



TECHNICAL COMMITTEE REPORT

2021

Report Date: November 2021

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Ronan Jamieson	SC C2 UK Regular Member
Josie Turner	SC C3 UK Regular Member
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1 Introduction

This report summarises CIGRE UK Technical Committee (UK TC) related work conducted over the 2021 and its intended recipients are the CIGRE UK National Committee 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 and Session Papers. Technical Panels is a rather new concept for CIGRE UK and 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 brief update from each Regular Member (RM) representing UK in the international Study Committees.

CIGRE UK TC has a dedicated 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 this 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 provide 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.

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://cigregrups.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 Chairs to the UK TC meetings. CIGRE UK TC meets twice annually and teleconference in the meantime in necessary.

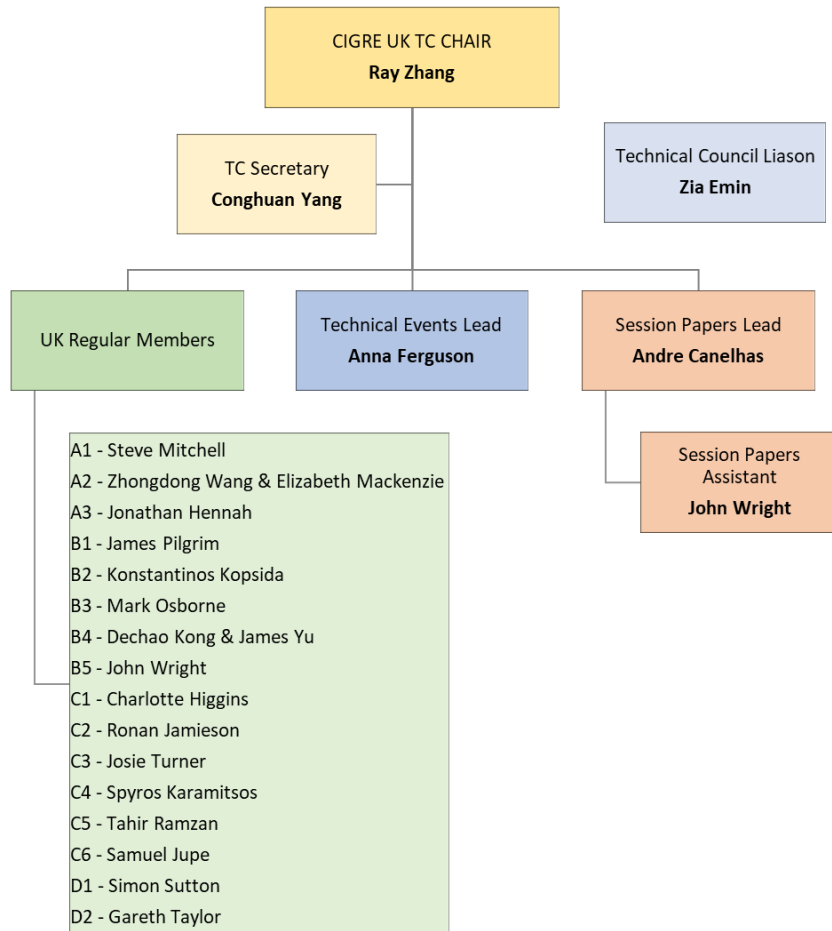


Figure 1: CIGRE UK TC structure

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	Email
A1	Steve Mitchell	stevejamesmitchell@msn.com
A2	Zhongdong Wang	Zhongdong.Wang@exeter.ac.uk
A2	Elizabeth Mackenzie	elizabeth.a.mackenzie@btinternet.com
A3	Jonathan Hennah	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	Charlotte Higgins	charlotte.higgins@tneigroup.com
C2	Ronan Jamieson	Ronan.Jamieson@nationalgrideso.com
C3	Josie Turner	josie.turner@nationalgrid.com
C4	Spyros Karamitsos	spyroskara@hvdctech.com
C5	Tahir Ramzan	tahir.ramzan@live.co.uk
C6	Samuel Jupe	samuel.jupe@nortechonline.co.uk
D1	Simon Sutton	simon.j.sutton@gmail.com
D2	Gareth Taylor	Gareth.Taylor@brunel.ac.uk

3 CIGRE-UK Technical Events

3.1 Introduction

CIGRE-UK has organized seven Technical Liaison Meetings, nine webinars and many other events in 2021. The active support of RM's, NGN and the wider CIGRE community has been greatly appreciated.

3.2 Technical Liaison Meetings 2021

CIGRE UK A2/D1 Liaison Meeting

14th January 2021

The purpose of the meeting was to provide a high-level 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 (Materials and emerging Test Techniques) led by UK Regular Member, Simon Sutton. Technical Brochures published in the last year were highlighted, along with a status update on all of the active Working Groups where the UK has an interest. The meeting also discussed the latest new work items approved by the Study Committees during the Paris e-session, and to provide feedback on possible future work items that could be proposed in the future.

CIGRE UK C4 Liaison Meeting & Technical Event

25th February 2021

This CIGRE UK Study Committee C4 Technical Event held in conjunction with the C4 Liaison Meeting aimed to bring together experts from industry and academia to present certain issues and discuss developments towards facilitating the integration of renewable energy and the transformation of the power system into a future converter dominated grid.

The purpose of the SC C4 Liaison Meeting was to provide a high-level overview of the ongoing activities in CIGRE related to C4 (Power System Technical Performance) led by UK Regular Member, Spyros Karamitsos. 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. The meeting also discussed the latest work items approved by the C4 Study Committee during the Paris e-session and possible work items that could be proposed in the future.

List of Speakers	
Assessments of Conducted Disturbances above 2 kHz in MV and LV Power Systems	Prof. Dave Thomas
Challenges and Opportunities Towards Resilient Power Systems: An Overview by the CIGRE C4.47 and an Introduction to JWG C1/C4.46	Dr Mathaios Panteli
Characteristics of Converter Dominated Power Grids - Integrating OWFs	Dr Spyros Karamitsos
Power Electronics Based Devices in the Grid and System Studies	Dr Afshin Pashaei
Introduction to TOTEM (Transmission Owner Tools for EMT Modelling)	Dr Ryan Tumilty
Changes in the Characteristics of the SP Transmission Network, the Phoenix H-Sc Project and the Future Role of Synchronous and Hybrid Synchronous Compensation	Prof Cornel Brozio
BlackStart Project: Experience of using a Wind Farm to Energise Part of the Transmission Network	Dr Paul Crolla & Dr Isaac Guitierrez
National HVDC Centre; Project Related De-Risking and Interoperability Research	Ben Marshall
Online system Strength and Inertia Monitoring	Brian Berry & Dr Daniel Gheorghe

CIGRE UK B4 Liaison Meeting – DC system and power electronics

28th April 2021

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 Member Dechao

Kong. Technical Brochures published in the last year will be highlighted, along with a status update on all of the active Working Groups where the UK has an interest. The meeting also discussed the latest new work items approved by the Study Committees during the Paris e-session, and to provide feedback on possible future work items that could be proposed in the future.

CIGRE UK C1 Liaison Meeting

29th June 2021

The purpose of the meeting was to provide a high-level overview of the ongoing activities in CIGRE related to Study Committees C1 (Power Systems Development & Economics) led by UK Regular Member Charlotte Higgins. Technical Brochures published in the last year will be highlighted, along with a status update on all of the active Working Groups where the UK has an interest. The meeting also discussed the latest new work items approved by the Study Committees during the Paris e-session, and to provide feedback on possible future work items that could be proposed in the future.

List of Speakers	
Rethinking resilience for a Net-Zero future	Dr Graeme Hawker (University of Strathclyde)
Offshore Coordination Project Update	Alice Etheridge (National Grid ESO)
C1/C6.37 Optimal Transmission and Distribution Investment Decisions under Increasing Energy Scenario Uncertainty	Dr Geev Mokryani (University of Bradford)
C1.40 Planning Co-ordination between System Operators, Transmitters and Distributors	Dr Laura Kane (Smarter Grid Solutions)
C1.41 Closing the gap in understanding between stakeholders and electrical energy specialists	Dr Sami Abdelrahman (National Grid ESO)
C1/C6.42 Planning tools and methods for systems facing high levels of distributed energy resources	Dr Charlotte Higgins (Arup)
C6/C1.33 Multi-energy system interactions in distribution grid	Dr Eduardo Martinez- Cesena (University of Manchester)
C1.45 Harmonised metrics and consistent methodology for benefits assessment in CBA of electric interconnection project	Ninad Lale (European Bank for Reconstruction & Development), Rohit Trivedi (International Energy Research Centre)
C4.47 Power System Resilience C1/C4.46 Optimising power system resilience in future grid design	Dr Mathaios Panteli (University of Cyprus)
C1.47 Energy Sectors Integration and impact on power grids	Polly Osborne (Burns McDonnell)
C1.48 Role of green hydrogen in energy transition - Opportunities and challenges from technical and economic perspectives	Callum Dell (WSP)
C1 study committee updates	Dr Charlotte Higgins (Arup)
A Whole Energy System Study - The Glasgow Energy Operator	Dr Graeme Hawker (University of Strathclyde)
Whole System Coordination in Network Planning	Dr Charlotte Higgins (Arup)
The impact of Reduced System Inertia on System Planning and HVDC Interconnection	Dr Waqqas Bukhsh (University of Strathclyde)

CIGRE UK B1 New Work Update

24th September 2021

In August each year the B1 Study Committee meets to review the progress of existing Working Groups and Task Forces, and to discuss which topics related to insulated cable systems will be the focus of new work in the coming years. In this meeting, the B1 Regular Member for the UK, James Pilgrim, provided an update on key decisions taken at the August 2021 Study Committee meeting, including a preview of which new working groups might be launched in the 2022 year and a quick look ahead to the Technical Brochures which B1 expected to publish in the coming months.

CIGRE UK B1/D1 Technical Liaison Meeting 2021

4th November 2021

The annual CIGRE B1/D1 UK Technical Liaison meeting was held as a Virtual Meeting on November 4th 2021. 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. The meeting also discussed the latest new work items approved by the B1 Study Committee during the Paris e-session, 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, the UK Regular Member for D1, Simon Sutton, provided a summary of activities relevant to the B1 audience.

CIGRE UK B5/D2 Technical Liaison Meeting 2021

18th November 2021

The purpose of the meeting, led by UK Regular Members John Wright & Gareth Taylor, was to provide a high-level overview of the ongoing activities in CIGRE related Study Committee B5 (Protection & Automation) and Study Committee D2 (Information Systems & Telecommunications). Technical Brochures published in the last year were highlighted, along with a status update on active Working Groups where the UK has an interest. The meeting also discussed the latest new work items approved by the B5 and D2 Study Committees during the Paris e-session, and to provide feedback on possible future work items that could be proposed in the future.

3.3 CIGRE-UK Webinars

Webinar Programme

Date	Title	Presenter
Jan	<u><i>Power System Developments for a Net Zero Future</i></u>	Dr Charlotte Higgins
Feb	<u><i>Optimising subsea cable sizing: through improved modelling</i></u>	Dr James Pilgrim
Mar	<u><i>Are Electricity Substations Net Zero Carbon Ready</i></u>	Mark Osborne
Apr	<u><i>Cybersecurity and the Resilience of Power System Substations</i></u>	Dr. Daniel Texidor Dantas
May	<u><i>CLASS: Enabling Customers to Solve System Challenges</i></u>	Steve Cox
Jun	<u><i>Capabilities and Requirements Definition for Power Electronics Based Technology for Secure and Efficient System Operation and Control</i></u>	Dr Chris Smith, Dr Yunjie Gu
Jul	<u><i>HV Cable PD Monitoring – identifying faults before they become failures</i></u>	Dave A Roberts, Ramiz Ahmed, Evgeniya Kalinnikova, Stuart Aird
Sep	<u><i>System HILP Event Demand Disconnection (SHEDD) Project</i></u>	Dr Abdullah Emhemed
Oct	<u><i>Frequency Response Analysis (FRA) for Transformer Winding Deformation and Movement: from Measurement to Diagnosis</i></u>	Dr Dahlina Sofian & Rafal Zaleski

3.4 CIGRE-UK Other Events

Resiliency of the Grid - a collaborative webinar between CIGRE UK NGN and CIGRE Italy NGN

19th March, 2021

List of Speakers	
Heatwaves effects on MV electrical grid	Dr. Luigi Calcara
Techno-economic modeling and assessment of forward resilience measures	Dr. Eduardo Alejandro Martínez Ceseña

Impact of COVID-19 on Electrical Power Systems - organized by CIGRE NGN United Kingdom and NGN Netherlands

29th March 2021

List of Speakers	
Lessons learnt from the COVID-19 Pandemic: How Resilient Are We?	Matthias Noebels & Mathaios Panteli
Impact of COVID on electrical power system and the organisation of TenneT	Jan Vorrink

Smart Cities – A Collaborative event with CIGRE Germany

21st April 2021

List of Speakers	
Welcome and Introduction	Dr. Biljana Stojkovska & Christine Schwaegerl
Keynote from CIGRE UK and Germany	Frank Golletz, & Adam Middleton
Results of CIGRE Working Group C1/C4 36. Key Findings and Trends on Smart Grids in Metropolitan Area and Large Cities Power Systems	Stanislav Utts
Tools and Techniques for Smart City Network Analysis	Anna Ferguson
Network integration of electric mobility	Eric Junge
Smart City Berlin	Thomas Schäfer
The Path to Zero Carbon Heat and the Impact on GB Electrical Systems	Douglas Ramsay

Global Youth Engineering Climate Conference 2021

7th & 8th September 2021

Engineering green energy solutions at the first global youth engineering climate conference.

CIGRE partnered with international companies, universities, and youth groups to gather this September for a fully virtual Global Youth Engineering Climate Conference (GYECC21) hosted by National Grid – attracting students and young professionals from multiple nations to collaborate on climate challenges facing us all.

Opportunities & Challenges for HVDC & Power Electronics in the UK

15th September 2021

List of Speakers	
GB Transmission System Operability Considerations for HVDC and PE Applications	Dechao Kong
Technology, Market & Outlook	Theodor Heath

The Evolution of FACTS applications in the GB Transmission System	Mark OSBORNE
Acoustic Noise Considerations on HVDC Converter Station	Chidinma Agwu

Grid Forming Technologies for the Net Zero Power Network - A CIGRE UK NGN and Study Committee B4 collaboration

3rd December 2021

Grid Forming technology is one of the potential solutions that can support zero carbon operation of GB electricity network. CIGRE UK NGN, in collaboration with experts from Study Committee B4, has organised this technical webinar to discuss the latest developments in Grid Forming technology in the UK. The two speakers are Ben Marshall and Agusti Alvarez. Dechao Kong chaired this webinar.

4 CIGRE-UK Technical Panels

More information on the above Technical Panels is available on individual Regular Member reports.

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 2020. Data related to 2021 will be available in 2022.

5.1 Active Working Group

- Number of total active Working Groups (WGs) and Joint Working Groups (JWGs) has changed from 260 in January 2020 to 248 in January 2021. In January 2019 there were total 259 WGs.
- Out of the 248 total active WGs in 2021, 38 are active JWG
- Study Committees A1 and B2 have the largest number of active WGs including JWGs. C2 and C5 has the least number of WGs (including JWG). 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 4350 experts from 74 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 and C3 have a considerable gap between the number of experts and available WG positions highlighting one expert is participating more than one WG. C2 and C6 on the other hand has a good balance between the number of experts and available WG positions.

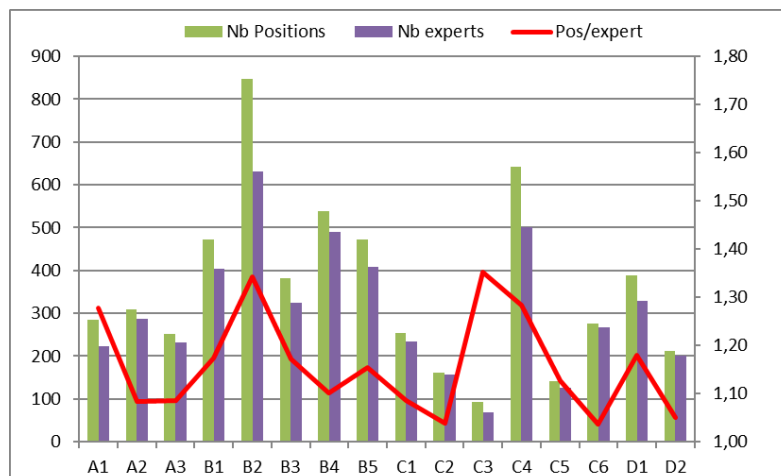


Figure 3: Number of Experts and WG Positions

- 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 for 2020. 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.

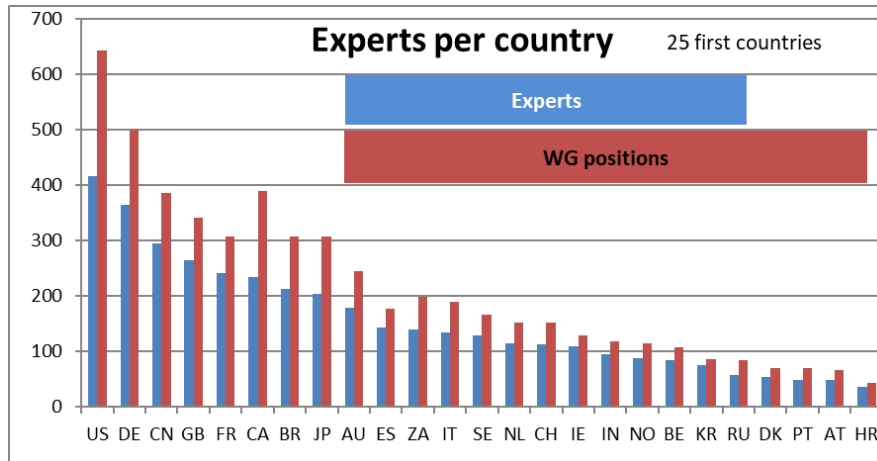


Figure 4: Number of WG positions filled by experts based on country of origin

- 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 participating in more than one WG.

5.3 Working Group Publications

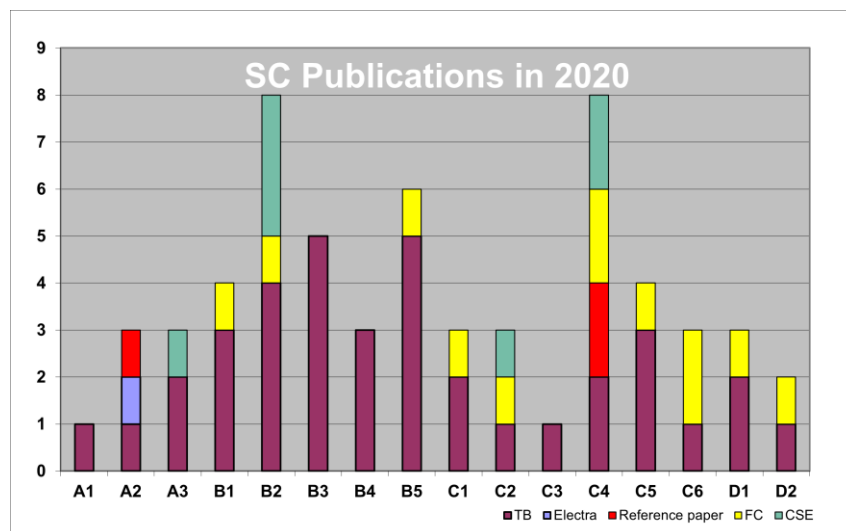


Figure 5: Study Committee Publications in 2019

- As shown in Figure 5, B3 and B5 have produced five Technical Brochures each in 2020, which were the highest number of Technical Brochures produced by a study committee in 2020.
- Only A2 and C4 have produced “Reference Papers” in 2020.

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 2022 Preferential Subjects

2022 Preferential Subjects will be at the Paris bi-annual meeting and the tradition of even year will be resynchronized for the deferred 2020 meeting due to the coronavirus.

PS1 : Generation Mix of the Future

- Impact and effect of increasing renewable power mix on new and existing generators, generator auxiliaries and motors
- Synchronous compensator and high inertia machine design and performance for supporting power generation networks
- Adaptation of international standards for electrical machine design & performance to current power grid requirements

PS2 : Asset Management of Electrical Machines

- Experience with refurbishment, replacement, conversions, power up-rating and efficiency improvement of generators
- Novel techniques to overcome known operational and design problems
- Optimised condition monitoring, diagnosis, prognosis and maintenance practices to improve reliability and extend operational life of conventional plant and in new volatile grid conditions, including data handling and digital modelling

PS 3: Developments of Rotating Electrical Machines and Operational Experience

- Latest design, specification, materials, manufacture, maintenance and performance and efficiency improvements
- Operational experience: Failures, root cause analysis, recovery options, cost and time reduction initiatives
- Evolution and trends in designs of rotating electrical machines for renewable generation (wind, hydro)

6.4 New Working Groups

Proposed in 2020 session (2021)	Convener	Status
Generator Stator Radial Wedging Testing Methods	Convener to be found	Mr. Villarrubia withdrew as possible convener
Factory Quality Assurance Testing Requirements – step 2	Convener to be found	Mr. Roderiques withdrew as possible convener
Torsional Interaction of Turbo-generators resulting from grid	Matthias Humer	JWG C4/B4 - 52 "Guidelines for Sub-Synchronous Oscillation Studies in Power Electronics Dominated Power Systems" covers largely the topic. Mr. Humer joint JWG C4/B4 – 52 on behalf of SC A1
The impact of new network codes on generators		Rejected: topic already sufficiently covered by IEEE

6.5 Technical Panel Meetings, Seminars & Tutorials

The Study Committee invited written contributions to provide discussion material for the General Discussion Meeting in the Virtual Centennial Session 2021 based on the questions raised in the Special Report. Special reporters included members from the UK.

The papers had been submitted in 2020 and presented in the 2020 e-session. A total of 27 abstracts had been accepted from those submitted for approval under three Preferential Subjects. One paper was subsequently withdrawn. The submitted 26 papers were summarised under the three Preferential Subjects chosen for the 2021 Session.

6.6 Technical Brochures

No new technical brochures were published in 2021.

6.7 Last Study Committee Meeting (Highlights)

The on-line attendance for both the afternoon sessions of the Virtual Centennial Session 2021 SCA1 General Discussion Meeting was lower than in past Paris sessions. Typically, attendance figures have been in the range 80-100 compared to the 42/35 achieved during the VCS. Although the number of accepted papers was the same as in previous years, there were fewer prepared contributions with only 19 being received compared to 29 in 2018. The contributions submitted were however carefully thought out, well prepared and of high technical interest. Due to the lower attendance and the novelty of the 'Sparkup' platform, audience participation was more muted than in face-to-face meetings, although the survey facility in 'Sparkup' was an interesting feature to gather audience opinion.

As seen in the past, certain topics ignited a larger response reflecting hot topics in the field of rotating electrical machines. Such topics include generator diagnostic testing, specifically performance testing of stator bars and windings and diagnostics of partial discharge behaviour.

It was encouraging to see an increased participation of younger SC members and a higher ratio of female members.

The recommendations from the study committee general report:

- It is clear that wind generators are more of interest to younger engineers due to the high level of deployment and design development. SC A1 must make wind generators more prominent its scope to encourage CIGRE membership in this important field.

6.8 Current Working Groups and UK Members

Number	Title	UK Member
A1.29	Guide on Generator/Power System Inter relationship Issues	
A1.33	Guide for Cleanliness and Proper Storage of Generators and Components	Ben Adams (Member)
A1.35	Hydroelectric Generators behaviour under abnormal operation conditions	
A1.36	Vibration and stability problems met in new, old and refurbished Hydro-generators, root causes and consequences	
A1.40	Survey on Hydro Generator Instrumentation and Monitoring	
A1.42	Influence of Key Requirements on the Cost of Hydro-generators	
A1.43	State of the art of rotor temperature measurement	
A1.44	Guideline on Testing of Turbo and Hydro-generators	
A1.45	Guide for Determining the Health Index of Large Electric Motors	
A1.46	Guide on Use of Premium Efficiency Motors & Carbon Credit Claim	
A1.47	Technological Feasibility Studies for IE4 / IE5 Efficient Motors	
A1.48	Guidance on the Requirements for High Speed Balancing / Overspeed Testing of Turbine Generator Rotors Following Maintenance or Repair	Ben Adams (convenor) Steve Mitchell (Member)
A1.49	Magnetic Core Dimensioning Limits in Hydro Generators	
A1.51	Monitoring, Reliability and availability of Wind Generators	
A1.52	Wind generators and frequency-active power control of power systems	David McMillan (convenor)
A1.53	Guide on Design Requirements of Motors for Variable Speed Drive Application	
A1.54	Impact of Flexible Operation on Large Motors	
A1.55	Survey on Split Core Stators	
A1.56	Survey on lap and wave winding and their consequences on maintenance and performance	
A1.58	Selection of Copper Versus Aluminium Rotors for Induction Motors	
A1.59	Survey on Industry Practices and Effects associated with the cutting out of stator coils in hydrogenerators	
A1.60	Guide on economic evaluation for refurbishment or replacement decisions on hydro generators	
A1.61	Survey on Partial Discharge Monitoring in Large Motors	
A1.62	Thrust bearings for hydropower - A survey of known problems and root causes	
A1.63	Turbo Generator Stator Winding Bushings and Lead Connections - field experience, failures and design improvements	
A1.64	A guide for evaluating the repair / replacement of standard efficiency motors	
A1/C4.66	Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators	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	
A1.68	Evaluating Quality Performance of Electric Motor Manufacturing and Repair Facilities	Steve Mitchell (Member)
A1.69	Hydro-Generator Excitation Current Anomalies	
A1.70	Dielectric Dissipation Factor Measurements on Stator Windings	Richard Ludlow (Member) Ian Simmonds (Member)

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 2.8 Lower Voltage Applications – Peter Werle

7.3 Draft Preferential Subjects

The Preferential Subjects for 2021 Paris Session are the same as for 2020:

PS 1 / Experience and new requirements for transformers for renewable generation

- Operational experience: problems, maintenance, condition assessment, monitoring , failure rate, lifetime, lessons learnt,
- Design, test, insulation, monitoring, maintenance of step-up, secondary substation and DC converter transformers,
- Design and operational requirements for future applications: wind and photovoltaic.

PS 2 / Beyond the mineral oil-immersed transformer and reactors

- Alternative technologies for improved safety and environmental performance: gas-insulated, ester-immersed, dry-type and solid-state transformers,

- Operational experience with transformers using these new technologies,
- Advantages and limitations, impact on specifications, high temperature applications, business cases.

PS 3 / Best practices in transformers and reactors procurement

- Return of experience: factory qualification, design reviews, implementation of new specifications, on-site vs virtual witnessing,
- Quality control and testing: manufacturing check points, sub-supplier qualification, validity period for type tests, enhancements to standards, special tests, short-circuit test, paper DP measurement,
- Dealing with non-conformities, performance guarantees, warranty

7.4 New Working Groups

Due to Covid-19, activity of working groups has been limited this year. No new group was established.

7.5 Technical Panel Meetings, Seminars & Tutorials

The UK A2 technical panel held its last meeting on the afternoon of the 9th December 2019. Due to Covid restrictions and other commitments, the next panel meeting is yet to be scheduled.

The A2/D1 liaison meeting was held virtually on the 14th January 2021 and was well attended with a peak of 52 attendees.

7.6 Technical Brochures

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 A2.

Ref.	WG	Title
TB812	A2.53	FRA Interpretation
WGR_310_1	A2.54	Load sound power levels for specification purposes of three-phase 50 Hz and 60 Hz liquid-filled power transformers
Pending 2021	Ref	Drying and Impact on DP
Pending 2021	Ref	Condition of Solid Insulation at end-of-life
Pending 2022	A2/C4.52	HF Modelling of transformer (5 brochures expected)
Pending 2020	A2/D.51	UHF PD in transformers
Pending 2020	A2.55	Transformer Life Extension
Pending 2021	A2.58	Installation, pre-commissioning and trial operation
Pending 2021	A2.59	On-site assembly, rebuild and HV testing
Pending 2021	A2 56	Transformer losses and efficiency
Pending 2021	A2.57	Transformer DC magnetization
Pending 2021	A2.54	Transformer sound levels
Pending 2021		Green Book on Transformer Procurement

7.7 Last Study Committee Meeting (Highlights)

Study Committee A2 met in virtually on 15th-16th September 2021.

Tim Gradnik (SI) received the Technical Council Award for Study Committee A2.

Cigre e-session pioneer awards wen to Thomas OLESEN, Alvaro PORTILLO, Stefan TENBOHLEN, Janine JAGERS, Simon RYDER and Tim GRADNIK.

Ciprian Gheorge DIACONU received a Fellowship Award.

Working Group convenors each gave a brief report on the progress of their group. As detailed in section 6, a number of these groups were due to finish their work and publish their Technical Brochures by the end of 2020, but due to Covid these have been delayed.

The place of women in SC A2 remains a challenge and efforts are being made to increase the participation of women at SC and Convener level.. SC A2 is supporting the CIGRE Women's Network especially through the participation of Khayakazi Dioka (ZA) who gave a presentation on Womenin Energy Network at the SC meeting. Tara-Lee Macarthur gave a presentation on the NGN network.

Work on a Transformer Green Book has started. Simon Ryder is hopeful that this can be completed in 2021.

The 2021 A2 Colloquium will be held in Bucharest, Romania week beginning the 11th October. The 2023 A2 Colloquium will be held in Croatia, date to be confirmed. .

7.8 Current Working Groups and UK Members

WG	Title	UK Member	Organisation
A2/D1.51	Improvement to Partial Discharge Measurements for Factory and Site Acceptance Tests of Power Transformers	Paul Jarman Martin Judd	NG HFDE
A2/C4.52	High Frequency Transformer Models for Non-Standard Waveforms	Zhongdong Wang	Exeter Univ
A2.54	Power Transformer Audible Noise Requirements	Mark Warren Janine Dickinson	Unifin Int NG
A2.55	Transformer Life Extension	Asim Bajwa David Walker	Doble SPEN
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 Manchester University
A2.61	On-load tap-changer best practices	Richard Josebury	NG
A2.62	Analysis of AC Transformer Reliability	Shengji Tee	SPEN

A2.63	Transformer Impulse Testing	Stefan Dragostinov Qiang Liu	Doble Engineering Manchester University
A2.64	Condition of cellulose insulation in oil immersed transformers after factory acceptance test	Hongzhi Ding Andrew Fieldsend- Roxborough	Doble NG
TF EoL	The Condition of Transformer Solid Insulation at end-of-life		
D1/A2.77	Liquid tests for electrical equipment	Atitila Gyore Qiang Liu Russel Martin David Walker Gordon Wilson	M&I Materials Man Uni M&I Materials SPEN -

Updates on working groups:

A2/D1.51 Update

In the past year, the JWG has not met, since the Technical Brochure was already complete apart from some very specific debate about the meaning of calibration. The draft was subject to a few final edits and submitted to the Study Committee for review in December 2020. The review is now complete and some grammatical and presentational changes implemented, with no alteration to the technical content. Release of the Brochure can therefore be expected within a few months. Its main theme concerns the use of UHF PD sensors and measurements as an additional tool for quality assurance of transformers in the context of acceptance tests in the factory and on site. The document proposes a method for standardising UHF PD measurements in a manner that is analogous to the ‘calibration’ of an IEC60270 PD measurement instrument – that is, the readings given by one manufacturer’s test equipment must be comparable to those of another when responding to a particular PD. This of course does not imply anything about calibration of the so-called ‘true’ charge vs. apparent charge in relation to the PD current pulse at the location of the discharge.

A2/C4.52 Update

The JWG has now completed 4 out of the 5 planned Technical Brochures (TBs); the 5 TBs are TB1 White-box Models, TB2 Black-box Models, TB3 Grey-box Models, TB4 Model Interfacing and Specifications, TB5 Measurements and Design Data. The Task Force on white-box models has worked hard during the second half of 2020 and first half of 2021, revising and finalising its TB. The last (5th) TB (measurements and design data) will be finalised in October/November 2021.

A2.54 Update

The technical work of WG A2.54 is complete and the group is working towards the completion of the final brochure. The key outputs of our work include the typical no-load and load sound power levels for transformers of different rated power, which can be used for specification purposes. The last activity of the full working group was in September 2020 when the group came to an agreement on how to complete the brochure. The next task for the working group is to compile the brochure between October to December 2021 with the aim of completion at the end of 2021.

A2.55 Update

There have been no formal WG meetings in 2021. Nevertheless, there have been a number of smaller meetings to finalise and proof-read the document. This was completed by Dave Walker and Elisa Figueroa in June 2021. The Technical Brochure (TB) paperwork is currently with the A2 committee for review and approval. It is expected that the TB will be published in the near future.

A2.57 Update

There had been a couple of online meetings in the past year; all focussed on finalising the Technical Brochure, be it individual sections or the whole brochure. At this stage of the working group, manufacturers' designing criteria and modelling have become the focal aspects. Therefore, academia is not closely involved anymore. In addition, it has been noted that industry (i.e. National Grid) has had difficulty in affording quality time. Brochure is expected to be ready by late 2022.

A2.59 Update

Work is complete and the Technical Brochure is in press with imminent publication.

A2.60 Update

There has been one plenary meeting, and several task force meetings in 2021. These were all conducted online. The ongoing work is to finalise the brochure structure and chapter contents. Progress is roughly at 50% for all 4 task forces: TF1 Transformer Thermal Behaviour, TF2 Dynamic Transformer Thermal Modelling (DTTM), TF3 DTTM Benchmarking, TF4 DTTM Application. The Technical Brochure is anticipated to be completed in 2023.

A2.61 Update

This WG has been disbanded.

A2.62 Update

Two virtual meetings have been held in 2021. The WG have so far collected data covering a population of 27,200 transformers and 10,200 reactors, with 670 and 300 major failures for transformers and reactors respectively, as well as 1060 and 690 retirements for transformers and reactors respectively. These data represent roughly 60% of the data collected previously by WG A2.27. WG members are still engaging with big utilities to gather more data. Data analysis and evaluation are scheduled until the end of 2021, with writing of the brochure scheduled for 2022.

A2.63 Update

There have been 3 plenary meetings with multiple Task Force (TF) meetings in between. The 3 plenary meetings were held on 23-24 November 2020, 19-20 April 2021 and 16-17 August 2021. TF3 leader has been changed to Ricardo Castro Lopes from Efacec Transformers. WG is planning to conduct transformer transient modelling under a number of specific scenarios (effects of LI front time, LI tail time, chopped LI waveform etc.). Tasks for writing specific sections have also been allocated to WG members. Draft brochure is expected late 2022 or beginning of 2023.

A2.64 Update

So far the WG has had 8 WG meeting in total, the latest in October 2021. The recent meeting in October has decided on the final structure of the final WG document and has agreed schedule and responsibilities for the next steps to

- (1) finalize each subgroup documents,
- (2) merge all subgroup documents into a final draft brochure,
- (3) final WG review of the draft brochure,
- (4) formatting draft brochure, and
- (5) submit the draft brochure into SC A2 for review by the end of year or beginning of 2022.

D1/A2.77 Update

Convenor of this WG is Fabio Scatiggio, helped by secretary Carl Wolmarans and assistant secretary Senja Leivo. There are currently 67 members. All meetings have been carried out online. The first plenary meeting was held on 8 October 2020 and three Task Forces were created: TF1 Measurement Aspects, TF2 Data Handling and Categorisation, TF2.1 (Sub-Group) Electrical Testing, TF3 Modelling and Case Studies. Further plenary meetings were held on 9 November 2020, 3 December 2020 and 2 September 2021. The Task Forces have all met virtually at least 3-4 times in 2021 and work is progressing well.

7.9 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	Web Master & Events	62
David Walker	SP Energy Networks	Transmission	55
Paul Jarman	Manchester University	Transmission	51, 53, 57
Paul Dyer	UK Power Networks	Distribution	
Tom Breckenridge	TB TCS	Consultant	
Ian Hunter	Polaris	Contractor	Green Book
Qiang Liu	Manchester University	Member	58
Simon Ryder	Doble	Member	63, Green Book
Gordon Wilson	-	Member	
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 University	WG Member	60
Richard Josebury	NG	WG Member	61
Mike Munro	Polaris	WG Member	64
Andrew Fieldsend-Roxborough	NG	WG Member	64

8 RM Report on SC A3 Transmission and Distribution Equipment

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

9 RM Report on SC B1 Insulated Cables

9.1 Study Committee Scope

SC Chair: Marco Marelli

SC Secretary: Matthieu Cabau

9.2 Strategic Advisory Groups

There are three advisory groups in the B1 SC, Strategic Advisory Group (Chair: Marco Marelli), Customer Advisory Group – membership is shown below (September 2021).

Convenor	John Vail	UK
Africa	Kieron Leeburn	South Africa
North America	Walter Zenger	USA
South America	Julio Lopez	Brasil
Far East (Oceania)	Colin Peacock Shoji Mashio Xiaolong Cao	Australia Japan China
Eastern Europe	Alexsandra Rakowska	Poland
Western Europe	S Damsgaard Mikkelsen	Denmark
India	Deepal Shah	India

There is also a Tutorial Advisory Group (Chair: Geir Clasen geir.clasen@nexans.com) – membership is shown below (September 2021).

Names	Country	Type Vendor T Utility D Utility Consultant Academic	Role Convenor Secretary Regular Corresponding NGN
BASCOM, Rusty	United States	Consultant	Regular
BOONE, Wim	Netherlands	Consultant	Co-Convenor
CLASEN, Geir	Norway	Vendor	Convenor
DENSLEY, John	Canada	Consultant	Regular
DAMASCENO, Carla	Brazil	Utility	Regular
OTTERSBERG, Heiner	Germany	Vendor	Regular
RAKOWSKA, Alexandra	Poland	Academic	Regular
WORZYK, Thomas	Sweden	Vendor	Regular
YING Liu	China	Academia	Regular

9.3 Draft Preferential Subjects

The Preferential Subjects for 2022 Paris Session are:

PS 1 : Learnings from experiences

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

PS 2 : Future functionalities and applications

- Innovative cables and systems, exploring the limits
- Future projects requiring new functionalities expected from cable systems
- Prospective impacts on cable life-cycle from use and implementation of Big Data and Industry 4.0

PS 3: Towards sustainability

- Environmental challenges in current, planned and future cable systems
- Safety considerations, cyber and physical security and IoT and including case studies
- 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 B1.83 and B1.86 (post sign-off from the Technical Council) is still awaited, but the activities were approved by the B1 Study Committee.

Number	Title	UK Member
B1.82	MVDC Cable system requirements (Conv: Paul Knapp, US)	TBC
B1.83	Grounding aspects for long HVDC land cable connections (Conv: Christian Remy, France)	Dongsheng Guo (National Grid)
B1.86	Assessment, Prevention and Mitigation of Safety Risk in Cable Systems (Conv: Julio Lopes, Brazil)	TBC
B1.87	Finite Element Analysis for Cable Rating Calculations (Conv: James Pilgrim, UK)	Venkata Chalapathi (Vattenfall), NGN: Hugo Hui (WSP)

New Task Forces are shown below, with the additional of TF B1.81 which has had its scope extended and now runs for an additional year to finalise the scope of a future Advisory Group. Note that the B1.89 activity was proposed by the UK, and after several attempts and scope revisions it has now been accepted as a preparatory Task Force.

Number	Title	UK Member
TF B1.81	How to have statistics every two years (Conv: Soren Mikkelsen, Denmark)	Francis Waite (WSP)
TF B1.88	Non-SF6 GIS terminations	Manu Haddad (Cardiff University)
TF B1.89	Guidance for conducting cable systems failure analysis	Roman Svoma (PowerSure Technology)

9.5 Technical Panel Meetings, Seminars & Tutorials

A Virtual Technical Liaison meeting was held in November 2020, with attendance of approximately 50 persons. Although the networking elements of the traditional in person meetings were sadly missing, the attendees confirmed that there was still good value in having the meeting. The same approach was used for the November 2021 meeting, which was held on 4th November.

A webinar was given by the B1 RM in February 2020.

Future webinars are under consideration on recently completed groups, to drive awareness about the release of the new TBs. Examples of TBs published in 2020 are:

- TB 784 Standard design of a common, dry type plug-in interface
- TB797 Sheath bonding systems of AC transmission cables
- TB 801 Guidelines for safe work on cable systems under induced voltages
- TB 815 Update of service experience of HV underground and submarine cable systems

9.6 Technical Brochures

The following TBs have been published in 2021:

- TB825 Maintenance of HV Cable Systems
- TB841 After laying tests on AC and DC cable systems with new technologies
- TB852 Recommendations for testing DC extruded cable systems for power transmission at a rated voltage up to and including 800 kV
- TB853 Recommendations for testing DC lapped cable systems for power transmission at a rated voltage up to and including 800 kV

9.7 Last Study Committee Meeting (Highlights)

The TF/WGs cover growth areas (for instance HVDC) and new technologies or applications of technology (eg non-SF6 gases, MVDC technology). Gaps in recommendations and problem areas are also explored.

Many WG have been delayed due to the impact of the COVID pandemic and restrictions on physical meetings. The volume of online meetings now required as part of the “day job” appears to have weakened the desire of many Cigre B1 to participate in online WG meetings, a phenomena which is not just present in the UK. Therefore the majority of WG in progress requested additional time to complete their work, and the number of published TB this year is lower than had been predicted.

9.8 Current Working Groups and UK Members

Note: although the final publications of B1.54, B1.56 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 B1.61	Installation of HV Cable Systems (Chinosi/2016-2019)	Simon Lloyd (UK)
WG B1.62	Updating of TBs for EHVDC and UHVDC Cables Systems	Rosemary Urban (UK), Stuart Williams (IE), Roman Svoma (IE)
WG B1.63	Specifications for HVAC Dynamic Cables above 36 kV	Adam Paxton (IE), Stephen Ingram (UK), P. Paradine (NGN - corresponding), Stuart Noble (IE), Michael Hart (NGN)
WG B1.64	Evaluation of Armour Losses	James Pilgrim (UK), Uta Huang (NGN), R. Svoma (IE)
WG B1.65	Installation of offshore Cable Systems	Tony Zymelka (UK)
WG B1.66	Recommendations for testing DC lapped cable systems for power transmission at a rated voltage up to and including 800 kV	Roman Svoma (UK), Greg Tzemis (IE Corresponding)

WG B1.67	Loading pattern on cables connected to windfarms	Ross Wilson (UK), John Sinclair (IE)
WG B1.68	Update of TB 358 'Remaining Life Management of Existing AC Underground Lines'	Stelios Christou (UK)
WG B1.69	Revision of TB 189 'Insulation co-ordination for HV AC underground cable systems'	Francis Waite (UK)
WG B1.70	Recommendations for the use and the testing of optical fibres in submarine cable systems (Svoma/2018-2021)	Roman Svoma (UK, Convener), Jingyi Wan (NGN)
WG B1.72	Current rating verification (Part 2)	James Pilgrim (UK), Kenneth Benton (NGN)
WG B1.73	Recommendations for the use and the testing of optical fibres in land cable systems (Burgos/2019-2022)	None, Jingyi Wan (NGN)
WG B1.74	Recommendations for a performance standard of insulated bus-bars (Mirebeau/2019-2022)	Ian Johnstone (UK)
WG B1.76	Increasing the role of quality assurance and quality control to reduce the cable failure possibility (Freitag/2020-2023)	Roman Svoma (UK)
WG B1.80	Guidelines for Site Acceptance Tests of DTS and DAS Systems used for Cable Systems Monitoring (Cherukupalli/2020-2023)	Matthew Connell (NGN)
JWG B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC application (Gustafsson/2019-2022)	Thomas Andritsch (UK)
JWG D1/B1.75	Mechanism for corrosion and how to monitor it (2019-2020)	Andrew Woolridge (UK)
JWG B1/B3/D1.79	Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends	Drew Boa (UK), Jack Stride (NGN)
JWG B1/C3.85	Environmental issues of decommissioning	John Sinclair (UK)
JTF B4/B1.88	Insulation coordination procedure for DC cable systems in HVDC stations with Voltage Source Converters (VSC)	Rosemary Urban (UK)

NOTE: UK denotes the UK member, IE denotes Invited Expert, NGN denotes Next Generation Network member. Where members have withdrawn or become unresponsive, membership is shown as None but with the original member highlighted.

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.

A technical panel was started in December 2016 with a representative from each membership category. The members as per August 2020 were:

- James Pilgrim – now Orsted (Developer), formerly University of Southampton – Panel Chair
- Roman Svoma – PowerSure Tech (Consultancy – former manufacturer) former B1 RM
- Oliver Cwikowski – formerly National Grid (TSO), now Orsted (Developer)
- Doug Gracias – Prysmian (Manufacturer/Supplier)

- Brian Gregory – CCI (Consultancy – former manufacturer)
- Uta Huang – Orsted (Developer/TSO – NGN) Secretary

With an increasing number of job changes to the same organization (Pilgrim, Cwikowski) and retirements (Gregory), it will be necessary to refresh the membership of the Technical Panel for 2022. Traditionally there has been one meeting per year in the summer before the SC B1 meeting. No meeting has yet been held in 2021, as the hope was to have an in person meeting, but this has not yet proved possible.

The B1 panel has been trying to organise a B1 shadow Working Group ‘day’ where some of the more popular WGs will be discussed separately as a ‘deep dive’ rather than an overview as in the liaison meeting. It is hoped a physical panel session will be held at the same time.

As raised previously the TSO/DNO B1 WG/TF and UK participation is still an issue. TSO/DNO are under-represented and international travel restrictions are a problem for prospective UK participants becoming a member of an international WG. Some members in WGs have moved to jobs where the company does not have a collective UK membership and this is resulting in the loss of members.

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)

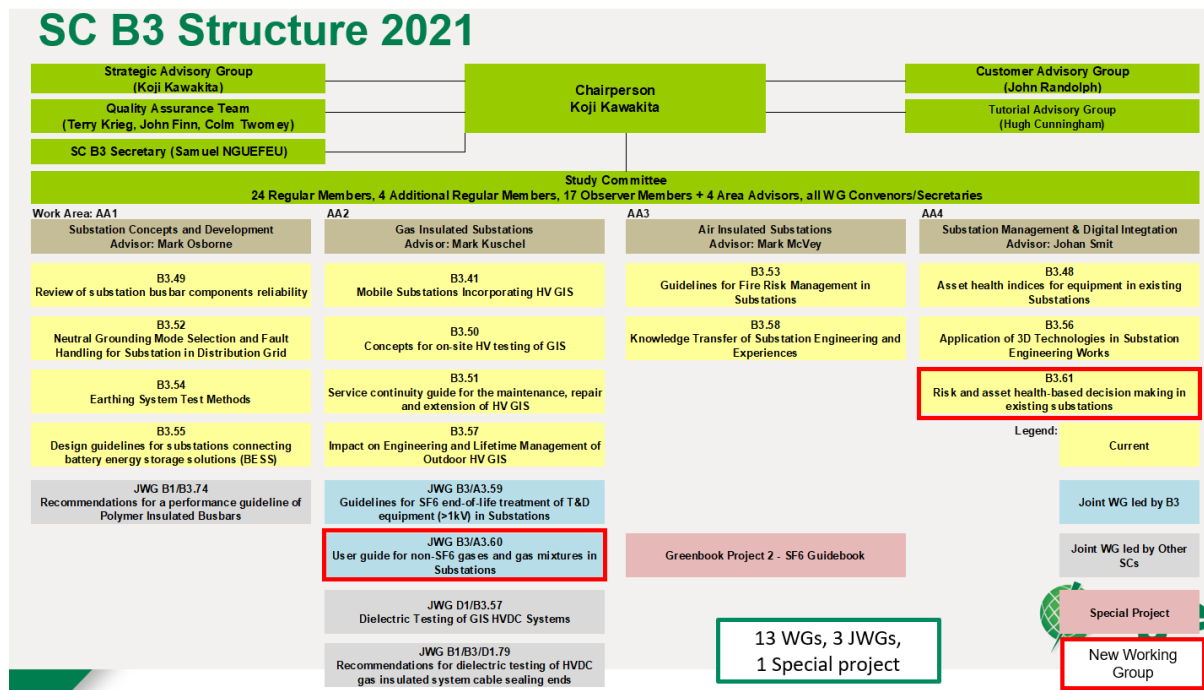
The scope of Study Committee (SC) B3 addresses topics throughout the asset management life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life. At all stages, technical, safety, economic, environmental and social aspects are addressed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

The Preferential Subjects for the Substation 2022 Paris Session are:

PS1: Increased impact of clean energy transition on Substation Design

- On-Offshore wind, PV, Geothermal, etc.
- Energy Storage, Hydrogen, Synchronous compensators, etc.
- GIS/GIL application for DC network

PS2: Sustainability Management Challenges in Substations

- External drivers for substation intervention (resilience, reliability, security of supply, life expectancy coordination, etc.)
- SF6 alternatives and emission management, 3R (Reuse, Reduce, Recycle) of materials
- New set of skills for new technologies, Knowledge transfer and high standards of education in engineering skills

PS3: Integration of Intelligence on Substations (TBD common PS with B5)

- Data analytics, remote supervising & monitoring and autonomy application
- IoT and Machine learning applications based on Protection Automation and Control data including asset management, monitoring and data analysis (TBD)
- IEC 61850 Principles and applications to substations (TBD)
- Expectations and benefits from digital substation.

11.4 New Working Groups

Number	Title	UK Member
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
B1/B3.74	Recommendations for a performance guideline of Polymer Insulated busbars	TBC

11.5 Technical Panel Meetings, Seminars & Tutorials

The 2021 Study Committee B3 meeting was held via GoToWebinar on 23/08/2021 using a short session format of only 4 hours. (see section 7)

The Virtual Centennial Session 2021 combined both live presentations using a TV format and the remote on-line presentation using either live voice over or pre-recorded powerpoint sessions.

Summary:

- B3 session held over 2 days 26/27 August. Day 1 focused on Koji Kawakita's introduction & PS1 and day 2 for PS2 & PS3
- 24 presentations took place live (including 1 Young Member showcase from Japan, and 2 COVID-19 experiences.
- 8 WG showcases
- 2 Tutorials held '*Impact of SF6 free alternatives in T&D substations and its switchgear*' & '*Management of Risk in Substations TB 734*'

CIGRE 2022: 28 August – 2nd Sept 2022, Paris, France

- B3 poster session, B3 poster tutorial:
- B3 Ground Discussion Meeting (GDM): Tues, 25 August 2021
- *Paper selection already closed.

Kyoto 202 – May

UK (venue to be confirmed) May 2023 Colloquium Proposal in development: Focus will be on Managing SF6 to achieve the net zero targets

11.6 Technical Brochures

TB 834	Reliability Analysis and Design Guidelines for LV AC Auxiliary Systems (B3.42)
TB 823	Substation servicing and supervision using mobile devices and smart sensing
TB 814	Low Power Instrument Transducers (LPIT) applications in HV Gas Insulated Switchgear
TB 807	Application of Robotics in substations (B3.47)
TB 805	Guidelines for Safe Work Methods in substations (B3.46)
TB 802	Application of non-SF6 gases or mixtures in MV and HV GIS (B3.45)

11.7 Last Study Committee Meeting (Highlights)

Due to COVID, this was a short form on-line meeting (4 hrs), held on GoTo Meeting 22/08/2021. It was attended well with 24 regular members, 4 additional members, 17 observers, addressing 40 countries.

6 Technical Brochures have been published in the last year – see the list above. These are all available on e-Cigre;

CIGRE Women in Engineering is now rebranded as CIGRE Women in Energy. We are looking for any opportunities to combine activities in the substation arena. Please contact me with any ideas.

New format for 2022 session papers – full paper to be submitted by 24 Jan 2022

Looking for volunteers to assist with reviewing the papers to notify the authors by 24th May

Full notification by 24 May 2022

Development of a Substation Training Course (on-line) based on the Substation Greenbook. Provided in modules typical 1-2hrs interspersed with multiple choice questions to vary the format. John Finn is part of this activity.

B3 recognition for contributions to CIGRE

The following have been identified for their contribution in various ways to the success of CIGRE;

- B3 Technical Council 2021 award **Romain MIGNE (FR)**
- CIGRE Fellows 2021 **Ciprian DIACONU (RO)**

New Green Book – Electricity Supply Systems of the Future – available in both eBook and Hardback version on the Springer web page

Technical Committee project – the latest activity of the TC is to prepare a report on the Sustainability of the Network. This is a field which will also be added into the new TOR for new Working Groups

For the next Paris session in 2022 a new paper management system will be implemented (review the slide in the ppt) – 74 abstracts submitted – only 1 from the UK

Please look at the B3 KMS site for more information. If you do not have access, please get in touch and we can get access sorted out.

Next SC meeting will be on the 22 August 2022, in Paris.

11.8 Current Working Groups and UK Members

Number	Title	UK Member
B3.41	Mobile substations incorporating HV GIS	Paul Fletcher, Stefie Cray
B3.48	Asset Health Indices for existing substation equipment	Alan Wilson
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	TBC
B3.53	Fire Risk assessment and mitigation in substations	Russell Martin, Rob Slaughter
B3.54	Earthing System Test methods	Mark Osborne AA1 advisor
B3.55	Design guidelines for substation connecting battery energy storage solutions (BESS)	Thiruvaramkan, Mahalingam (CM)
B3.56	Application of 3D technologies in substation engineering works	Marcin Mroz
B3.57	Design and operational experience of HV GIS installed outdoors	Namita Uppal,
B3.58	Knowledge transfer of Substation Engineering and Experiences	TBC
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

11.9 UK Members of the Technical Panel

Delivered Technical Webinar

- March Webinar 'Are Electricity Substations Net Zero Carbon ready – Mark Osborne. It was attended by 74 on-line participants.

The presentation addressed the range of substation specific challenges facing utilities and engineers in developing energy networks fit to support a net zero carbon economy. We examined transmission and distribution systems and the range of opportunities to address external drivers around system access, technology evolution, engineering resource and smarter operations.

B3 Substation and HV installation Annual meeting

No dedicated meeting held. I am seeking some help to organise and need to work on the development of a group to support UK activities (this will be required for the UK Colloquium).

Looking at establishing Mirror Groups to support the popular interest in two new WGs. A number of UK members expressed interest, so there is a wider interest we feel will need to be addressed in the longer term. The UK RMs will be the UK Convenor and coordinate the organisation of the meetings:

- 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 2023 Colloquium in UK

Planning 2023 Colloquium event associated with B3 and possibly A3 and D1 to address the challenges facing managing SF6 as we try to meet Net Zero Carbon targets by 2030 and ultimately 2050. Further details will

12RM Report on SC B4 HVDC and Power Electronics

12.1 B4 Study Committee Scope

SC B4 Chair: Joanne HU (Canada)

SC B4 Secretary: Rebecca OSTASH (Canada)

The scope of SC B4 covers High Voltage Direct Current (HVDC) systems and power electronic equipment for AC transmission systems. SC B4 is also expanding its activities to cover DC and power electronics applications in distribution systems. 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, consultants and research institutes. The aim of SC B4 is to facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of DC systems and power electronics; to add value to this information and knowledge by means of sharing good practices and developing recommendations.

12.2 UK Members of the Technical Panel

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

Other Panel Members*:

Mike BARNES	Academia
Jun LIANG	Academia
Tim GREEN	Academia
Norman MACLEOD	Consultant
Andre CANELHAS	Consultant
Carl BARKER	Supplier
Nigel SHORE	Supplier
Ziming SONG	Supplier
Benjamin MARSHALL	TSO/Test Centre
Christopher SMITH	TSO

Note*: Current list of members on the 05/11/2021. It can be evolved in future.

12.3 B4 2021 Virtual Centennial Session

- Programme
 1. The 2021 VCS was held on 18-27 August, 2021.
 2. The session for B4 SC was held on 18 & 19 August, 2021.
 3. B4 Tutorial "HVDC Harmonics – Topical and Emerging Issues for AC and DC Sides" on 26 August 2021.

For details of programme, please see the URL:

https://session.cigre.org/sites/default/files/download/virtual_session_programme_ed2.pdf

12.4 B4 2022 Paris Session

- The Subjects for 2020 Paris Session are:
 1. PS 1: HVDC Systems and Their Applications:
 - Planning and implementation of new HVDC projects including need, justification, design, integration of renewables, environmental assessment, and economic assessment.
 - Application of new technologies including cyber security and advanced controls to address emerging network issues, DC grid, multi-terminal HVDC, hybrid HVDC systems.
 - Refurbishment and upgrade of existing HVDC systems, service and operating experience of converter stations including offshore converters, and implications for converter equipment resulting from the conversion of AC circuits to DC circuits.
 2. PS 2: DC for Distribution Systems:
 - New concepts, technologies and designs of DC converters for distribution systems.
 3. PS 3: FACTS and Power Electronics (PE):
 - Planning and implementation of new FACTS and other PE devices including need, justification, for integration of renewables, environmental and economic assessment.
 - Application of new technologies in FACTS and other PE devices including interfacing generation and storage to the network.
 - Refurbishment and upgrade of existing FACTS and other PE devices, service and operating experience.
- Special reporters:
 1. Kamran SHARIFABADI (Norway)
 2. Ricardo TENORIO (Brazil)
 3. Christian WINTER (US)

12.5 Tutorials as Delivered in 2020-21

1. AC Side Harmonics and Appropriate Harmonic Limits for VSC HVDC (by Nigel SHORE)
2. Protection of DC Grids (by Kees KOREMAN and Willem LETERME)
3. Inverters in Weak/Isolated Grids - Operational Aspects (by Chandana KARAWITA)
4. Introduction to VSC HVDC Systems (Les BRAND)
5. HVDC Planning, Technology Selection and Specification (by Bruno BISEWSKI)
6. 2021 VCS: Part 1: DC Side Harmonics and Filtering (by Nigel SHORE) & Part 2: Harmonic Stability and Converter Interoperability (by Mats LARSSON)
7. State of the Art of DC Circuit Breakers in T&D (by Junzheng CAO)

12.6 2021 CIGRE Awards for B4 SC members

1. CIGRE Fellow Award - Mohamed RASHWAN
2. CIGRE Technical Council Award - Ting AN
3. CIGRE Pioneer 2020 e-session Achievement Award - Les BRAND, Mohamed RASHWAN and Ting AN

12.7 B4 SC AGM Meeting (Highlights)

Attended by all B4 SC national regular members, working group convenors and guests

1. The virtual B4 SC AGM meeting was held on 5 November, 2021. It was chaired by Joanne HU and attended by all SC national regular members, working group convenors and guests.
2. Working group reports were presented by WG convenors or representatives (See Table 1-2 within this report for completed/current WGs/JWGs and TFs as well as UK resources in support to those WGs/JWGs and TFs.
3. Introduction of the B4 Green Book on HVDC by Bjarne ANDERSEN.
4. 41st CIGRE Symposium which will be held on 21-24, November 2021 in Ljubljana: 15 papers from B4 SC; a tutorial by Dragan Jovcic "The Application of DC/DC Converters in DC

- Transmission Grids”. For details, see URL: <https://cigre-symposium2021-ljubljana.si/>
- The 2023 B4 SC meeting will be held in September 2023 in Austria.

Note*: for more details, please see SC B4 Newsletters in Cigre UK Technical Zone for B4 SC together with this RM report.

12.8 SC B4 UK Events

- The 2021 Cigre UK B4 Liaison Meeting was held on 28 April 2021 (Virtual Event). For details, see URL: <https://cigre.org.uk/technical-posting/cigre-uk-b4-technical-liaison-meeting-presentations/>
- The 2021 Cigre UK B4 Webinar “Capabilities and Requirements Definition for Power Electronics Based Technology for Secure and Efficient System Operation and Control.” was held on 9 June, 2021 (Virtual Event). For details, see URL: <https://cigre.org.uk/blog/cigre-uk-technical-webinar-june/>
- The 2021 Cigre UK B4/NGN Webinar “Opportunities & Challenges for HVDC & Power Electronics in the UK.” was held on 15 September, 2021 (Virtual Event). For details, see URL: <https://cigre.org.uk/events/opportunities-challenges-for-hvdc-power-electronics-in-the-uk-review/>
- The 2021 Cigre UK B4/NGN Webinar “Grid Forming Technologies for the Net Zero Power Network” to be held on 3 December, 2021 (Virtual Event). For any update, see URL: <https://www.eventbrite.co.uk/e/grid-forming-technologies-for-the-net-zero-power-network-tickets-204576181867>
- The Technical Zone for Cigre UK B4 was firstly released in Q3, 2021 where more details can be found about Cigre UK B4 events since 2021 as well as Cigre B4 SC global newsletters as issued on a quarterly basis. For details, see URL: <https://cigre.org.uk/category/b4-zone/>

12.9 Strategic Advisory Groups

Number	Title	Convenor	Secretary
AG01	Strategic Advisory Group	Joanna HU	Rebecca OSTASH
AG02	B4 Newsletter	Ting AN	Dechao KONG
AG03	Communication and Website	Carman Longás VIEJO	
AG04	HVDC/FACTS System Performance	Lyle CROWE	Murray BENNETT
NGN	B4 NGN Group	Dave ROOP	
WIE	B4 Women in Energy	Rebecca OSTASH	

12.10 Working Groups and UK Members

Note: C – Convenor; S – Secretary; O – Observer; Co – Corresponding Member;
NGN – Next Generation Network

- Current Working Groups and UK Members

Table 1 – Current Working Groups

Number	Title	UK Member
WG B4.92	STATCOMs at Distribution Voltages	1. Diptargha CHAKRAVORTY (NGN)
WG B4.91	Power Electronics-based Transformer Technology, Design, Grid Integration and Services Provision to the Distribution Grid	2. Ahmed ABOUSHADY 3. Michael EVES 4. Alejandro Nieto CALVO 5. Taibo ZHANG (NGN)
WG B4.90	Operation and Maintenance of HVDC and FACTS Facilities	1. Patrice MOUSSET (S) 2. Malcolm MINCHIN 3. Anne THORNTON 4. Chininma AGWU (Co)
WG B4.89	Condition Health Monitoring and Predictive Maintenance of HVDC Converter Stations	1. Faiva WADAWASINA 2. Moorthy SUBRAMANIAN 3. Angus BRYANT 4. Harry EVANS (NGN) 5. Christopher SMITH (Co)
TF B4/B1.88	Insulation Coordination Procedure for DC Cable System in HVDC Stations with Voltage Source Converters (VSCs)	1. Amit KUMAR
WG B4.87	Voltage Source Converters (VSC) HVDC Responses to Disturbances and Faults in AC Systems Which Have Low Synchronous Generation	1. Carl BARKER (C) 2. Yinru CHEN 3. Panos MARINAKIS 4. Agatha WILLIAMS-KELLY
JWG B4/A3.86	Fault Limiting Technologies for DC Grids	1. Xiaoze PEI 2. Masoud BAZARGAN
WG B4.85	Interoperability in HVDC Systems Based on Partially Open-Source Software	1. Perry HOFBAUER 2. Leandro VACIRCA
WG B4.84	Feasibility Study and Application of Electric Energy Storage Systems Embedded in HVDC Systems	1. Agusti ALVAREZ 2. John VODDEN 3. Paul JUDGE
WG B4.82	Guidelines for Use of Real Code in EMT Models For HVDC, FACTS and Inverter-based Generators in Power Systems Analysis	1. Pablo BRIFF 2. Robin GUPTA
WG B4.81	Interaction between Nearby VSC-HVDC Converters, FACTs Devices, HV Power Electronic Devices and Conventional AC Equipment	1. Omar JASIM 2. Ahmed ABOUSHADY 3. Afshin PASHAEI 4. Ziming SONG 5. Benjamin MARSHALL 6. Oluwole ADEUYI 7. Yurinov MAMBAU
JWG B4/A3.80	HVDC Circuit Breakers - Technical Requirements, Stresses and Testing Methods to Investigate the Interaction with the System	1. Dragan JOVCIC 2. Andrzej ADAMCZYK 3. Dechao KONG (O)
WG B4.79	Hybrid LCC/VSC HVDC Systems	1. Ziming SONG 2. Chandra SONNATHI 3. Emmanuel AMANKWAH
JWG B4/B1/C4.73	Surge and Extended Overvoltage Testing of HVDC Cable Systems	1. Antonios TZIMAS

WG B4.71	Application Guide for the Insulation Coordination of Voltage Source Converter HVDC (VSC HVDC) Stations	1. Damien FONTEYNE 2. Kamal SIRIWARDHANA 3. Davor VUJATOVIC 4. Amit KUMAR
WG B4.69	Minimizing Loss of Transmitted Power by VSC During Overhead Line Fault	1. Robin GUPTA
WG B4.64	Impact of AC System Characteristics on the Performance of HVDC Schemes	1. Carl BARKER 2. Dragan JOVCIC 3. Andre CANELHAS 4. Robin PREECE 5. Vincent MALALA
JWG C4/B4.52	Guidelines for sub-synchronous oscillation studies in power electronics dominated power systems	1. Afshin PASHAEI 2. Elisabetta LAVOPA

- Completed Working Groups and UK Members for Contribution

Table 2 – Completed Working Groups and UK Members for Contribution

Number	Title	UK Member for Contribution
WG B4-66	Implications for Harmonics and Filtering of Staged Installation of HVDC Converter Stations in Proximate Locations	1. Nigel SHORE
WG B4-68	DC Side Harmonics and Filtering in HVDC Transmission Systems	1. Nigel SHORE (C) 2. Gearoid O'HEIDHIN 3. Kah-Leong KOO
WG B4.70	Guide for Electromagnetic Transient Studies Involving VSC Converters	None
WG B4-72	DC Grid Benchmark Models for System Studies	1. Mike BARNES 2. Jun LIANG 3. Joseph AWODOLA (Co)
WG B4.74	Guide to Develop Real-Time Simulation Models (RTSM) For HVDC Operational Studies	1. Ziming SONG 2. Gen LI
WG B4.75	Feasibility Studies for Assessment of Lab Losses Measurement of VSC Valves	1. Colin DAVIDSON
WG B4.76	DC-DC Converters in HVDC Grids and for Connections to HVDC Systems	1. Dragan JOVCIC (C) 2. Ali JAMSHIDIFAR 3. Adria JUNYENT-FERRE
WG B4.77	AC Fault Response Options for VSC HVDC Converters	1. John GLEADOW (C) 2. Carl BARKER
WG B4.78	Cyber Asset Management For HVDC/FACTS Systems	None
WG B4.83	Flexible AC Transmission Systems (FACTS) Controllers' Commissioning, Compliance Testing and Model Validation Tests	1. Graeme BATHURST 2. Timothy MILES
JWG C2/B4.38	Capabilities and Requirements Definition for Power Electronics Based Technology for Secure and Efficient System Operation and Control	1. Christopher SMITH 2. Yunjie GU
JWG C6/B4.37	Medium Voltage DC Distribution systems	1. James YU (C) 2. Jun LIANG (S) 3. Tobin JOSEPH

		4. Gen LI 5. Norman MACLEOD 6. Samuel JUPE 7. Andrew MOON 8. Wei LIU (Co)
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13RM Report on SC B5 Protection and Automation

13.1 Study Committee Scope

SC B5 Chair: Rannveig Løken (Norway)

SC B5 Secretary: 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)

SC B5 Green Books Peter Bishop (New Zealand)

Substation Automation (TG.51), Volker Leitloff (France)

Protection & Monitoring (TG.52), Bogdan Kasztenny (US)

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 Cigre Centennial 2021 - Preferential Subjects

The Centennial virtual event Paris Session 2021 for Study Committee B5, Protection and Automation was held from 24th to 25th of August in Paris local time (CET) to present sessions related to papers from the two selected preferential subjects; Human aspects in Protection, Automation and Control (PACS) and Communication network in Protection, Automation and Control (PACS): Experience and Challenges.

The virtual meeting was chaired by the Study Committee B5 Chair, Rannveig S. J. Løken, supported by Volker Leitloff (France) in Paris and Mr. Simon Hussey, Mr John Wright, and Mr. Richard Adams as SC B5 Secretary remotely.

PS 1 HUMAN ASPECTS IN PROTECTION, AUTOMATION AND CONTROL SYSTEMS (PACS)
Special reporter: Simon Hussey (IE)

- **17 Papers from 13 Different Countries – 10 Questions: 18 Prepared Questions Accepted**

PS 2 COMMUNICATIONS NETWORKS IN PROTECTION, AUTOMATION AND CONTROL SYSTEMS (PACS): EXPERIENCE AND CHALLENGES
Special reporter: John Wright (UK)

- **23 Papers from 15 Different Countries – 10 Questions: 25 Prepared Questions Accepted**

During the session a presentation was given NGN - **Design of IEC 61850 Adapter supporting various communication systems used in Telecontrol: By Saroj Paudel (Japan)**

13.4 New Working Groups

Number	Title	UK Member
WG B5.74	Busbar Protection Considerations When Using IEC 61850 Process Bus	UK RM: Mohseen Moheemmed, SSE UK CM: Robert Leone, Siemens UK CM: Rasoul Azizipanah, Nationalgrideso
WG B5.75	Documentation and version handling related to Protection, Automation and Control functions	UK CM: Piotr Sawko, GE UK CM: Daniel Dantas, Nationalgrid
WG B5.76	Architecture, Standards and Specification for metering system in a Digital Substation and Protection, Automation and Control (PACS) Environment	UK RM: Ian Nicoll, elxon UK CM: Joao Jesus, GE

13.5 Technical Panel Meetings, Seminars & Tutorials

Meetings:

- Joint B5 & D2, 18/11/21, University of Brunel
- TP meeting virtual 27/10/21

13.6 Technical Brochures

Reference	Working Group	Title
843	WG B5.62	Life Cycle Testing of Synchrophasor Based Systems used for Protection, Monitoring and Control
829	JWG C4/B5.41	Challenges with series compensation applications in power systems when overcompensating lines

13.7 Last B5 Study Committee Meeting (Highlights)

Given the ongoing Covid-19 situation and the replacement of the Paris Session by virtual session, the meeting was held virtually via GoToMeeting on August 26th and 27th, 2021.

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 4 new working groups were selected for 2021:

- New WG1 – PACS Design for Reliability
- New WG2 – Requirements for IT and OT Managed PACS
- New WG3 – Protection Roadmap for Low Inertia and Low Fault Current Networks
- New WG4 – New Requirements of Network Protection & Control for Renewable Energy Integration

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.

3 Preferential Subjects were also selected at the Meeting for the 2023 Colloquia: (Potential Cairns)

- Interoperability for IEDs of Different Manufacturers Integrated in one PAC
- IEC61850 Engineering & Test Tools & Settings
- Improvement in Fault Detection

The special reporters for Paris 2022 were also names for the preferential subjects:

PS1 Addressing protection related challenges in network with low-inertia and low fault-current levels
Special Reporter: Sean McGuinness(IE)

PS2 Applications of emerging technology for protection automation and control
Special Reporter: Tianshu Bi(CN)

PS3 Integration of intelligence on substations(Joint PS with B3)
Special Reporter: Peter Kreutzer (CH)

Next Event: **Slovenia** (Ljubljana) 41stInternational CIGRE Symposium related to “Reshaping the Electric Power System Infrastructure” 21 – 25 November 2021

13.8 Awards

The following awards were presented by the B5 SC Chair – Rannveig Loken to UK and Ireland members

- Cigre Pioneer e-session awards: Simon Hussey, John William Wright, Richards Adams
- 2021 B5 SC Technical Council Award : John William Wright

13.9 Current Working Groups and UK Members

Number	Title	UK Member
B5.48	Protection for developing network and different characteristics of generation	Convenor: Tianshu Bi CM: Philip Newman, GE CM: Fahd Hashiesh, ABB
B5.55	Application of Travelling Wave Technology for Protection and Automation	Convener : Peter Crossley (UK) Vladimir Terzija, (non UK)
B5.56	Optimization of Protection Automation and Control Systems	Convener : Klaus-Peter Brand (CH) RM Peter Watson, WSP CM John Wright, GE
WG B5.57	New challenges for frequency protection	Convenor: Vladimir Terzija, (non UK) RM : Dechao Kong, NG UK CM: Bojana Djukic, Scottish Power,
WG B5.58	Faster protection and network automation systems	Convenor: Andrei PODSHIVALIN (RU) RM: Abraham Varghese, GE
WG B5.60	Protection, Automation and Control Architectures with Functionality Independent of Hardware	Convener : Alexander Voloshin (RU) RM - Abraham Varghese, GE Grid Solution UK, CM- Veronika Koseleva, J. Murphy & Sons Limited UK
JWG B5/C4.61	Impact of Low Inertia Network on Protection and Control	Convenor: Ray Zhang(NG UK) Sec: V. Terzija, no UK

		RM: Supipi Weerasinghe Ramboll (UK) RM: Bikash Pal, Imperial college (C4) CM: Xin Zhang National Grid (UK)
WG B5.63	Protection, Automation and Control System Asset Management	Convenor : Massimo PETRINI (IT) CM-John Wright from GE
WG B5.64	Methods for Specification of Functional Requirements of Protection, Automation, and Control	Convener: Iony Patriota de Siqueira (BR) RM-Dr Tom Charton from National Grid, CM - Steven Blair - Synaptec
WG B5.65	Enhancing Protection System Performance by Optimising the Response of Inverter-Based Sources	RM: Colin Scoble - UKPN CM: Patricia Horton (GE) Dave Hewings (Network rial)
JWG B5.D2.67	Time in Communication Networks, PAC Applications – Time Sources and Distribution Methods	RM: mingyu.han- UoM (moved to China) CM: chee-pinp.teoh - GE
WG B5.68	Optimisation of IEC 61850 PACS Eng. process & tools	RM: Linwei Chen – NG CM: Suresh kalaichelvan - GE CM: Mark Stockton - SSE
WG B5.69	Experience and Recommendations for Implementation of Process Bus in PACS	Convenor: Alex Apostolov US RM:Thomas Charton - NG CM: Jason Vieira Ferreira - Siemens
WG B5.70	Reliability of PACS of power systems – Evaluation Methods and Comparison of Architectures	Convenor: Alexander Voloshin (RU) RM: Chris More - Siemens CM: Haiyu Li - UoM CM: Hengxu Ha, - GE
WG B5.71	Communication Requirements for Inter-Substation and Wide Area Applications	CM: Mohammed Younes, Linxon CM: Shimeh Jahangiri, Balfour Beatty RM: Mark Stockton, SSE
WG B5.72	Modelling, Assessment, and Mitigation of Protection Performance Issues caused by power plants during Dynamic Grid Events	RM: Peter Watson, WSP CM: Usman Ajmal, GE CM: Dr Jianing Li, Uni Of Birmingham CM: Dr Daniel Gheorghe, Reactive Technologies
WG B5.73	Experiences and Trends related to Protection Automation and Control Systems Functional Integration	RM: Joao Pestana. GE CM: Yasemin Baygar, Siemens CM: Saurabh Makwana, GE

13.10 UK Members of the Technical Panel

Chairman: John Wright

Secretary: Gen Li

The following positions are in the process of being confirmed.

- Academia by Haiyu Li / Xiao-Ping Zhang
- Transmissions by Mark Stockton / Thomas Charton / Craig McTaggart
- Distributions by Sean Stack / Colin Scoble
- Manufacturers (OEMs) by Danny Lyonette / Chris More
- Consultancies/Contractors by Peter Watson
- Others/Rail by Dave Hewings
- NGN : Zhenkun Yang
- Women's Network : Bojana Djukic / Anis Yaakob

- Testing – Ali Abdulla - Om

14RM Report on C1 System Development and Economics

14.1 Study Committee Scope

SC Chair: Antonio Iliceto
SC Secretary: Peter Roddy

The scope of SC C1 is to study economic and system analysis methods important for the development of power systems and to assist utilities to find the best solutions in various evolving, competitive and unbundled conditions in the context of the overall energy supply system and with social and environmental considerations.

14.2 Strategic Advisory Groups

System Development – Ronald Marais (South Africa)
Business Management – Chongqing Kang (China)
Asset Management – Graeme Ancell (Australia)
Horizontal and Vertical Integration & Data – Juan Carlos Araneda (Chile)
Tutorials/webinars – Keith Bell (Scotland)

14.3 Draft Preferential Subjects

Preferential subjects for 2022 symposium in Kyoto and Paris session 2022 now finalised.

14.4 New Working Groups

Four new working groups were set up this year and terms of reference for a further joint working group with B1 is being developed.

14.5 Technical Panel Meetings, Seminars & Tutorials

2020 Paris session run virtually in August/September 2021 for Cigre centenary Tutorials

- Joint webinar with C6 on Hydrogen
- C1 Tutorial on System resilience and climate change mitigation/adaptation

UK activities:

- C1 webinar delivered by Charlotte Higgins in January 2021
- C1 technical liaison session delivered in mid June 2021
 - Guest Speakers - Graeme Hawker (University of Strathclyde), Alice Etheridge (NG ESO)
 - Panel Session on Net Zero and Network Resilience (facilitated by Charlotte Higgins with Bless Kuri (SHE-T), Laura Kane (SGS), Graeme Hawker (Uni Strathclyde) and Alice Etheridge (NG ESO))
 - C1 Technical Working Groups Updates
 - C1 Study Committee Update
 - Selected C1 Technical Papers from Paris 2020 e-Session
 - Proposals for future C1 activities

Next events with expected C1 webinars:

- Vienna SEERC 29 Nov- 2 Dec, 2021 → Tutorial on Multi-Party Interconnections
- Paris General Session August 2022 → Workshop 'EXTRA-LONG TRANSNATIONAL TRANSMISSION LINKS'

Technical Brochures

Final Technical Brochure by C1.39

14.6 Last Study Committee Meeting (Highlights)

2022 Paris Session, in person

Preferential subjects are as follows:

PS 1 / SYSTEM TRANSITION RESILIENCE & ASSET MANAGEMENT RESPONSE

- Resilience metrics and measures to safeguard stakeholder value through grid forming, power electronics control, smart load shedding, fast restoration,
- Response to unexpected emerging system and business risks during the energy transition,
- New standards (equipment design and system planning) for resilient and life-cycle sustainable system.

PS 2 / ENERGY SECTOR INTEGRATION AND TACKLING THE COMPLEXITY OF MULTI-FACETED NETWORK PROJECTS

- Energy sector integration, hydrogen & power-to-gas, deep electrification: technical and economic aspects,
- Multi-purpose, multi-terminal, multi-actor, multi-jurisdiction grid projects: how to tackle their planning complexity,
- Including in the planning process the flexibility options from non-network-assets and non-electric solutions (storage, virtual power plants, DR, energy communities, behind-the-meter resources).

PS 3 / PLANNING UNDER UNCERTAINTY AND WITH CHANGING EXTERNAL CONSTRAINTS

- Modelling the impact of environmental conditions, technical advancements, greater stakeholder involvement, generation fleet shift, new type of contingencies, use of data driven network methods for long-term load forecasting, including impact of COVID pandemic on load profiles, planning scenarios, investments patterns and assets' maintenance schemes,
- Decision-making under pervasive energy policies: optimising economic vs environmental benefits for consumers and matching centralized energy targets with private driven investments,
- Leveraging the evolving system services, market products and load profiles to optimize investment and timing, avoiding stranded assets (also from fossil plants dismissal)

Kyoto Symposium Apr 2022

- PS1: Driving towards an enhanced system reliability, security and resiliency
- PS2: New commercial and technical relations between TSO, DSO, and customers
- PS3: Innovative developments for a sustainable power network

Study Committee (Sep 21) - virtual

- Updates from all active working groups and recently closed working groups
- Update on C1 session and webinars/tutorials
- Increase interaction with young engineers
- Articles on Hydrogen, Africa energy future, Sector Coupling, WG C1.47 topics, Global Interconnections, WG C1.44 several dissemination activities

- Green Book Supply Systems of the Future → published
- Green Book on Asset Management → final version under editor processing → publication forthcoming
- TC has the goal of preparing for 2022/2023 a Green Book on E2E: End-to-End energy system
- Discussed and agree new Working Groups
- Reasonable attendance

14.7 Current Working Groups and UK Members

Number	Title	UK Member
C1.23	Transmission investment decision points and trees	Daniel Clarke (National Grid)
C1.33	Interface & Allocation Issues in multi-party and/or cross-jurisdiction power infrastructures projects	Callum McIver (Uni. Of Strathclyde)
C4/C1.36	Review of Large City & Metropolitan Area Power System Development Trends Taking into Account New Generation, Grid and IT	Priank Cangy (RINA Consulting) Supipi Weerasinghe (TNEI) <i>Based on Paris update</i>
C1.37	Optimal transmission and distribution investment decisions under growing uncertainty	None
C1.40	Planning Co-ordination between System Operators, Transmitters and Distributors	Arash Nateghi (National Grid) Laura Kane (Smarter Grid Solutions) Rui Zhang (National Grid)
C1.41	Closing the gap in understanding between stakeholders and electrical energy specialists	John Wilson (National Grid) Colin Ray (Consultant) Simon Gill (Scottish Government) + UK sub-group
C1/6.42	Planning tools and methods for systems facing high levels of distributed energy resources	Charlotte Higgins (TNEI) Xiaolong Hu (National Grid)
C1.43	Defining a typical set of requirements for Asset Analytics data platforms and tools aimed at supporting Asset Management decision making processes	None
C1.44	Global Interconnected and sustainable electricity system - Effects of storage, demand response and trading rules	None
C1.45	Harmonised metrics and consistent methodology for benefits assessment in Cost-Benefit Analysis (CBA) of electric interconnection projects	Ninad Lale Rohit Trivedi
C1.46	Optimising power system resilience in future grid design	Mathaios Panteli (University of Cyprus) Calum Mackenzie
C1.47	Energy Sectors Integration and impact on power grids	Graeme Hawker (University of Strathclyde) Polly Osborne (Burns McDonnell)

C1.48	Role of green hydrogen in energy transition: opportunities and challenges from technical and economic perspectives	James Crouch (Burns McDonnell) Callum Dell (WSP)
B2/C1	Asset Management of Overhead Transmission Lines	<i>New</i>
C6/C1.33	Multi-energy system interactions in distribution grid	Eduardo Martinez-Cesena (University of Manchester)

14.8 UK Members of the Technical Panel

Ewa Krzywkowska (NGESO) – Secretary
 Other members tbc

15RM Report on SC C2 System Operation and Control

15.1 Study Committee Scope

SC Chair: **Jayme Darriba Macedo**

SC Secretary: **Flavio Alves**

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

For the Paris 22 Session the following subjects are under consideration

PS 1 / System control room preparedness: today and in the future

- > Operator training, situational awareness and decision supporting tools,
- > Effective and efficient use of synchro-phasor data in power systems operation,
- > Advanced and intelligent methods applied to power systems operation.

PS 2 / Operational planning strategies, methodologies and supporting tools

- > High share of grid-connected and distributed power electronic interfaced resources including hybrid AC-DC systems,
- > Advanced and intelligent methods applied to power systems operational planning and day-ahead programming,
- > Impact of low demand and other predictable extreme operating conditions.

15.4 New Working Groups

Number	Title	UK Member
WG C2.46	The impact of the growing use of machine learning based Artificial Intelligence in the operation and control of Power Networks from an Operational perspective	Ronan Jamieson

15.5 Technical Panel Meetings, Seminars & Tutorials

- Large Disturbances Workshop – Paris 2021.
- Tutorial – WG C2.25 Operating strategies and preparedness for system operational resilience

15.6 Technical Brochures

TB 845 - TSO-DSO Co-Operation Control Centre Tools Requirements by WG C2.40.

TB 883 - Operating strategies and preparedness for system operational resilience by WG C2.25

Published Reference Paper

- Tools and Techniques for System Restoration – B. Badrzadeh et al.
- System Strength Challenges and Solutions Developed for a Remote Area of Australian Power System with High Penetration of Inverter - Based Resources – B. Badrzadeh et al.
- Capabilities of Power Electronic Devices in Enabling the Energy Transition and Mitigating System Operational Challenges - J. van Putten et al.
- Sustained islanding operation of a normally interconnected power system with a high share of inv

15.7 Last Study Committee Meeting (Highlights)

Virtual Session -

- Much discussions around the Paris 2022 session, plus whether the next session would be held virtual or hybrid

UPCOMING EVENTS

- 2022 Symposium: Japan
- 2022 CIGRE Session
- 2023 Symposium Proposal: Australia

15.8 Current Working Groups and UK Members

Number	Title	UK Member
JWG C2.39	Operator Training in Electricity Grids at Different Control Levels and for Different Participants/Actors in the New Environment	None
JWG C2/C5.05	Development and changes in the business of system operators	Dozie Nnabufie
JWG C2/B4.38	Capabilities and requirements definition for Power Electronics based technology for secure and efficient system operation and control	None
JWG C2/C4.41	Impact of high penetration of inverter-based generation on system inertia of networks.	None
JWG C2/C5.06	The Impact of Electricity Market Interventions by System Operators during Emergency Situations	Christopher Challan
WG C2.26	Power system restoration accounting for a rapidly changing power system and generation mix	Dan Auty
WG C2.24	Mitigating the risk of fire starts and the consequences of fires near overhead lines for system operations	None
WG C2.25	Operating Strategies and Preparedness for System Operational Resilience	None

15.9 UK Members of the Technical Panel

RM – Ronan Jamieson (National Grid – ESO)

16RM Report on SC C3 System Environmental Performance

16.1 Study Committee Scope

SC Chair: Mercedes Vázquez Miranda (ES)

SC Secretary: Cesar Batista (BR)

The scope of SC C3 is to cover the assessment and management of interactions between the natural and social environments, and the end-to-end electric power system, recognising the importance and influence of a wide range of stakeholders and communities. Recommendations for appropriate monitoring, management and control measures in fields such as greenhouse gasses, air, soil, and water, electric and magnetic fields, noise, visual amenity, land use and consequences for flora and fauna.

16.2 Strategic Advisory Groups

One SAG, to advise the SC Chair. UK Member Hector Pearson is a SAG member.

16.3 Preferential Subjects

The Draft Preferential Subjects for 2022 Paris Session are:

PS1: Setting ambitious climate strategies

- Standards and methods used to define goals and carbon reduction pathways.
- Reasons for setting ambitious climate strategies and benefits resulting from them.
- Company internal and external challenges to commit to an ambitious climate strategy and possible solutions.

PS2 Biodiversity and the supply of electricity: risks, challenges, solutions and opportunities

- Showcase how biodiversity has been enhanced in a Generation (including renewables), Transmission or Distribution project.
- Showcase how biodiversity has been accommodated in a Generation (including renewables), Transmission or Distribution project.
- Highlight special measures or actions taken to protect biodiversity impacted by a Generation (including renewables), Transmission or Distribution project.

PS3 (JPS with B2): Combination of B2 proposal and Engineering solutions to Environmental Challenges).

16.4 New Working Groups

No new working groups, although several proposals were discussed at the last Study Committee meeting in August 2021.

16.5 Technical Panel Meetings, Seminars & Tutorials

A tutorial on Environmental Issues of High Voltage Transmission Lines in Urban and Rural Areas will be given by UK Member Hector Pearson at the Cigre Ljubljana Symposium in November 2021.

16.6 Technical Brochures

None in 2021.

16.7 Last Study Committee Meeting (Highlights)

Last SC meeting held via video conference in August 2021. At the meeting Mercedes Vázquez Miranda (ES) introduced herself as the new SC Chair, following Flavia Serran’s (BR) departure. Updates were given on the progress of current the Working Groups.

16.8 Current Working Groups and UK Members

Number	Title	UK Member
C3.01	EMF and Human Health	
C3.09A	Corridor management	Hector Pearson
C3.12	Methodologies for greenhouse gas inventory and distribution activities	
C3.14	Impact of environmental liability on transmission and distribution activities	
C3.15	Best environmental and socioeconomic practices for improving public acceptance of high voltage substations	Hector Pearson
C3.16	Interactions between electrical infrastructure and wildlife	
C3.17	Interaction between wildlife and emerging renewable energy sources and submarine cables	
C3.18	Eco-friendly approaches in transmission and distribution	
C3.19	Responsible management of the electric and magnetic fields issue	Hayley Tripp
C3.20	Sustainable development goals in the power sector	
C3.21	Including stakeholders in the investment planning process (Renewed TOR of former JWGC1/C3.31)	Josie Turner

16.9 UK Members of the Technical Panel

None.

17RM Report on SC C4 System Technical Performance

17.1 Study Committee Scope

SC C4 Chair: Dr Zia Emin (UK)

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](#).

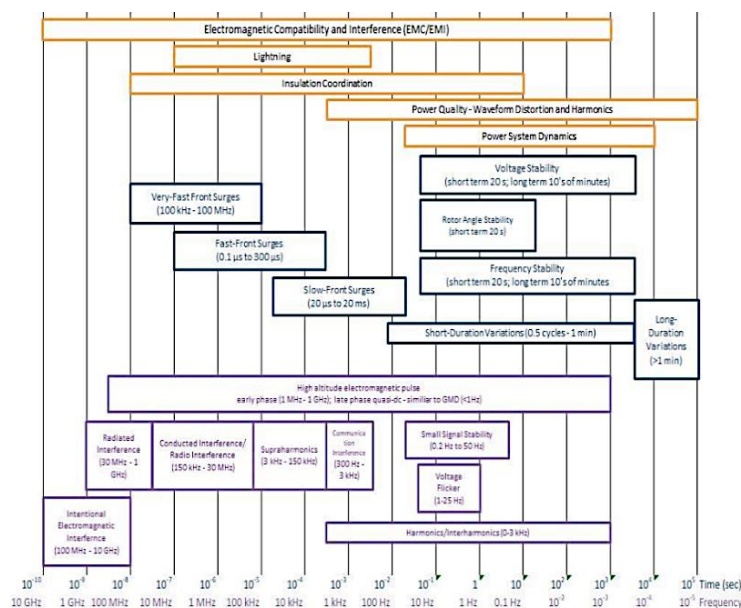


Figure 17.1: Time Frame with the Range of Phenomena Investigated by SC C4.

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 42 countries. At the 2021 SC C4 online meeting on Friday, August 28th, the composition of the SC was confirmed as follows:

- Chairman and Secretary
- 24 Regular Members and 3 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) – Convenor: Dr Zia Emin (UK)
- Customers AG C4.2 (CAG) – Convenor: Dr Filipe Faria da Silva (DK)
- Tutorials & Conferences AG C4.3 (TAG) – Convenor: Marta Val Escudero (IE)

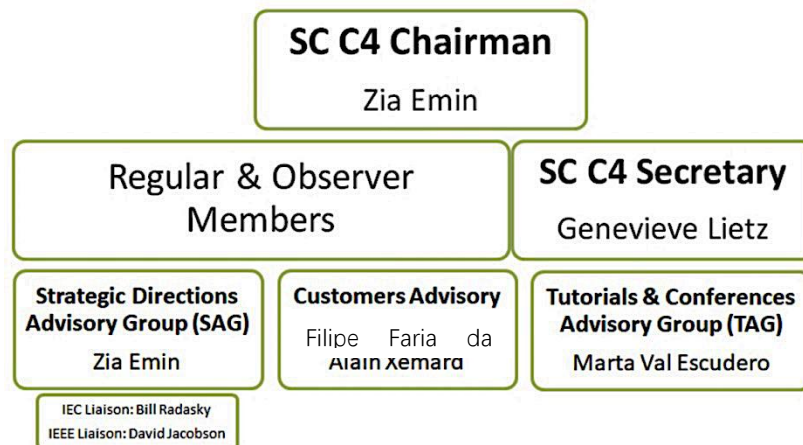


Figure 17.2: Organisational Structure of SC C4.

17.3 CIGRE SESSION 2022 – Preferential Subjects

The Preferential Subjects (PS) for the CIGRE 2022 Paris Session are the following:

PS 1: Challenges and Advances in Power Quality (PQ) and Electromagnetic Compatibility (EMC)

- Modelling, measurement and assessment of PQ phenomena including emerging areas such as supra-harmonics, harmonic instability, geomagnetically induced currents and other,
- Integration and application of advanced signal processing, artificial intelligence techniques and big data analytics for event diagnostics and system planning purposes such as hosting capacity or emission limit calculation,
- Impacts on equipment compatibility and immunity, and emerging mitigation approaches.

PS 2: Challenges and Advances in Insulation Coordination and Lightning Research

- Insulation coordination practices for end-to-end power networks, including the effects of long lines, long cables and frequency-dependent models,
- Development on IC in power electronics and DC systems, and the need for standardisation,
- Lightning evaluation of transmission and distribution systems covering new asset designs and extreme meteorological events.

PS 3: Challenges and Advances in Power System Dynamics

- Modelling, analysis and validation of individual components and wide-area system interactions including system-level protection schemes considering changing system dynamics,
- Impact of emerging technologies such as hydrogen and other storage devices, grid forming inverters and demand-side management,
- Analysis of security and resilience of power systems having a high share of grid-connected or distributed IBR including the feasibility of providing system support such as black start, islanding, system strength and inertia.

17.4 Current Working Groups and UK Members

SC C4 presently consists of some 39 active (J)WGs performing highly technical work aligned with its strategic fields. These WGs are composed of over 600 individual technical experts from 50+ countries around the world, some serving in more than one WG. The number of active WGs by topic is as follows:

Number	Title	UK Member
<u>WG C4.36</u>	Winter Lightning – Parameters & Engineering Consequences for Wind Turbines	
<u>JWG C1/C4.36</u>	Review of Large City & Metropolitan Area power system development trends taking into account new generation, grid and information technologies.	
<u>WG C4.39</u>	Effectiveness of line surge arresters for lightning protection of overhead transmission lines	
<u>JWG C4.40/CIREd</u>	Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14	Emin, Zia Foster, Sarah Koo, Leong Vujatovic, Davor
<u>JWG C2/C4.41</u>	Impact of high penetration of inverter-based generation on system inertia of networks	
<u>JWG C4.42/CIREd</u>	Continuous assessment of low-order harmonic emissions from customer installations	Djokic, Sasa Moore, Fabian
<u>WG C4.43</u>	Lightning problems and lightning risk management for nuclear power plants	Siew, Wah-Hoon Knott, Robert
<u>WG C4.44</u>	EMC for Large Photovoltaic Systems	Siew, Wah-Hoon
<u>WG C4.46</u>	Evaluation of Temporary Overvoltages in Power Systems due to Low Order Harmonic Resonances	Mills, David Pashaei, Afshin Peng, Jinsheng
<u>JWG C1/C4.46</u>	Optimizing power system resilience in future grid design	Panteli, Mathaios
<u>WG C4.47</u>	Power System Resilience (PSR WG)	Rapier, Aisling Panteli, Mathaios Skarvelis-Kazakos, Spyros Strbac, Goran Zhou, Yutian
<u>WG C4.48</u>	Overvoltage Withstand Characteristics of Power System Equipment 35-1200 kV	Moore, Fabian Kho Tiong Aik, Denis
<u>WG C4.49</u>	Multi-frequency stability of converter-based modern power systems	Mills, David Xiaoling, Ding Shore, Nigel

<u>WG C4.50</u>	Evaluation of Transient Performance of Grounding Systems in Substations and Impact on Primary & Secondary System	Negi, Himanshu
<u>WG C4.51</u>	Connection of Railway Traction System to Power Network	Emin, Zia Vujatovic, Davor-Convenor
<u>JWG A2/C4.52</u>	High-frequency transformer and reactor models for network studies	Vujatovic, Davor Jamil, Shakin
<u>JWG A1/C4.52</u>	Wind generators and frequency-active power control of power systems	Horne, Jonathan
<u>JWG C4/B4.52</u>	Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems	
<u>JWG C4/A3.53</u>	Application Effects of Low-Residual-Voltage Surge Arresters in Suppressing Overvoltages in UHV AC Systems	Haddad, Manu
<u>WG C4.54</u>	Protection of high voltage power network control electronics from the High-altitude Electromagnetic Pulse (HEMP)	Hoad, Richard
<u>WG C4.55</u>	EMC related very-fast transients in gas-insulated substations - EMC interferences, measured characteristics, modelling and simulations	James, Jonathan Haddad, Manu
<u>WG C4.56</u>	Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter connected generation	Pashaei, Afshin Sridhar, Sahukari
<u>WG C4.57</u>	Guidelines for the Estimation of Overhead Distribution Line Lightning Performance and Application to Lightning Protection Design Scope	Haddad, Manu
<u>JWG C4/C2.58/IEEE</u>	Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems	Awadallah, Selma
<u>WG C4.59</u>	Real-time Lightning Protection of the Electricity Supply Systems of the Future	
<u>WG C4.60</u>	Generic EMT-Type Modelling of Inverter-Based Resources for Long Term Planning Studies	Rui Li Vozikis, Dimitrios Nieto, Alejandro Larkins, Andrew Jahromi, Amir Abiri
<u>WG C4.61</u>	Lightning transient sensing, monitoring and application in electric power systems	
<u>JWG B5/C4.61</u>	Impact of Low Inertia Network on Protection and Control	Zhang, Ray - Convenor
<u>JWG: C4/C2.62/IEEE</u>	Review of Advancements in Synchrophasor Measurement Applications	Blair, Steven Clark, Stuart Simmons, Clarke Li, Yun Cowan, Ian L Shams, Negar
<u>WG C4.63</u>	Harmonic power quality standards and compliance verification – a comparative assessment and practical guide	Shore, Nigel – Convenor Koo, Kah-Leong Djokic, Sasa
<u>WG C4.64</u>	Application of Real-Time Digital Simulation in Power Systems	
<u>WG C4.65</u>	Specification, Validation and Application of Harmonic Models of Inverter Based Resources	Pampana, Ramesh Monteiro, Jose
<u>WG C4.66</u>	New concept for analysis of multiphase back-flashover phenomena of overhead transmission lines due to lightning	Nurashikin, Jamil
<u>JWG A1/C4.66</u>	Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators	
<u>WG C4.67</u>	Lightning Protection of Hybrid Overhead Lines	

<u>WG C4.68</u>	Electromagnetic Compatibility (EMC) issues in modern and future power systems	Ragusa, Antonella Frosinou, Asimina
<u>WG C4.69</u>	Quantifying the lightning response of tower-footing electrodes of overhead transmission lines: methods of measurement	
<u>JWG B1/C4.69</u>	Recommendations for the insulation coordination on AC cable systems	
<u>WG C4.70</u>	Application of space-based lightning detection in power systems	
<u>JWG B4/B1/C4.73</u>	Surge and extended overvoltage testing of HVDC Cable Systems	
<u>JWG B2/C4.76</u>	Lightning & Grounding Considerations for Overhead Line Rebuilding and Refurbishing Projects, AC and DC	

The number of the above-mentioned 39 active (J)WGs by topic is as follows:

- Power Systems Performance Models and Numerical Analysis (PMNA): 14 (J)WGs
- Power quality (PQ): 6 (J)WGs
- EMC/EMI: 4 (J)WGs
- Insulation Coordination (IC): 6 (J)WGs
- Lightning (L): 9 (J)WGs

17.5 New Working Groups

During the 2020 Annual SC C4 meeting, it was decided to put together a list of areas that require further consideration and propose possible new WGs. As a result of this gap analysis, 12 new WGs were formed in SC C4 since October 2020 as listed below and work is in progress to propose further WGs:

- **WG C4.60:** “Generic EMT-Type Modelling of Inverter-Based Resources for Long Term Planning Studies”
- **WG C4. 61:** “Lightning transient sensing, monitoring and application in power systems”
- **JWG C4/C2.62/IEEE:** “Review of Phasor Measurement Unit Applications”.
- **WG C4.63:** “Harmonic power quality standards and compliance verification”
- **WG C4.64:** “Application of Real-Time Digital Simulation in Power Systems”
- **WG C4.65:** “Specification, Validation and Application of Harmonic Models of Inverter Based Resources”
- **WG C4.66:** “New concept for analysis of multiphase back-flashover phenomena of transmission lines due to lightning”
- **WG C4.67:** “Lightning Protection of Hybrid Overhead Lines”
- **WG C4.68:** “EMC issues in modern and future power systems”
- **JWG C1/C4.46:** “Optimising power system resilience in future grid design”
- **WG C4.69:** “Quantifying the lightning response of tower-footing electrodes of overhead transmission lines: methods of measurement”
- **WG C4.70:** “Application of space-based lightning detection in power systems”

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 2020 as a result of work done by SC C4 WGs and JWGs:

- TB 829: “Challenges with series compensation applications in power systems when overcompensating lines”, JWG C4/B5.41, 2021.
- TB 836: “Measuring techniques and characteristics of fast and very fast transient overvoltages in substations and converter stations”, WG C4.45, 2021.
- TB 839: “Procedures for Estimating the Lightning Performance of Transmission Lines – New Aspects”, WG C4.23, 2021.
- TB 063 – Re-issue: “Guide to procedures for estimating the lightning performance of transmission lines”, WG C4.23, 2021.

The following Technical Brochures are being finalised for publication in 2022:

- WG C4.36: “Winter Lightning – Parameters and Engineering Consequences for Wind Turbines”
- JWG C1/C4.36 “Review of Large City & Metropolitan Area power system development trends taking into account new generation, grid and information technologies”
- WG C4.39: “Effectiveness of line surge arresters for lightning protection of OTLs”
- JWG C4.42/CIRED: “Continuous assessment of low-order harmonic emissions from customer installations”
- WG C4.43 “Lightning problems and lightning risk management for nuclear power plants”
- JWG B4/B1/C4.73 “Surge and extended overvoltage testing of HVDC Cable Systems”
- JWG A2/C4.52 “High-frequency transformer and reactor models for network studies”
- JWG A1/C4.52 “Wind generators and frequency-active power control of power system”

SC C4 has also produced 1 **Reference Paper** since October 2020, entitled “System Strength” ELECTRA N.315 April 2021. The Reference Paper had an accompanying paper published in the CIGRE Science & Engineering Journal’s Volume No 20, February 2021 issue.

SC C4 embarked on a new **Green Book** on “Power system dynamic modelling and analysis in evolving networks” to be co-edited by Dr Babak Badrzadeh and Dr Zia Emin. Various chapters within the book will be led by SC C4 experts. The Green Book on power system dynamic modelling and analysis will provide information about all aspects of contemporary power system dynamic modelling and analysis in a rapidly changing power system with increasing uptake of inverter-based resources. It will also provide a comparison of changes occurring in conventional power systems with a dominance of synchronous generators, and an evolving power system with a high share of grid-connected and distributed inverter-based resources. Topics that will be addressed include dynamic phenomena experienced, analysis methods and simulation tools required, and enablers to achieve this.

17.7 Last Study Committee Meeting (Highlights)

The 2021 Annual SC C4 Meeting was held online on Thursday, August 26, during the CIGRE 2021 Virtual Centennial Session. The meeting agenda covered, among others, the following:

- Review of SC C4 Membership & Structure
- Study Committee Chairman's Report
 - The schedule and highlights of 2019-2021 Technical Council (TC) meetings
 - Key items related to WGs (e. g. WGs statistical information, rules for WGs creation, membership and management)
 - Evolution of WGs and Communication strategy used within CIGRE.

- Other topics related to the synthesis of the 2020 review, the CIGRE awards to SC C4 members in 2021 and the involvement of women in CIGRE
- Advisory Group 1 - Strategic Directions (SAG)
 - Summary of the status of AG1 membership
 - Summary of the status of current WGs and JWGs
 - Discussion regarding various WG issues; Task Force ToRs; Liaisons
 - Discussions for 9 new and 3 disbanded WGs
 - Strategic Plan 2018-2022
 - Evaluation of the Gap Analysis Task Force that has resulted in WGs
 - SC C4 System Phenomena Timeframes
 - Institutional Liaison (IEC, IEEE, etc.)
- Advisory Group 2 - Customers (CAG)
 - New C4.AG2 Convenor
 - Discussions for Task Force (TF) in SC C4 for Power Quality (PQ)
- Advisory Group 3 - Tutorials & Conferences (TAG)
 - Update on the new policy on tutorials
 - Review of recent events (6 webinars for 2020-2021)
 - Review of new proposals
 - WG outputs as tutorials (1 new Tutorials)
 - Future events – Slovenia 2021, Kyoto (Japan) Apr. 2022, Paris (France) Aug. 2022 and Cairns (Australia) 2023, ICLPS (Suzhou – TBD)
- Publications
 - Electra, CSE, Green Books, Reference Papers, Technical Brochures
 - Plan-ahead: 9 TBs close to being finalised
- Review of SC C4 Website and KMS
 - Suggestions to make this a better experience
- CIGRE Paris 2022 Session: Preferential Subjects
 - Preferential Subjects 1 – 3 (PS 1 – 3) for the SC C4 2022 in KMS
 - Special Reporters; Currently ~80 synopses have been submitted.
- Next SC C4 Meetings
 - CIGRE Session 2022 in Paris, France

Finally, all SC C4 members were encouraged to be active in the SC and use KMS instead of email for sending SC C4 documents and asking questions to SC and AG members.

17.8 Technical Panel Meetings, Seminars & Tutorials

As part of the **CIGRE 2021 Virtual Centennial Session (VCS)** that was held from Wednesday 18th to Friday 27th August 2021, SC C4 had two half-day General Discussion Meeting sessions mainly based on the Session Papers and WG updates, as well as a Workshop and Tutorial events described below:

- **The SC C4 VCS General Discussion and Paper Session** included **WG updates** and **56 papers** from more than 20 countries was held on August 24-25, covering the following 3 preferential subjects:
 - **PS1** – Improving Power System Technical Performance through the use of Advanced Methods, Models and Tools
 - **PS2** – Modelling of the Future Grid Based on Lessons Learned from System Events
 - **PS3** – Methods, Models, and Techniques for Evaluating Lightning, Power Quality, and Insulation Co-ordination to Enhance the Performance of the Evolving Grid
- **The SC C4 VCS Workshop** entitled: C4.56 WG – “EMT analysis for large-scale system impact studies in power systems having a high penetration of inverter connected generation” was held on August 23rd and its agenda is shown below:

Time	Speaker's name	Topic of intervention
12:00	Zia Emin	Introduction to SC C4
12:10	Babak Badrzadeh	Introduction
12:25	Nathan Crooks	Network model development
12:40	Jean Mahseredjian	Network model development
12:50	Jingwei Lu	Model acceptance testing
13:00	BREAK	
13:10	Sorrell Grogan	Wide-area EMT model validation
13:20	Mark Davies	Validation of wide-area EMT models with real-time simulation tools
13:35	Hani Saad	Hardware-in-the-loop (HIL) testing
13:45	Babak Badrzadeh	Q&A
14:10	BREAK	
14:20	Flavio Fernandez	Co-simulation
14:35	Jean Mahseredjian	Dynamic phasors
14:38	Mark Davies	Case study 1: Application of real-time EMT simulation for assessing real vs virtual synchronous machines
14:45	Sachin Goyal	Case study 2: control interaction mitigation: grid-forming inverters vs synchronous condensers
15:00	Hani Saad	Case study 3: Combined use of offline EMT, phasor-domain and HIL for large power systems
15:10	Jean Mahseredjian	Case study 4: The use of wide-area EMT simulation for protection system studies
15:20	Nathan Crooks	Case study 5: The use of cloud computing for wide-area EMT studies
15:30	Babak Badrzadeh	Q&A
15:55	Zia Emin	Closing remarks
16:00	FINISH	

- **The SC C4 VCS Tutorial** entitled: JWG C4/B5.41 – “Challenges with series compensation applications; the case of overcompensated lines” was held on August 27th.

In addition, the following **Webinars** related to SC C4 were delivered in 2021; the last three in conjunction with the National Committee in India:

- **WG C4.23:** “Procedures for Estimating the Lightning Performance of Transmission Lines – New Aspects”, by C.S. Engelbrecht, F.H. Silveira, I. Tannemaat and S. Visacro (July 2021).
- **WG C4.28:** “Extrapolation of Measured Values of Power Frequency Magnetic Fields in the Vicinity of Power Links”, by P. Munhoz (March 2021).
- **JWG C4/C6.35/CIREC:** “Modelling and Dynamic Performance of Inverter Based Generation in Power System Transmission and Distribution Studies”, by K. Yamashita, H. Renner, S. Martinez and P. Aristidou (February 2021).
- **WG C4.31:** “Assessment of Conducted Disturbances above 2 kHz in MV and LV Power Systems”, by D. Thomas (February 2021).


In terms of upcoming events supported by the CIGRE SC C4 Meetings, Seminars, and Tutorials will be planned are the following:

- **2022 CIGRE Symposium**
 - Kyoto (Japan): “Power system transformation including active distribution”, moved from October 2021 → April 2022 due to covid-19 planned event changes.
- **2022 CIGRE Paris Session, France**
- **2023 Symposium Proposal, Australia**
 - Cairns (Australia): “Renewables and challenges of integration and the impact of renewable generation on the Grid”, September 2023.
- **TBD International Colloquium on Lightning and Power Systems (ICLPS)**

17.9 UK SC C4 Technical Panel Members and Meeting

The 2021 CIGRE UK Study Committee C4 Technical Panel Liaison Meeting held in conjunction with the CIGRE UK SC C4 Technical Event entitled “Developments for Facilitating the Integration of RES in a Transforming Converter-Dominated Power-Grid” This online event was held on February 25th and was led by SC C4 UK Regular Member, Spyros Karamitsos. It aimed to provide a high-level overview of the ongoing activities in CIGRE related to C4 and bring together experts from industry and academia to present certain issues and discuss developments towards facilitating the integration of renewable

energy and the transformation of the power system into a future converter dominated grid. The 2021 CIGRE UK Event's Agenda is shown below:

 CIGRE UK SC-C4 Liaison Meeting & Technical Event 2021		
AGENDA		
Developments for Facilitating the Integration of RES in a Transforming Converter-Dominated Power-Grid		
Time	Topic	Presenter
11:00	Welcome from the UK Regular Member & Introduction to SC C4: Brief Overview and Updates	Dr Spyros Karamitsos, Senior Electrical Engineer at Scottish Power Renewables (SPR), CIGRE SC C4 Elected Regular Member for the UK
11:20	Works of the CIGRE JWG C4.31 and the resulted Technical Brochure TB 799 (2020): "Assessment of Conducted Disturbances above 2 kHz in MV and LV Power Systems"	Prof. Dave Thomas, Professor of Electromagnetics Applications in The George Green Institute for Electromagnetics Research, University of Nottingham. Convener of CIGRE JWG C4.31
11:50	Challenges and Opportunities Towards Resilient Power Systems: An Overview by the CIGRE WG C4.47 and an Introduction to JWG C1/C4.46	Dr Mathaios Panteli, Assistant Professor in Resilient, Low-Carbon Energy Systems, University of Cyprus. Co-Convener of CIGRE WG C4.47 and Member of JWG C1/C4.46
12:20	Break - Q&A	
12:30	Characteristics of Converter Dominated Power Grids - Integrating OWFs	Dr Spyros Karamitsos, Senior Electrical Engineer at Scottish Power Renewables (SPR), CIGRE SC C4 Elected Regular Member for the UK
13:00	Power Electronics Based Devices in the Grid and System Studies	Dr Afshin Pashaee, Power System Expert, Network Development, National Grid UK. Member of CIGRE WG C4.56, JWG C4/B4.52, WG B4.81
13:30	Introduction to TOTEM (Transmission Owner Tools for EMT Modelling)	Dr Ryan Tumilty, System Performance Manager, SSEN
13:40	Break - Q&A	
13:50	Changes in the Characteristics of the SP Transmission Network, the Phoenix H-Sc Project and the Future Role of Synchronous and Hybrid Synchronous Compensation.	Prof. Cornel Brozio, Network Planning and Regulation, SP Energy Networks
14:20	BlackStart Project: Experience of using a Wind Farm to Energise Part of the Transmission Network	Dr Paul Crolla, Senior Project Engineer, SPR Dr Isaac Gutierrez, Lead Electrical Engineer, Control & Grid Integration, SPR
14:50	Break - Q&A	
15:00	National HVDC Centre; Project Related De-Risking and Interoperability Research	Ben Marshall, HVDC Technology Manager, The National HVDC Centre. Member of CIGRE WG B4.81
15:30	Online System Strength and Inertia Monitoring	Brian Berry, Power Systems Specialist, Reactive Technologies. Co-Author of C4-102, C4 106 Dr Daniel Gheorghe, Power Systems Engineer, Reactive Technologies. Co-Author of C4-102
16:00	Q&A - Closing Remarks	

The 2022 CIGRE UK SC C4 Liaison Meeting and Technical Event is yet to be scheduled.

The UK SC C4 technical panel to be confirmed for 2021-2022. The current technical panel with a representative from each membership category:

Chair: Dr Spyros Karamitsos

Secretary: Dr Xiaolong Hu

Webmaster: Dr Qiteng Hong

Event Coordinator: TBC

Transmission: TBC

Manufacturer: Dr Yanni Zhon

Academia: TBC

The goal will be to organise a CIGRE UK SC C4 Technical Panel and hold a successful CIGRE UK SC C4 online 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.

18RM Report on SC C5 Electricity Markets and Regulation

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

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

19.1 Study Committee Scope

SC Chair: Christine Schwaegerl
SC Secretary: Geza Joos

The scope of this study Committee is focused on the fields of distribution systems and dispersed generation. SC C6 contributes to the international exchange of information and knowledge in the field, adding value and knowledge by means of synthesizing state of the art practices and developing recommendations.

Main areas of attention are:

- Distribution-level 'smartness' – massive penetration of distributed energy resources (generation, storage and intelligent loads) imposes the need for their control and coordination.
- The coordination of a large number of small resources, which imposes technical challenges that require application of decentralized, intelligent control techniques.
- The massive implementation of smart metering and demand-side response - metering as information collectors for distribution networks automation, home energy management and electric vehicles.
- Novel distribution network architectures that include microgrids.
- New coordination and control schemes of distributed generators, such as in virtual power plants, interacting with distribution grid operation.

19.2 Strategic Advisory Groups

AG C6.02 Quality Check of Brochures' (Conv. Ray Brown, AU)
AG C6.12 Tutorials (Conv. Samuel Jupe, GB)
AG C6.17 'Rural Electrification' (Conv. Britta Buchholz, DE, Kurt Dedekind, ZA)

19.3 Preferential Subjects (CIGRE 2022)

PS 1 / DER SOLUTIONS AND EXPERIENCES FOR ENERGY TRANSITION AND DECARBONISATION

- > Electric mobility charging systems configuration and operation.
- > Demand response and intelligent load configuration for customer empowerment.
- >> Electrification of transportation, heat systems and industrial processes.

PS 2 / INNOVATIVE PLANNING AND OPERATION OF ACTIVE DISTRIBUTION SYSTEMS

- > Aggregation and management platforms for active distribution systems with DER.
- > Strategies and tools for DER integration, hosting capacity, congestion management, and system service provision by DER.
- > Greening rural and green-field electrification, off-grid distribution and zero emission industrial systems.

PS 3 / AGGREGATED DER FOR ENHANCING RESILIENCE, RELIABILITY AND ENERGY SECURITY OF DISTRIBUTION SYSTEMS

- > Configuration of local energy storage systems for managing uncertainties.
- > Coordination of multi-energy systems supported by state-of-the-art technologies including intelligent inverter controls.

> Individual AC and DC micro-grids, multiple micro-grids, virtual power plant and local energy communities' control and network integration.

19.4 New Working Groups

Number	Title	UK Member
WG C6.43	Aggregation of battery energy storage and distributed energy resources (DER), including solar PV	Spyros Skarvelis-Kazakos (Recently convened UK Shadow Working Group due to high level of interest in UK community)
WG C6.44	Nodal Value of Distributed Renewable Energy Generation	<i>UK Vacancy</i>

19.5 Technical Panel Meetings, Seminars & Tutorials

The following tutorials were presented by SC C6 during 2021:

- “Rural Electrification (C6.38)” – CIGRE Centennial Session 2021
- “Workshop on Hydrogen Supporting the Energy Transition (C6 with C1)” – CIGRE Centennial Session 2021
- “Multi-Energy System Interactions in Distribution Grids (C6.33, joint with C1)” – CIGRE Centennial Session 2021

19.6 Technical Brochures

The following brochures were published 2021:

- WG C6.28 - ‘Hybrid systems for off-grid power supply’
- WG C6.38 - ‘Rural electrification’

The following brochures are being finalized for publication in 2022:

- JWG C6/C1.33 - ‘Multi-energy system interactions in distribution grids’
- JWG C6/C2.34 - ‘Flexibility provision from distributed energy resources’
- JWG C1/C6.37/CIRED - ‘Optimal transmission and distribution investment decisions under increasing energy scenario uncertainty’
- JWG C6/B4.37 - ‘Medium Voltage DC distribution systems’

19.7 Last Study Committee Meeting (Highlights)

The last SC C6 meeting took place online on Wednesday 25th August 2021 in conjunction with the CIGRE 2021 Centennial Session. Minutes from the meeting are yet to be published.

The meeting covered the following topics:

1. Welcome and introduction
2. Report of the Chair (Christine Schwaegerl)
3. Final reports of terminated WGs (by the relevant convenor)
4. Advisory Group Reports (by the relevant convenor)
5. Status of On-going WGs (by the relevant convenor)
6. Status of WGs led by other SCs with expected C6 contribution (by the relevant convenor)
7. New and Planned WGs
8. Other Technical Activities
9. Recent SC C6 Events
10. Next SC Meeting, Future Events and Activities
11. Organizational Issues

Samuel Jupe was delighted to receive the Technical Council Award 2021 for services to Study Committee C6 and the CIGRE Pioneer e-session Achievement Award for helping to plan and deliver the 2020 and 2021 CIGRE Sessions as a Special Reporter.

19.8 Current Working Groups and UK Members

Number	Title	UK Member
JWG C6/C1.33	"Multi-energy system interactions in distribution grids"	Chris De Beer (Mott MacDonald)
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 C6.36	Distributed Energy Resource Models for Impact Assessment	Samuel Jupe (Nortech Management Limited)
JWG C6/B4.37	'Medium Voltage DC distribution systems'	James Yu (SP Energy Networks) - Convenor Norman McLeod (WSP) Julio Perez Olvera (Imperial) – NGN Rep
WG C6.38	"Rural electrification"	Jonathan Bowes (University of Strathclyde)
WG C6.39	"Customer empowerment"	<i>Vacant</i>
WG C6.40	Electric Vehicles as Distributed Energy Resource (DER) systems	Adam Maloyd, WSP
WG C6.41	Technologies for Electrical Railway Distribution Supply Systems	<i>Vacancy for UK contribution</i>
WG C6.42	Electric Transportation Energy Supply Systems	Jhan Chan Preye Ivry Harry Evans (NGN)
JWG D2/C6.47	"Advanced consumer side energy resource management systems"	James King (Nortech Management Limited)

19.9 UK Members of the Technical Panel

Name	Company	Role
Samuel Jupe	Nortech Management Ltd	TP Chair / Manufacturer Representative
James King	Nortech Management Ltd	TP Secretary / Manufacturer Representative
Julio Perez Olvera	SSEN	NGN / DSO Representative
Harry Evans	GHD	NGN / Industry Representative
Tania Wallis	University of Strathclyde	Women's Network / Academia Representative
Milana Plecas	SP Energy Networks	DNO / DSO Representative
Inma Martinez	National Grid	TSO Representative
Chris De Beer	Mott Macdonald	Consultancy Representative
Gordon Watson	TNEI	Consultancy Representative
James Yu	SP Energy Networks	Convenor of WG C6/B4.37

20RM Report on SC D1 Materials and Emerging Test Techniques

20.1 Study Committee Scope

SC Chair: Ralf Pietsch

SC Secretary: Johannes Seiler

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 (Lars Lundgaard)

AG D1.02 High Voltage and Current Testing and Diagnostic (Uwe Riechert)

AG D1.03 Solid Materials (Simon Sutton)

AG D1.04 Gases (Karsten Juhre) – re-established in 2021

Tutorial AG (Ivanka Atanasova-Hoehlein)

Strategic and Customer AG (Ralf Pietsch)

20.3 Draft Preferential Subjects

The Preferential Subjects for 2022 Paris Session are:

PS 1 Testing, Monitoring and Diagnostics

- Testing and experience with non-standardized, composite and combined voltages
- PD measurement under DC, rectifier and impulse stress
- Requirements of systems for testing, monitoring and diagnostics

PS 2 Materials for electro technical purposes

- Ageing under electrical, mechanical & thermal stress (e.g. power electronics and semiconductors, load cycling, higher temperatures, compact applications, corrosion and radiation ageing, etc.)
- Functional properties of insulation materials & testing for validation
- Materials for battery and charging devices

PS 3 Simulation tools partnered with measurement techniques

- Application and development of new multi-physical simulation methods
- Digital twin for insulation components and insulation systems
- Physical models and sensors

20.4 New Working Groups

Number	Title	UK Member
D1.76	Tests for verification of quality and ageing performance of cellulose insulation for power transformers	Richard Heywood Qiang Liu Mike Munro
JWG D1/A2.77	Liquid Tests for Electrical Equipment	None

20.5 Technical Panel Meetings, Seminars & Tutorials

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

- 06/11/20 – Joint B1/D1 meeting. This had to be held virtually due to the pandemic.
- 14/01/21 – Joint A2/D1 meeting. This had to be held virtually due to the pandemic.

Both events were attended by 30-40 people.

20.6 Technical Brochures

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

- TB822 Methods for dielectric characterisation of polymeric insulating materials for outdoor applications
- TB842 Dielectric testing of gas insulated HVDC systems
- TB846 Electrical Insulation Systems at Cryogenic Temperatures

20.7 Last Study Committee Meeting (Highlights)

- In the past year an Advisory Group for Gases has been created (Convenor Karsten Juhre)
- This year's SC meeting was postponed due to the Chairman's health.
- The next meeting will hopefully be held virtually in November 2021.

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	
D1.54	Basic principles and practical methods to measure the AC and DC resistance of conductors of power cables and overhead lines	
D1.58	Evaluation of dynamic hydrophobicity of polymeric insulating materials under AC and DC voltage stress	
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
D1.63	Partial discharge detection under DC stress	Malcolm Seltzer-Grant Steve Swingler Imad Khan Ian Cotton
D1.64	Electrical insulation systems at cryogenic	

Number	Title	UK Member
	temperatures	
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	Mark Waldron
D1.67	Dielectric performance of new non-SF6 gases and gas mixtures for gas-insulated systems	Manu Haddad
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
D1.72	Test of material resistance against surface arcing under DC	Simon Rowland
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	Richard Heywood Qiang Liu Mike Munro
D1/B1.49	Harmonized test for the measurement of residual inflammable gases	
D1/B3.57	Dielectric Testing of Gas-insulated HVDC Systems	
A2/D1.51	Improvement to Partial discharge Measurements for Factory and Site Acceptance Tests of Power Transformers	Martin Judd
B1/B3/D1.79	Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends	
B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC applications	
D1/B1.75	Strategies and tools for corrosion prevention for cable systems	
D1/A2.77	Liquid Tests for Electrical Equipment	

20.9 UK Members of the Technical Panel

There is no UK Technical Panel for D1.

21RM Report on SC D2 Information Systems & Telecommunication

21.1 Study Committee Scope

SC Chair: Mrs Olga V. Sinenko (RU)

SC Secretary: Mr Joël Nouard (FR)

The scope of SC D2 is to covers all aspects in relation to the use of the 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 drawing recommendations.

21.2 Strategic Advisory Groups

AG D2.01: Core business information systems and services – Marcelo Aroujo (Brazil)

AG D2.02: Cybersecurity techniques and technologies – Giovanna Dondossola (Italy)

AG D2.03: Telecommunication networks, services and technology – Victor tan (Australia)

21.3 Draft Preferential Subjects for 2022 Paris Session

PS 1: The opportunities and challenges brought by emerging information and communication technologies to electric power utilities in their path to Digital Transformation

- IoT architectures and applications in physical asset management
- Challenges and benefits of Artificial Intelligence, Big Data and Analytics in operation and maintenance
- Augmented and virtual reality applications in substations and power plants
- Experiences with Digital Twins in the power sector

PS 2: Cybersecurity techniques and technologies for securing critical utility assets and applications including protection and control

- Directives, supporting standards and cyber security certification schemes – experiences from the countries worldwide
- Incident response and power system defence strategies and tools to: mitigate the impact of cyber attacks on power system operation, stop propagation of cascading failures, and prevent a blackout
- Extension of the current simulation and analysis capabilities of power system engineers to assess the impact of cyber attacks on power system operation. Studies and experiences in the integration of industrial-grade simulator for communication networks and cybersecurity with existing power system analysis tools, e.g., DlgSILENT PowerFactory, PSS SINCAL, or PSS/e

PS 3: Meeting the demands of the modern utility and DER with an agile and resilient telecommunication network

- Supporting OT services and applications using current and next generation cellular (4G/5G) and IoT-based wireless technologies
- Improving and maintaining reliability and resiliency of critical services including protection services using modern telecommunication techniques and technologies

- Increasing efficiency with the use of cloud-based techniques and intelligent networks including modern network management systems, network automation and service orchestration, NFV and SDWAN

21.4 New Working Groups

Number	Title	UK Member
D2.56	Interdependence and Security of Cyber-Physical Power System	TBC

21.5 Technical Panel Meetings, Seminars & Tutorials

Participation with D2 Tutorial at SEERC conference, 29 November – 2 December 2021, Vienna. Tutorial “Cyber Security Management – a key player in the EPU resilience strategy” will be delivered by Giovanna Dondossola and Roberta Terruggia (IT)

Co-leadership in the Kyoto Symposium 2022 “Power System transformation including active distribution”, 3-8 April 2022. Chair: SC C6 and D2. Participating SCs: B3, C1, C2, C4, C5

Conduction of CIGRE 2022 Paris Session, 28 August – 2 September 2022

A D2 CIGRE UK Information and Data Exchange webinar was arranged in January 2021

21.6 Technical Brochures

The following Technical Brochure has been published since the last regular meeting:

- TB 840 “Electric Power Utilities’ Cybersecurity for Contingency Operations”
The Tutorial for TB 840 should be presented by Q4 2021.
Two publications are planned for Electra:
- Russian NC publication “Cybersecurity in the Russian energy sector in the age of digitalization”
- Article “An open source driven transformation in the power industry” by Lucian Balea (R&D Program Director and open source manager, RTE), Benoît Jeanson (Open Source Enterprise Architect, RTE), Arjan Stam (Director of System Operations, Alliander)

21.7 Last Study Committee Meeting Highlights

Advisory Group D2.02 convened by Mrs Giovanna Dondossola (IT) established liaisons with other international bodies to promote the work carried out by CIGRE in the field of cyber security and obtain new inputs to determine key priorities for work:

- Collaborations with IEC TC 57 WG 15;
- AG D2.02 update has been given at each plenary meeting of the WG 15 (IEC TC 57);
- Proposal of establishing synergisms between CIGRE SC D2 and IEEE WG on cybersecurity;
- Under IEEE PES Technical Committee on Analytical Methods for Power Systems, a WG chaired by Drs. Manimaran Govindarasu, Iowa State University, and Adam Hahn, MITRE Corp. is a good candidate for D2 collaborations with IEEE PES;
- possibility to organise a joint session on cybersecurity among CIGRE, IEC, IEEE at CIGRE 2022.

21.8 Current Working Groups and UK Members

Number	Title	UK Member
D2/C6.47	Advanced Consumer-Side Energy-Resource Management Systems	James King, Spyros Skaravelis-Kazakos

D2/C2.48	Enhanced Information and Data Exchange to Enable Future Transmission and Distribution Interoperability	Rui Zhang
D2.46	Cybersecurity future threats and impact on EPU organizations and operations	Gareth Taylor
D2.45	Impact of governance regulations and constraints on EPU sensitive data distribution and location of data storage	
D2.43	Enabling Software Defined Networking for EPU telecom applications	Gareth Taylor
D2/C2.48	Enhanced Information and Data Exchange to Enable Future Transmission and Distribution Interoperability	Gareth Taylor (Convenor)
B2/D2.78	Condition Monitoring and Remote Sensing of OH Lines	A Kulkarni

21.9 UK Members of the Technical Panel

NA