe different types of PS studies and associated analysis tools as the system evolves.
- Present modelling requirements for different PS components, both existing and emerging technologies, such that power system can be planned and operated securely and reliably.
- Present practical examples obtained from real power systems worldwide as a step-by-step study guide such that they can be applied by practicing engineers in their day-to-day tasks.
- Demonstrate the importance of PS model acceptance testing and validation by practical examples describing applications of various methods.

17.7 Last Study Committee Meeting (Highlights)

The 2023 Annual SC C4 Meeting was held online on Thursday, September 7, during the **CIGRE 2023 Symposium in Cairns, Australia**. Participants included SC C4 Regular Members, AG Members and WG Conveners. The meeting agenda covered, among others, the following:

- Review of SC C4 Membership & Structure
- Study Committee Chair's Report
    - The schedule and highlights of 2022-2023 TC meetings
    - The SAG-ET meetings and NC forums
    - CIGRE 2023 Strategic Plan
    - Statistical information related to WGs
    - The involvement of women in CIGRE
    - The structure of CIGRE Awards and how to nominate a person for a CIGRE Award; recent recipient (Yicheng Liao)
- Advisory Group 1 - Strategic Directions (SAG)
    - Summary of the membership and status of AG1 membership
    - Summary of the status of current WGs and JWGs
    - The Chair of SC B5, Rannveig Loken, presented details of the 2025 CIGRE Symposium to be held in Trondheim, Norway
    - Issues for convenors using the TB template were mentioned; AX said this would be followed-up.
    - Discussion regarding ideas for new WGs
- Advisory Group 2 - Customers (CAG)
    - SC C4 Task Force (TF) ToR in “Statistics on Power Quality (PQ)”
    - Upcoming activities were discussed (short videos, educational videos, PQ database, liaison with industry/academia).
- Advisory Group 3 - Tutorials & Conferences (TAG)
    - List of supported SC C4 events and gave an overview of tutorials, workshops, and webinars
    - Discussion on future supported events:
        - AU C4 event: BB gave overview; may include hybrid, GDM-style presentations
        - BR C4 event: AR gave overview; end of April 2024; focus on August 2023 blackout in Brazil
        - The 2025 Symposia (Israel and Norway).
- Publications

- Electra, CSE, Green Books, Reference Papers, Technical Brochures
- Plan-ahead: TBs close to being finalised

- TB Review Process
  - List of TBs expected before end of 2023.
  - Chair highlighted for SC members to delegate reviews in their NCs. Advance notice of TB review schedule.
- Next SC C4 Meetings

CIGRE Session 2024 in Paris, France

17.8 Technical Panel Meetings, Seminars & Tutorials

Past Events: Since August 2022, SC C4 has supported the following events:

CIGRE 2022 Paris Session: As part of the CIGRE 2022 Paris Session that was held from Sunday 28 August 2022 to Friday, 2 September 2022, SC C4 had a Group Discussion Meeting on Thursday September 1st, 2022,a Paper Session, as well as a Workshop and a Tutorial event described below:

- **The SC C4 Group Discussion and Paper Session:** SC C4 selected **59 papers** aligning with the **3 Preferential Subjects (PS)** for the 2022 CIGRE Session. 2 out of the 59 selected papers were submitted as part of Next Generation Network Young Member showcase competition.
- **The SC C4 Workshop** entitled: JWG C4/B4.52 and WG C4.49 – "Oscillatory instabilities and interactions in inverter based resource (IBR) dominated power systems", August 30, 2022.
- **The SC C4 Tutorial** entitled: WG C4.46 – "Evaluation of Temporary Overvoltages in Power Systems due to Low Order Harmonic Resonances", August 27, 2022.

CIGRE 2023 Symposium: Cairns (Australia): "Renewables and challenges of integration and the impact of renewable generation on the Grid", September 2023. It comprised of:

- **9 paper sessions** with **46 selected Papers** and **45 Presentations.**
- **The SC C4 Workshop** entitled: WG C4.56, WG C4.71 and JWG A1/C4.52 – "Modelling and analysis of new and emerging forms of system stability".

CIGRE 2023 International Colloquium: Sendai (Japan): "Recent Overhead Transmission Line Technology and Environmental Measures", International Colloquium SC B2/C/C4, October 2023. It included **9 submitted Papers** and the following **2 Tutorials**:

- **Tutorial 1** entitled: WG C4.59 – "Real-time Lightning Protection of the Electricity Supply Systems of the Future".
- **Tutorial 2** entitled: JWG C4/A3.53 – "Advanced metal-oxide varistors for surge arresters with better protection properties

CIGRE 2023 International Colloquium ICLPS-CIPDA: Suzhou (China): "International Colloquium on Lightning and Power Systems (ICLPS)", October 2023.

CIGRE ACADEMY Webinars:

- WG C4.56 – "EMT simulation models for large-scale system impact studies in power systems with high IBR penetration", Babak Badrzadeh, Jean Mahseredjian, Sorrell Grogan
- "Modeling and Analysis of Power Networks with High Percentage of Inverter Resources", Deepak Ramasubramanian
- WG C4.46 – "Evaluation of Temporary Overvoltages in Power Systems due to Low Order Harmonic Resonances" Filipe Miguel Faria da Silva, Konstantinos Velitsikakis, Oscar Lennerhag, Chris Liberty Skovgaard, Julien Michel
- JWG C4/B4.52 – "Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems", Chandana Karawita (CA)

Future Events: Below are the upcoming events supported by the CIGRE SC C4, in terms of planned Meetings, Seminars, and Tutorials:

CIGRE 2024 Paris Session, France, 25-30 August 2024

CIGRE 2025 Symposium Tel Aviv (Israel), April-May 2025:

CIGRE 2025 Symposium Trondheim (Norway) – "Changes needed in the power system - For the energy transition", 22-25 September2025.

17.9 UK SC C4 Technical Panel Members and Meeting

The 2022 CIGRE UK Study Committee C4 Technical Panel Liaison Meeting held in conjunction with the CIGRE UK SC C4 Technical Event entitled "**Developments in Modelling Methods and Study Tools for the Analysis of the Transforming Power System".** This online event was held on December 7th and was chaired by SC C4 UK Regular Member, Spyros Karamitsos. It aimed to bring together experts from industry and academia to present issues of the transforming power systems and discuss developments in modelling methods and study tools for further analysis. It also provided a high-level overview of the ongoing activities in CIGRE related to SC C4. Technical Brochures published in the last year were highlighted, along with a status update on the active SC C4 Working Groups where the UK has an interest. Special mention was made to the work items approved by the C4 Study Committee during the CIGRE 2022 Paris Session. The 2022 CIGRE UK Event's Agenda is shown below:

AGENDA	CIGRE UK SC-C4 Liaison Meeting & Technical Event 2022 Developments in Modelling Methods and Study Tools for the Analysis of the Transforming Power System	
Time	**Topic**	**Presenter**
13:00	Welcome from the UK Regular Member & Introduction to SC C4. Brief Overview of SC C4 Works and Updates, incl. Paris Session 2022	Dr Spyros Karamitsos, Grid Compliance and System Studies Manager at Scottish Power / Iberdrola (SPR/IBR), CIGRE SC C4 Elected Regular Member for the UK
13:15	Works of the CIGRE JWG C4/B4.52: "Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems"	Dr Afshin Pashaei, Power Quality & Dynamic Performance Manager at National Grid UK Member of the CIGRE WG C4/B4.52
13:30	Works of the CIGRE WG C4.56 and the resulted Technical Brochure TB 881 (2022): "Electromagnetic Transient Simulation Models for Large-Scale System Impact Studies in Power Systems having a High Penetration of Inverter-Connected Generation"	Sridhar Sahukari, Senior Lead Power Systems Specialist at Ørsted, UK Member of the CIGRE WG C4.56
14:00 - 14:15	Q&A - Break	
14:15	Innovation Projects and Tools for Accelerating the Power System Transformation towards Renewable Energy	Ben Marshall, HVDC Technology Manager at The National HVDC Centre, UK Member of the CIGRE WG B4.81
14:45	Practical Transition into Wider EMT Modelling: "Example of Large-Scale Great Britain Network with High Penetration of IBRs"	Dr Dharshana Muthumuni, Managing Director at Manitoba HVDC Research Centre Dr Yousef Pipelzadeh, Director of European Operations at Manitoba Hydro International (MHI)
15:15 - 15:30	Q&A - Break	
15:30	Overview of TB 851 (2021): "Impact of High Penetration of IBR on System Inertia of Networks" NG ESO NIA Project: "A Probabilistic Approach to Stability Analysis for Boundary Transfer Capability Assessment"	Dr Diptargha Chakravorty, Principal Consultant at TNEI, UK Member of the CIGRE JWG C2/C4.41
16:00	Works of the CIGRE WG C4.64: "Application of Real-Time Digital Simulation in Power Systems" CIGRE 2022 PARIS SESSION PAPER SC C4-PS3-10205: "Real Time Simulation and Demonstration of Black Start on Transmission Networks using Embedded Synchronous Generators"	Bharath Ponnalagan, Offshore Wind HVDC Engineering Manager at Energie Baden-Württemberg AG (EnBW), UK Member at the CIGRE WG C4.64
16:30 - 16:45	Q&A - Closing Remarks	

The UK SC C4 technical panel to be confirmed for 2023-2024. The goal will be to organise a CIGRE UK SC C4 Technical Panel and hold a successful CIGRE UK SC C4 Liaison Meeting and Technical Event including a (J)WG Update Session and invite Keynote and Guest Speakers from industry, utilities, and academia to maintain member engagement. This CIGRE UK Event's Agenda will also include updates on the Technical Brochures published in the last year, along with a status update on the active SC C4 Working Groups where the UK has an interest as well as latest work items approved by the C4 Study Committee during the Cairns 2023 Symposium and possible work items that could be proposed in the future.

18 RM Report on SC C5 Electricity Markets and Regulation

No information was provided by the Regular Member by the time the report is written.

19 RM Report on SC C6 Active Distribution Systems and Distributed Energy Resources

19.1 Study Committee Scope

SC Chair: Kurt Dedekind
SC Secretary: *Evert de Haan*
Communications Officer: *Harry Evans*

Mission: Assessment of the technical impacts resulting from a more widespread adoption of DER applications on planning and operation and on approaches, and of enabling technologies and innovative solutions for DER integration in active distribution systems.

Areas of attention include:

- Enabling technologies for renewable and distributed energy resource integration and application: active network management, microgrids, virtual power plants, distribution management systems (DMS, ADMS, DERMS), DER monitoring and control, aggregation systems and platforms, block-chain applications.
- Innovative solutions for DER and distribution technology deployment: smart inverters and power electronic interfaces, interconnection and integration requirements, MV/LV DC supply systems, distribution system modernization.
- Storage technologies: deployment of various storage technologies such as electrochemical electric battery energy storage systems, flywheels, flow batteries, and new storage
- Multi-energy solutions (including thermal storage), Power2X applications (including power to heat, power to gas), electric vehicles.Enabling technologies: active network management, micro-grids, virtual power plants, distribution management systems (ADMS, DERMS), DER monitoring and control, aggregation systems, platforms, block-chain applications.
- New approaches to configure new distribution systems for enhanced reliability and resilience: islandable grid connected microgrids, power exchange between microgrids.
- New approaches to determine the impact and plan and operate distribution systems in the context of a wide deployment of DER, including the analysis of hosting capacity and protection
- Consumer integration and empowerment: demand side integration and participation, demand response, load management, smart load, new customer sectors such as electric vehicles, smart home and smart meter applications with impact on distribution systems.
- Smart cities: integrated distribution system technologies, power, control, and information and communication technology deployment for flexibility, integration of multi-energy systems.
- Rural Electrification: islanded power systems and individual customer off-grid systems, new solutions, weak grid connected systems

19.2 Preferential Subjects (Paris 2024)

Preferential Subject 1: ***Flexibility Management in Distribution Networks***

- Energy storage systems with the associated provision of their grid services
- Evolving planning and operational objectives and criteria with increased electrification, coupled with the changes in end-to-end technology behaviours
- Electric Vehicle integration and impacts

Preferential Subject 2: ***Power electronic based solutions for Smart Distribution Systems***

- Evaluating and quantifying the added value of smart invertor and convertor functions and their integration into Distribution Networks.
- Case Studies of DC and DC/ AC hybrid grid solutions for the future
- Provision of ancillary services for Distribution and upstream networks

Preferential Subject 3: ***Rural, islanded and industrial electrification standards, practices and technology options.***

- Microgrid and multi-microgrid installations

- Off-grid and island DER applications including appropriate resilience measures
- Applications highlighting the interface between technical and non-technical aspects for rural electrification

Receiving a record number of abstracts submitted to SC C6 (94 in total)
A very high percentage of abstracts have been accepted.
Sincere thanks to all the C6 and National Committee reviewers.
Authors will be hearing via email on whether their abstract was accepted last/this week.
The final paper submission deadline is the 6th February 2024.

19.3 Technical Panel Meetings, Seminars & Tutorials

- C6 Study Committee Meeting 2023 – Thursday 7 September 2023, Cairns, Australia + online
- CIGRE symposium in Muscat, Oman
- CIRED conference in Italy, Rome
- WG C6.36 Tutorial was hosted virtually on the 27th of September
- WG C6.47 kicked off technical activities at the Cairns Symposium

19.4 New Working Groups

Number	Title	UK Member
WG C6.47	DSO-customer interfaces for efficient system operation	Working with the Convenor Daniel Eghbal (Australia) , UK Committee, and CIGRE Women in Energy UK to promote and select UK members.
WG C6.46	Energy Efficiency in Distribution systems	Convenor Aradhna Pandarum (SOUTH AFRICA), to promote and recruit members.

19.5 Current Working Groups and UK Members

Number	Title	UK Member
JWG C6/C2.34	"Flexibility provision from distributed energy resources"	Milana Plecas (SP Energy Networks)
WG C6.35	"DER aggregation platforms for the provision of flexibility services"	Geev Mokryani (University of Bradford)
WG C6.39	"Customer empowerment"	
WG C6.40	Electric Vehicles as Distributed Energy Resource (DER) systems	Adam Maloyd, WSP
WG C6.42	Electric Transportation Energy Supply Systems	Maurizio Albano (new Convenor), Liana Cipcigan, Jhan Chan, Preye Ivry, Harry Evans (NGN),
WG C6.43	Aggregation of battery energy storage and distributed energy resources (DER), including solar PV	
WG C6.44	Nodal Value of Distributed Renewable Energy Generation	Geev Mokryani (University of Bradford)
WG C6.45	The Impact of Distributed Energy Resources (DER) on the Resilience of Distribution Networks	Shota Omi, Daniel Donaldson (NGN)
WG C6.46	Energy Efficiency in Distribution systems	
WG C6.47	DSO-customer interfaces for efficient system operation	
JWG D2/C6.47	"Advanced consumer side energy resource management systems"	James King (Nortech Management Limited)

19.6 Status of on-going SC C6 WGs

- JWG C6/C2.34 – Flexibility provision from distributed energy resources : to finish before the 2024 Paris Session and that some support for finalising the works would be welcomed.

- C6.35 – Distributed energy resources aggregation platforms for the provision of flexibility services No update is available at this point in time.
- C6.36 – Distributed Energy Resource Models for Impact Assessment The working group has completed their Technical Brochure (TB906), titled “Distributed Energy Resource Benchmark Models for Quasi-Static Time-Series Power Flow Simulations” (download link). An Electra article was included in the August issue. On Wednesday 27 September 2023 from 5:00 PM until 6:00 PM CEST, they will host their tutorial (registration link). So far around 400 people have accepted the invite. For those who are unable to attend, the tutorial will be recorded.
- C6.39 – Distribution Customer Empowerment: Current convenor has been unable to contribute to the working group recently. He will not be able to contribute before January 2024 either. It is felt that transferring responsibilities to a new convenor is a step backwards. We accept the further delay and value Michael’s input from 2024 going forward. There could be a relation between this working group and C6.47. but C6.47 is more focused on the technical side of things (communication interfaces and technologies), whereas C6.36 is more focused on behavioural aspects.
- C6.40 – Electric Vehicles as Distributed Energy Resource (DER) systems The working group will soon complete the technical brochure. An Electra article will be drafted as well. Before the 2024 Paris Session, the working group will be finished.
- C6.42 – Electric Transportation Energy Supply Systems Since Paris last year, unfortunately there has not been much progress in this working group’s work. It is hoped that by handing over the convenor role to Dr. Maurizio Albano, more progress will be made. Dr. Albano will be the fourth convenor of this working group.
- Christine Schwaegerl suggests that this working group may not work towards a technical brochure, but rather an Electra article and that we consider closing the working group afterwards. Albeit a very good suggestion, we will first see how the new convenor may spark progress before deciding on changing the working group’s scope.
- C6.43 – Aggregation of battery energy storage and distributed energy resources (DER), including solar PV The working group is finishing their draft technical brochure. It is expected that the final draft will be circulated for C6 to review within two weeks time. This working group’s work has been suggested for a tutorial at the 2024 Paris Session. In previous years, there has been some great interest in tutorials on storage.
- C6.44 – Nodal Value of Distributed Renewable Energy Generation It is expected that the working group will finish their technical brochure by the 2024 Paris session. This could potentially be a tutorial topic as well.
- C6.45 – The Impact of DER on the Resilience of Distribution Networks The working group wants to start the first drafting of the technical brochure. However, there has been limited interest in editing thus far. So support in this area is welcomed.
- C6.46 – Energy Efficiency in Distribution systems The kick-off meeting is to take place soon. NGN support in a secretary role is welcomed. The IEA is also publishing reports on energy efficiency. The scope of this working group is different, though. It is mainly related to the distribution systems and how planning and standards might change when energy efficiency measures are put in place.
- C6.47 – DSO-customer interfaces for efficient system operation The presentations during this conference have only confirmed the relevance of this working group. Daniel Eghbal will soon have a virtual kick-off with all interested parties.

19.7 SC C6 Strategy

The current version of the C6 strategy document was drafted by Christine Schwaegerl and Geza Joos in 2018. An update of this strategy document is currently being drafted. The strategy is an outlook for the next five to ten years to come. The draft update of the C6 strategy does incorporate the strategic directions as set out by the Central Office.
The idea is to have the document reviewed in various phases, to start with the strategy group and begin shared with a wider audience thereafter. Hopefully sharing it with the C6 members can be done in three to four months time.

20 RM Report on SC D1 Materials and Emerging Test Techniques

20.1 Study Committee Scope

SC Chair: Simon Sutton (UK)
SC Secretary: Gordon Wilson (UK)
UK RM: Thomas Andritsch
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

20.2 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))

20.3 Draft Preferential Subjects

The Preferential Subjects for 2024 Paris Session are:

PS 1 Testing, Monitoring and Diagnostics

- Testing and condition monitoring for reliability in conventional high voltage systems and power electronics applications.
- Assessment of diagnostics for equipment in remote or inaccessible locations.
- PD measurement under DC, rectifier, and impulse stress.

PS 2 Materials for electrotechnical purposes and modelling

- Ageing of materials under electrical, mechanical or thermal stresses and ageing markers.
- Modelling materials and field simulations for AC and DC applications.
- Assessment of compatibility of aged and new materials resulting from refurbishment or life extending activities.

PS 3 Materials to enable the energy transition

- Alternative electrotechnical materials or manufacturing processes which reduce environmental footprint.
- Materials and systems for energy storage; batteries, charging devices, capacitors etc.
- Materials to enable a hydrogen economy.

20.4 New Working Groups

Number	Title	UK Member
D1.78	Partial discharge properties of non-SF6 insulating gases and gas mixtures	Fraser Cook
D1.81	Methods and common data file format for Time-Domain Reflectometry	TBC
D1/A2.79	Improved understanding of dynamic behaviour of winding insulating materials in liquid insulated power transformers	TBC
D1/A2.80	Functional properties of non-metallic solid materials for liquid filled transformers and reactors and their compatibility with insulating liquids	TBC

20.5 Technical Panel Meetings, Seminars & Tutorials

Two UK liaison meetings were held in the last twelve months:

- 03/10/23 – Joint B1/D1 meeting.
- 17/01/23 – Joint A2/D1 meeting.

Both events were attended by 40+ people.

20.6 Technical Brochures

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

- TB894 Basic principles and practical methods to measure the AC and DC resistance of conductors of power cables
- TB888 Atmospheric and altitude correction factors for air gaps and clean insulators

20.7 Last Study Committee Meeting (Highlights)

- Held at the International Symposium in Cairns, Australia.
- The theme for the Symposium is The End to End Electricity System: transition, development and integration. The call for papers asked for submissions according to the following topic streams:
    1. Learning from experiences. What can we draw from past experience to develop the power system?
    2. Developing practices, functionalities and applications. What are the current developments and their application to the future power system?
    3. Towards a sustainable power system. What are the future needs and requirements of the power system?
- Next meeting will be held in Paris in August 2024.

20.8 Current Working Groups and UK Members

Number	Title	UK Member
D1.50	Atmospheric and altitude correction factors of air gaps and clean insulators	
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	Sean Lewington

Number	Title	UK Member
D1.63	Partial discharge detection under DC stress	Malcolm Seltzer-Grant Ian Cotton
D1.65	Mechanical properties of insulating materials and insulated conductors for oil insulated power transformers	
D1.66	Requirements for partial discharge monitoring systems for gas insulated systems	Graeme Coapes (NGN) Fraser Cook Carl Johnstone
D1.68	Natural and synthetic esters - Evaluation of the performance under fire and the impact on environment	Russell Martin
D1.69	Guidelines for test techniques of High Temperature Superconducting (HTS) systems	Bartek A. Glowacki
D1.70	Functional properties of modern insulating liquids for transformers+	Qiang Liu Attila Gyore Zhongdong Wang
D1.72	Test of material resistance against surface arcing under DC	Simon Rowland (left)
D1.73	Nanostructured dielectrics: Multi-functionality at the service of the electric power industry	Raed Ayoob Thomas Andritsch
D1.74	Partial discharge measurement on insulation systems stressed from HV power electronics	
D1.76	Tests for verification of quality and ageing performance of cellulose insulation for power transformers	Attila Gyore Richard Heywood Qiang Liu Mike Munro Shanika Matharage Gordon Wilson
D1.78	Partial discharge properties of non-SF6 insulating gases and gas mixtures	Fraser Cook Graeme Coapes (NGN)
D1.81	Methods and common data file format for Time-Domain Reflectometry	TBC
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	Thomas Andritsch
D1/B1.75	Strategies and tools for corrosion prevention for cable systems	
D1/A2.77	Liquid Tests for Electrical Equipment	Gordon Wilson Russel Martin Attila Gyore Dave Walker Qiang Liu
A2/D1.66	Breathing systems of liquid filled transformers and reactors	
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/D1.67	Guideline for online dissolved gas analysis monitoring	
D1/A2.79	Improved understanding of dynamic behaviour of winding insulating materials in liquid insulated power transformers	TBC
D1/A2.80	Functional properties of non-metallic solid materials for liquid filled transformers and reactors and their compatibility with insulating liquids	TBC

+D1.70 has delivered TB856 but is still running, and will deliver more TBs in future.

20.9 UK Members of the Technical Panel

There is no UK Technical Panel for D1.

21 RM Report on SC D2 Information Systems & Telecommunication

21.1 Study Committee Scope

SC Chair: Mr Victor Tan (AU)
SC Secretary: Mr Joël Nouard (FR)

The scope of SC D2 is to cover all aspects in relation to the use of Information, Telecommunication and Telecontrol systems in the Electric Power Industry (EPI), both for operational and business activities.

SC D2 mission is:

- To facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of information systems and telecommunications for power systems;
- To add value to this information and knowledge by means of synthesizing state-of-the-art practices and proposing recommendations.

21.2 Strategic Advisory Groups

- AG D2.01: Core business information systems and services – Marcelo Aroujo (Brazil)
  This advisory group is ITS user oriented. It monitors the needs and the stakes of the users in their core business which is linked with ITS like Telecontrol, asset management, customer relationship etc.
- AG D2.02: Cybersecurity techniques and technologies – Giovanna Dondossola (Italy)
  This Advisory Group fosters the adoption of specialized cybersecurity measures to protect Operational Systems
- AG D2.03: Telecommunication networks, services and technology – Zwelandile Mbebe (South Africa)
  This Advisory group focuses on pure telecommunication issues like transmission media, protocols, network architecture, service provision, etc.

21.3 Preferential Subjects for 2024 Paris Session

PS 1: IT/OT solutions to improve the efficiency and resilience of electric power systems:

- IoT architectures and applications in physical asset management
- Applications and Platforms of Artificial Intelligence, Big data and Analytics in operation and maintenance
- Technical challenges in the development of digital twins in operation and maintenance of power systems and DERs
- Business Continuity Architectures in the Cloud

PS 2: Cybersecurity in emerging application domains and technologies for securing energy organisations:

- Cybersecurity for DER and microgrid control infrastructures
- Cybersecurity for Energy Communities' digitalization
- Cybersecurity for Electric Vehicle charging and discharging control
- Cybersecurity in cloud-based applications of EPUs

PS 3: Meeting the challenges of energy transition with reliable, scalable, and efficient telecommunications networks:

- Building scalable and resilient networks with management, automation and orchestration solutions and methods.
- Integration of current and new wireless technologies in meeting the requirements of power utility applications.
- Techniques and methods in building resilient networks to support critical utility applications

21.4 New Working Groups

Proposals and ideas:

- Cybersecurity of Energy Operators Supply Chain – ToR drafted
- An assessment of EPU digital certificate management schemes – ToR drafted

Approved in 2023:

Number	Title	UK Member/Status
D2.58	Monitoring, maintenance and control of packet networks & services − From situational awareness to network control	Approved

21.5 Technical Panel Meetings, Seminars & Tutorials

- One day conference: “Data Science and Next Generation Communications in Electricity Networks, 30/06/2023, London.

- Cairns Symposium 04 – 07/09/2023, Australia. Theme: “The End to End electricity system: transition, development, operation and integration” - Including the Tutorial by JWG B5/D2.67 “Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods”

- Webinar: Improve operations with AI/ML Powered Analytics, 20/09/2023

Future events planned for 2023/24:

- Webinar: AI/ML applied to power systems

- D2 one day conference – spring 2024, details tbc

- CIGRE Paris session 25/08 – 30/08/2024, Paris, France.

21.6 Technical Brochures and Publications

During the last year the following key documents from Study Committee D2 were published:

- TB 892: Data Management

Previous publications:

- TB 884: Time in Communications networks, Protection and Control applications
- TB 866: Enabling Software Defined Networking for electric power utilities
- TB 840: Cyber Security for Contingency Operations
- TB 796: Cyber security – future threats
- TB 746 Design, Deployment and Maintenance of Optical Cables associated to Overhead HV Transmission Lines.

21.7 Last Study Committee Meeting Highlights

During the last SC meeting as part of the 2023 Cairns Symposium an overview of key topics from country reports was discussed:

- Successful deployment of AI/ML across asset management, cyber security, system monitoring etc.
- Leveraging digitalisation and digital tools to improve system performance and processes
- How to embed cyber security in a range of applications such as DER, EV charging infrastructure, supply chain, quantum safe encryption, data diodes, SDN, Big Data, IoT, M2M, 5G, encryption and key management, cyber physical threat modelling and detection.
- Migration from SDH networks to packet switched networks such as MPLS-TP / MPLS-IP / SD WAN
- Communication links for inter substation SV and GOOSE
- Adoption of 5G technology for OT applications

In 2023/24 the SC D2 aims to focus on the following objectives:

- Webinars potential topics to be proposed:
  - Time synchronisation
  - Teleprotection over packet networks
  - Work from other WGs nearing completion
- Country-in-focus in newsletter every 2-3 months

Note: New members to Strategic Advisory Groups as well as new and ongoing working groups are welcome – please contact your RM.

21.8 Current Working Groups and UK Members

UK membership is currently reviewed – current records indicate the following:

WG	WG Title	WG Convenor GB representative
WG D2.58	Monitoring, Maintenance and Control of Packet Networks & Services – From Situational Awareness to Network Control	Bongani Shezi (South Africa) Carlos Diago (GE Vernova) James Milsom (NGET)
WG D2.57	CIM (Common Information Model) Methodology	Roman Bogomolov (RU) Siva Kaviya, Trichy Siva Raman (NG ESO) / Gareth Taylor (Brunel)
WG D2.56	Interdependence and Security of Cyber-Physical Power System	QINGLAI GUO (CN) Wentao Zhu (GB)
WG D2.55	Application of 5G Technology to Smart Grids	KUNLUN GAO (CN) Lin Jiang (GB)
WG D2.54	Regulatory approaches to enhance EPU's cybersecurity frameworks	Tbc. Mohammed Zumla (GB)
WG D2.53	Technology and Applications of Internet of Things in Power Systems	ZHENGYUN SUN Ester Hwang (GB)
WG D2.52	Artificial Intelligence Application and Technology in Power Industry	KUNLUN GAO (CN) Fraser Cook / Giulio Riccardi (GB)
WG D2.51	Implementation of Security Operations Centers (SOC) in Electric Power Industry as Part of Situational Awareness System	V. KARANTAEV (RU) Shimeh Jahangiri / Gareth Taylor (GB)
WG D2.49	Augmented reality / Virtual reality to support Operation and Maintenance In Electric Power Utilities	S. H. KHALAJ (IR) Douglas Gray / Richard Moore (GB)

WG	WG Title	WG Convenor GB representative
JWG B2/D2.72	Condition monitoring and remote sensing of overhead lines	Y. Chen (CN) / A.KULKARNI (GB)
JWG D2/C2.48	Enhanced information and data exchange to enable future transmission and distribution interoperability	G. TAYLOR (GB)
		Rui Zhang (GB)
JWG D2/C6.47	Advanced consumer side energy resource management systems	A.A NEBERA (RU)
		James King / Spyros Skarvelis-Kazakos (GB)
JWG B5/D2.67	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods	Qiaoyin YANG (CN)
WG D2.45	Impact of governance regulations and constraints EPU sensitive data distribution and location of data storage	H. KLIMA (AT)
WG D2.44	Usage of public or private wireless communication infrastructures for monitoring and maintenance of grid assets and facilities	P. MULVEY (IE)
JWG A2/D2.65	Transformer Digital Twin – concept and future perspectives	P. Picher (CA)
JWG B3/D2.62	Life-long Supervision and Management of Substations by use of Sensors, Mobile Devices, Information and Communication Technologies	N. Fantana (DE)

21.9 UK Members of the Technical Panel

UK D2 Technical Panel Chair: Thomas Charton
UK D2 Technical Panel Secretary: Jianing Li
D2/B5 liaison officer: Gareth Taylor