



TECHNICAL COMMITTEE REPORT

2022

Report Date: November 2022

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1 Introduction

This report summarises CIGRE UK Technical Committee (UK TC) related work conducted over 2022 and its intended recipients are the CIGRE UK members.

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

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

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

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

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

2 CIGRE UK Technical Committee

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

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

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

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

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://cigregrroups.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 3 – 4 times annually and teleconference in the meantime as necessary.

A number of CIGRE TC members have stepped down, and new members have been elected to succeed the roles as shown in the updated TC Structure below, including TC Secretary, Technical Council Representative, Technical Events Lead, several Regular Members (RMs). In addition, a new Liaison Officer role has been created to promote the joint activities between Study Committees/RMs. We would like to thank all the outgoing members for their hardworking and contributions in serving their terms of office over the years, and wish all the new members every success in taking up the roles.

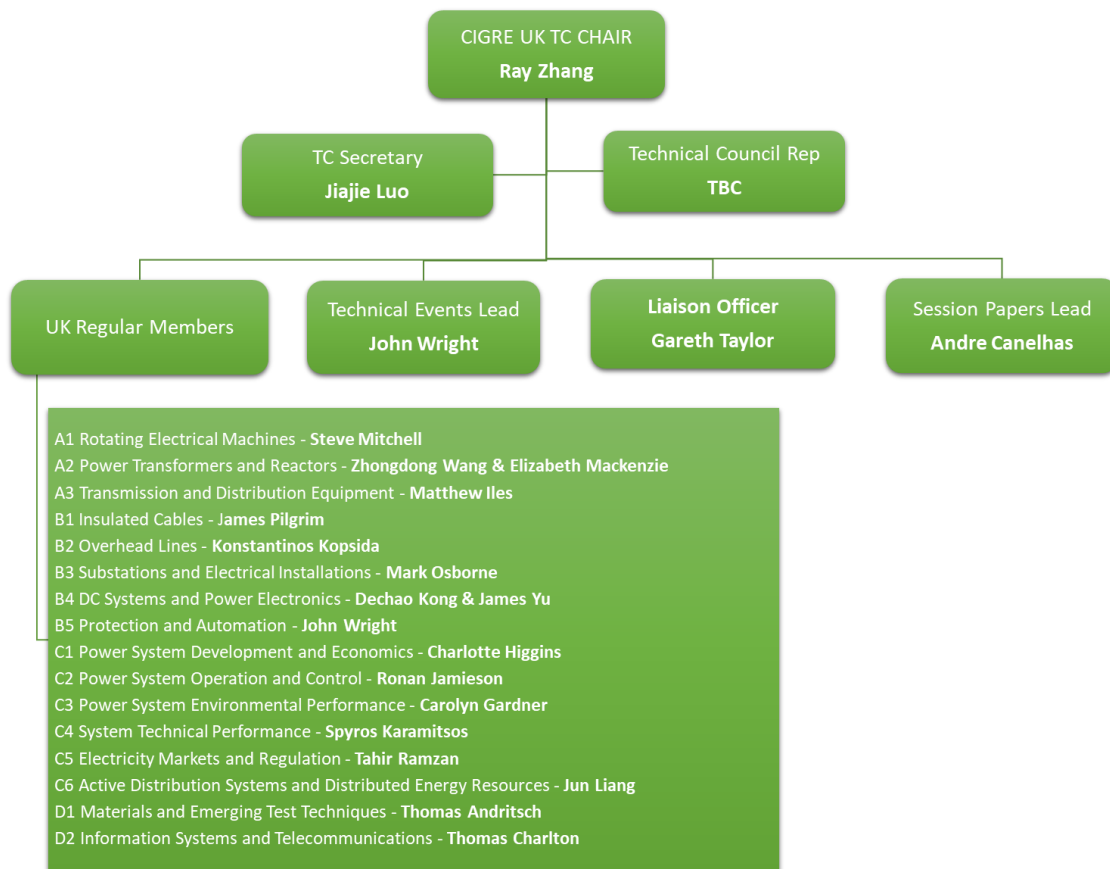


Figure 1: CIGRE UK TC structure

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/Additional 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 |
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| 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 | Carolyn Gardner | carolyn.gardner@nationalgrid.com |
| C4 | Spyros Karamitsos | spyros.karamitsos@ieee.org |
| C5 | Tahir Ramzan | tahir.ramzan@live.co.uk |
| C6 | Jun Liang | liangj1@cardiff.ac.uk |
| D1 | Thomas Andritsch | t.andritsch@soton.ac.uk |
| D2 | Thomas Charton | thomas.charton@nationalgrid.com |

3 CIGRE-UK Technical Events

3.1 Introduction

CIGRE-UK has organized Technical Liaison Meetings, webinars, and many other events in 2022. The active support of RM's, NGN and the wider CIGRE community has been greatly appreciated. For more details, please visit CIGRE UK website:

<https://cigre.org.uk/category/events/>

<https://cigre.org.uk/past-monthly-technical-webinars/>

3.2 Technical Liaison Meetings 2022

CIGRE UK A2/D1 Technical Liaison Meeting

17th Feb 2022

The purpose of the meeting was to provide an overview of the ongoing activities in CIGRE related to Study Committees A2 (Power Transformers & Reactors) led by UK Regular Members, Zhongdong Wang & Elizabeth Mackenzie, and D1 as relating to Transformers (Materials and emerging Test Techniques) led by UK Regular Member, Simon Sutton. Technical Brochures published in the last year were highlighted, along with a status update on the active Working Groups where the UK has an interest. There were also updates on IEC/BSi PEL/14 activities.

CIGRE UK B4 Hybrid Technical Liaison Meeting

4th May 2022

The purpose of the meeting, kindly sponsored by GE, was to provide a high-level overview of the ongoing activities in CIGRE related to Study Committee B4 (DC Systems & Power Electronics) led by UK Regular Member Dechao Kong. 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 attendees heard about the latest new work items approved by the Study Committees during the Paris e-session, and provided feedback on possible future work items that could be proposed in the future.

CIGRE UK B5/D2 Technical Liaison Meeting

31st October 2022

The purpose of the meeting, kindly hosted by the University of Birmingham, led by UK Regular Members John Wright (B5) & Thomas Charlton (D2) and supported by Professor 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. Presentations were made around the themes of the impact of renewables on protection and the applications of data and communication to a modern power system. Latest activities approved by the B5 and D2 Study Committees during the recent Paris Session 2022 and feedback on possible future work items, including joint D2/B5 working groups were discussed.

CIGRE UK B1/D1 Technical Liaison Meeting

15th November 2022

The annual Cigre B1 UK Technical Liaison meeting will be held as a Hybrid Meeting on November 15th. The purpose of the meeting is to provide a high level overview of the ongoing activities in Cigre related to Insulated Cables. Technical Brochures published in the last year will be highlighted, along with a status update on all of the active B1 Working Groups where the UK has an interest. You will also get a reminder about the latest new work items approved by the B1 Study Committee during the Paris 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, we will also be joined by the UK Regular Member for D1 who will provide a summary of activities relevant to the B1 audience. The event will be held as a Hybrid meeting, meaning that a dial in option will be available. There will be an opportunity for those attending virtually to submit questions to the presenters during the meeting.

3.3 CIGRE-UK Webinars

Webinar Programme

| Date | Title | Presenter |
|------------|--|---|
| Dec (2021) | <u><i>The Role of the Power Sector on the Path to Global Carbon Neutrality by 2050</i></u> | Enrique Gutierrez |
| Feb | <u><i>Advanced Monitoring of Overhead Line Distribution Networks</i></u> | Steven Pinkerton-Clark & Ben Brewen |
| Mar | <u><i>The Development of Electric Vehicle Charging Infrastructure in the UK</i></u> | Jianing Li |
| Apr | <u><i>Asset Management and Environmental Benefits of Switchgear Refurbishment and its potential role in Net Zero</i></u> | Matthew Iles |
| May | <u><i>Environmentally Friendly Ester Based Power Transformers</i></u> | Zhongdong Wang, Mark Lashbrook, Qiang Liu |
| Jun | <u><i>Data-Driven Thermal Rating for Overhead Lines</i></u> | Daniel Jones |
| Jul | <u><i>The Realities of Renewable Integration A 30 Minute Sprint Through a 30 Year Effort</i></u> | Doug Houseman |
| Sep | <u><i>CIGRE B1 (Insulated Cables) Post Paris Session Update</i></u> | James Pilgrim |
| Nov | <u><i>Understanding the Risk Climate change Presents to Power Infrastructure</i></u> | Stuart Large, Sébastien Burgess |

3.4 CIGRE-UK Other Events

The Application of Data Analytics to Enhance Power System Performance

27th May 2022

CIGRE UK held a one day conference in London on the subject of ‘The application of data analytics to enhance power system performance’. The event was Chaired by Prof Gareth Taylor, CIGRE UK (D2) Regular Member and Professor of Power Systems at Brunel University, who also opened the conference. This event was kindly hosted by Arup at its London offices (8, Fitzroy Street, W1T 4BJ) and supported by PSC Consulting/Harmonic Analytics.

CIGRE UK International Women In Engineering Day

23rd June 2022

This year, CIGRE UK’s Women in Energy marked the “International Women in Engineering Day” by celebrating the amazing work women engineers worldwide are doing.

Our panelists, from industry and academia, exemplify the qualities necessary to reach the higher echelons of the engineering profession. As role models for women aspiring for top roles, they were well qualified to answer the questions on building toward a brighter future.

Speakers: Biljana Stojkovska, Zhongdong Wang, Angeliki Loukatou, Onyeché Tifase and Anastasia Vaia.

CIGRE UK NGN Event on Innovation and Creativity

1st July 2022

For this event there were two distinguished speakers. Xiaolong Hu is an innovation manager with National Grid and Dennis Sherwood an accomplished consultant and author on the art of creativity. Following the presentations there was an opportunity to pose questions.

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 2021. Data related to 2022 will be available in 2023.

5.1 Active Working Group

- Number of total active Working Groups (WGs) and Joint Working Groups (JWGs) has changed from 248 in January 2021 to 266 in January 2022. In January 2019 there were total 260 WGs.
- Out of the 266 total active WGs in 2021, 40 are active JWG
- Study Committees C4 and B2 have the largest number of active WGs including JWGs. C2 and C5 have 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 has 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. 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.

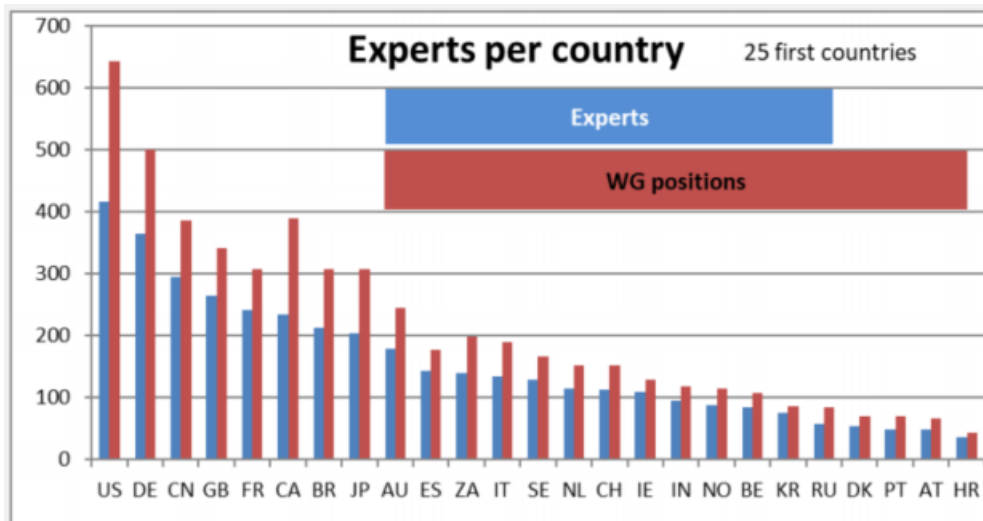


Figure 4: Number of WG positions filled by experts based on country of origin

- 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

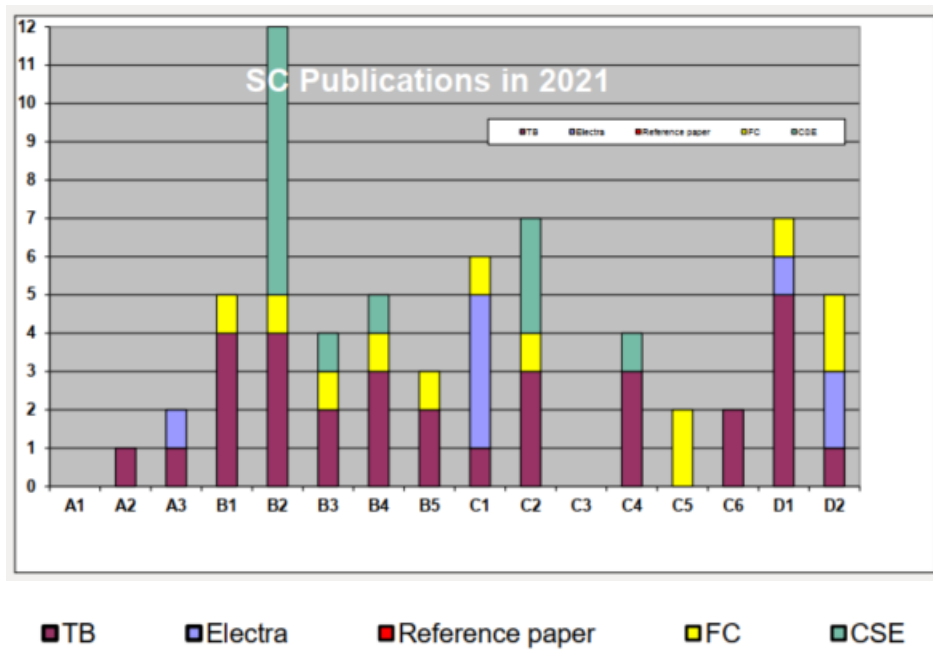


Figure 5: Study Committee Publications

- As shown in Figure 5, D1 has produced five Technical Brochures in the past year.
- B2 has the most publications in the past year combining all categories.
- No “Reference Papers” have been produced in the past year.

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 2022 session | Convener | Status |
|--------------------------|----------|--------|
| | | |

6.5 Technical Panel Meetings, Seminars &Tutorials

The Study Committee invited written contributions to provide discussion material for the General Discussion Meeting held in the Palais des Congrès based on the questions raised in the Special Report. Throughout the day 50-70 delegates attended the discussion meeting.

A total of 24 papers and 24 questions were raised with prepared contributions under three Preferential Subjects. The presentations were well prepared and presented, and, the authors were able to answer the resulting questions clearly and comprehensively. There was a good involvement of the audience resulting in some in-depth, informative and interesting discussions.

There were fewer prepared contributions than has been received in past Group Discussion Meetings, however, this facilitated more in-depth discussions on specific topics of high interest.

During the course of the day the themes from the presentations were as follows:

- Hybridised gas turbine generator and battery storage system
- Development of new generator products for future network operating regimes
- Influence of grid codes on generator designs
- Generators operation as synchronous condensers to meet future network requirements
- Design and testing requirements of insulation systems
- Partial discharge measurement and condition monitoring and assessment of electrical machines

As expected certain topics ignited a larger response reflecting hot topics in the field of rotating electrical machines. Particular topics include synchronous condensers, generator diagnostic testing, specifically partial discharge behaviour.

A tutorial was held on A1/C4 JWG66 “Guide on the Assessment, Specification and Design of Synchronous Condenser for Power System with Predominance of Low or Zero Inertia Generators.” Which was well attended and resulted in a number of questions and discussions.

6.6 Technical Brochures

| Working Group | Title | Technical Brochure |
|---------------|--|--------------------|
| A1.44 | Guideline on testing of turbo and hydro Generators | 879 |
| A1.48 | Guidance on high-speed testing of turbo generator rotors | 878 |
| A1.33 | Guide for cleanliness and storage of generators | 860 |

6.7 Last Study Committee Meeting (Highlights)

From previous years 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. The impact of national grid interactions and requirements has also been identified as critical to the

The scope and strategic direction of A1 is planned to be updated and was discussed during the meeting. With the strategic direction of the group being:

1. Asset management
2. Machine/Grid interaction and support
3. Renewable generation
4. Machine monitoring, diagnosis and prognosis
5. High efficiency and efficiency improvement of electrical machines

Overall the SC A1 priorities were discussed and the focus is on the following:

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

6.8 Current Working Groups and UK Members

| WG Nr. | WG TITLE | STATUS | |
|--------------|---|---|--|
| A1.33 | Guide For Cleanliness And Storage Of Generators | TB 860 published in e-cigre. Extract published in ELECTRA 360 | |
| A1.42 | Influence of key requirements to optimize the value of hydro generators | Draft TB available. Further review/rework required before circulation under the 6-week rule | |
| A1.43 | State of the art of rotor temperature measurement | TB reviewed. Associated documents to be compiled for submission | |
| A1.44 | Guideline on Testing of Turbo and Hydrogenerators | 6-week review completed. TB updated. Associated documents in preparation for submission. | |
| A1.45 | Guide for Determining the Health Index of Large Electric Motors | Need more responses to the questionnaire - recirculate | |
| A1.48 | Guidance on the Requirements for High Speed Balancing / Over-speed Testing of Turbine Generator Rotors Following Maintenance or Repair. | 6-week review completed. Documents updated and ready for submission | |
| A1- C4.52 | Wind generators and frequency-active power control of power systems | TB in preparation | |
| A1.53 | Guide on Design Requirements of Motors for Variable Speed Drive Application | In revision following 6-week rule feedback. | |
| A1.54 | Impact of Flexible Operation on Large Motors | 6-week review completed. TB updated. Associated documents in preparation for submission. | |

| | | | |
|-----------------|---|--|--|
| A1.55 | Survey on Split Core Stators | Pending feedback from convener | |
| A1.56 | Survey on Lap and Wave Winding and their Consequences on Maintenance and Performance | TB prepared. To be sent for review under the 6-week rule | |
| A1.58 | Selection of Copper Versus Aluminium Rotors for Induction Motors | Report prepared & in checking for 6-week review. | |
| A1.59 | Survey on Industry Practices and Effects associated with the Cutting Out of Stator Coils in Hydrogenerators. | TB+Electra abstract prepared. To be sent for review under the 6-week rule | |
| A1.60 | Guide on economic evaluation for refurbishment or replacement decisions on hydro generators | In work. TB chapters defined & allocated. Needs more WG members. | |
| A1.61 | Survey of Partial Discharge Monitoring in Large Motors | Pending feedback from convener | |
| A1.62 | Thrust Bearings for Hydropower - A Survey of Known Problems and Root Causes | Need more responses to the questionnaire - recirculate | |
| A1.63 | Turbo Generator Stator Winding Bushings and Lead Connections – Field Experience, Failures and Design Improvements | Working Group re-established and in progress. Questionnaire being finalised. | |
| A1.64 | Guide for Evaluating the Repair / Replacement of Standard Efficiency Motors | Report in preparation | |
| A1/C4.66 | Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators | TB review under 6-week rule completed on 22 April 2022. Feedback being assessed. | Fabian Koehler (Member) Liqiu Han (Member) |
| A1.67 | State of the Art in methods, experience and limits in end winding corona testing for Hydro Generators | Pending feedback from convener | |
| A1.68 | Evaluating Quality Performance of Electric Motor Manufacturing and Repair Facilities | Renewed call for WG members sent out on 4 May 2022. Needs more participation from manufacturers and responses. | |
| A1.69 | Hydro-Generator Excitation Current Anomalies | Team assembled. | |
| A1.70 | Dielectric Dissipation Factor Measurements on Stator Windings | Questionnaire and collection of information completed; Analysis in progress. | Richard Ludlow (member) Ian Simmonds (member) |
| A1.71 | Survey on damper-winding Concepts and its operational experience on hydro generators and motor-generators | Team assembled – start in 2022 | |

| | | | |
|--------------|--|-------------------------------------|--|
| A1.72 | Survey on multi-turn coils with dedicated turn insulation versus coils without dedicated turn insulation | Team assembled – start in Sept 2022 | |
| A1.73 | Customer Requirements for Qualification of Form Wound Stator Insulation Systems for Hydro Generators | Team assembled – start in 2022 | |

7 RM Report on SC A2 Transformers

7.1 Study Committee Scope

SC Chair: Pascal Müller

SC Secretary: Mark Foata

The scope of SC A2 covers:

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

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

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

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

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

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

7.2 Strategic Advisory Groups

AG 2.3 Technology – Henk Fonk;

AG 2.4 Utilisation - Brendan Diggin;

AG 2.6 Green Book – Simon Ryder;

AG 2.7 Transformer Digitalisation – Patrick Picher;

AG 2.8 Lower Voltage Applications – Peter Werle.

7.3 Draft Preferential Subjects

The Preferential Subjects for 2024 Paris Session are still in draft:

PS 1: Design of Resilient Transformers

- Stresses from the environment: Impact of global warming, high temperatures heavy rain, high winds, offshore installations, etc.
- Stresses from the system: Switching impulses, reverse flow, emergency overloading, harmonics, GIC, short-circuits and internal arcing etc.

- Specifications: Design criteria, materials and testing requirements for new transformers. Suitable maintenance standard and refurbishment strategies.

PS 2: Advances in Transformer Analytics

- Data management: Digitalisation and Information Model, online and offline test data, integration of condition and multiple data sources, data preparation for analytics.
- Diagnostic and on-line monitoring: Algorithm/Guidelines for on-line monitoring, advanced interpretation of condition data, case studies.
- Modelling: Transformer digital twins (thermal, dielectric, mechanical, etc.), physics-based and hybrid models, failure probability and ageing models, applications of Artificial Intelligence.

PS 3: Reliability of Transformers for Renewable Energy

- Transformers for Low Carbon Technologies: Voltage < 100kV, wind and photovoltaic parks, battery energy storage and Electric Vehicle Charger etc.
- Case Studies and Lessons Learned: Type of failure, root cause analysis, mode of operation. Recommendations concerning procurement, design, operation and asset management strategies.
- Failure Prevention: Useful diagnostic methods and monitoring systems. Optimization of operating conditions and additional measures such as overvoltage protection, harmonic reduction, cooling optimisation etc.

7.4 New Working Groups

JWG A2/D2.65 Transformer Digital Twin – concept and future perspectives

JWG A2/D1.67 – Guideline for Online Dissolved Gas Analysis Monitoring

7.5 Technical Panel Meetings, Seminars & Tutorials

The last UK A2 technical panel was on 9th December 2019 and the next panel meeting is scheduled on 17th January 2023.

The A2/D1 liaison meeting was held virtually on 17th February 2022 and was well attended with about 60 attendees.

7.6 Technical Brochures

As working group activity has been limited, three technical brochures, 1 working group report and 1 green book have been published during the period of 2020 - 2022. The following table details the most recent publications, and pending publications related to SC A2.

| Ref. | WG | Title |
|----------|---------|---|
| TB812 | A2.53 | Advances in the interpretation of transformer Frequency Response Analysis (FRA) |
| TB 861 | A2/D.51 | Improvements to PD measurements for factory and site acceptance tests of power transformers |
| TB859 | A2.59 | On-Site Assembly, On-Site Rebuild, and On-Site High Voltage Testing of Power Transformers |
| RP_321_1 | TF EoL | The Condition of Solid Transformer Insulation at End-of-Life |

| | | |
|---------------------|-------------------|--|
| WGR_310_1 | A2.54 | Load sound power levels for specification purposes of three-phase 50 Hz and 60 Hz liquid-filled power transformers |
| GB8 | All SC | Electricity Supply Systems of the Future |
| <i>Pending 2021</i> | <i>Ref</i> | <i>Drying and Impact on DP</i> |
| <i>Pending 2021</i> | <i>Ref</i> | <i>Condition of Solid Insulation at end-of-life</i> |
| <i>Pending 2022</i> | <i>A2/C4.52</i> | <i>HF Modelling of transformer (5 brochures expected)</i> |
| <i>Pending 2020</i> | <i>A2.55</i> | <i>Transformer Life Extension</i> |
| <i>Pending 2021</i> | <i>A2 56</i> | <i>Transformer losses and efficiency</i> |
| <i>Pending 2021</i> | <i>A2.57</i> | <i>Transformer DC magnetization</i> |
| <i>Pending 2021</i> | <i>A2.58</i> | <i>Installation, pre-commissioning and trial operation</i> |
| <i>Pending 2021</i> | <i>Green Book</i> | <i>Transformer Procurement</i> |

7.7 Last Study Committee Meeting (Highlights)

During the CIGRE Paris Session, A2 tutorial on the life extension of oil filled transformers and shunt reactors was presented by Ralf Schneider (CH) on 29th August 2022. Study Committee A2 met in person on 30th August, where 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.

Elizabeth MacKenzie gave a Women in Energy talk, where she emphasised the importance of future generation of electrical engineer and urge to attract more young people interested in engineering, female as well as male. Elizabeth MacKenzie and Simon Ryder both received the “Distinguished Member” title, in recognition of their long-standing important contribution through participation in the technical work of Study Committees or within their National Committee.

The 2023 A2 Colloquium will be held in Split, Croatia, October 4 – 7, 2023. It is jointly organised with the 6th International Colloquium Transformer Research and Asset Management.

7.8 Current Working Groups and UK Members

| WG | Title | UK Member | Organisation |
|----------|---|------------------------------|------------------|
| A2/C4.52 | High Frequency Transformer Models for Non-Standard Waveforms | Robin Gupta Kah Leong Koo | ... NGET |
| 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 Daghrh Jose Quintana Xiang Zhang | M&I Materials SPEN MMU |
| 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 Manchester Univ. |
| A2.64 | Condition of Cellulose Insulation in Oil-immersed Transformers after Factory Acceptance Test | Hongzhi Ding Andrew Fieldsend- Roxborough | Doble NG |
| A2/D2.65 | Transformer Digital Twin – concept and future perspectives | Zhongdong Wang Tim Zhao | Exeter Univ. - |
| A2/D1.66 | Breathing systems of liquid filled transformers and reactors | | |
| A2/D1.67 | Guideline for Online Dissolved Gas Analysis Monitoring | Michelle Fiddis Shuhang Shen | GE Exeter Univ. |
| D1/A2.77 | Liquid tests for Electrical Equipment | Atitila Gyore Qiang Liu Russel Martin David Walker Gordon Wilson | M&I Materials Man Univ. M&I Materials SPEN NG |
| A3/A2/A1/B1.44 | Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltages | | |
| TF | Power Transformer sound level on site | Janine Dickinson | NGET |

Updates on working groups:

A2/C4.52 Update

The 5 TBs are TB1 White-box Models, TB2 Black-box Models, TB3 Grey-box Models, TB4 Model Interfacing and Specifications, TB5 Measurements and Design Data. They are under review by the SC A2.

A2.54 Update

This working group was set up in 2016 and should complete in 2023. All meetings and all research have now completed, the technical brochure chapters drafted and individual chapters are now undergoing a review cycle prior to issue.

A2.55 Update

All work now complete and TB due to be published before the end of 2022.

A2.56 Update

Up to date no progress report has been received.

A2.57 Update

Brochure is expected to be ready by late 2022 (as stated in 2021 annual report).

A2.58 Update

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

A2.59 Update

Work is complete and the Technical Brochure is in press with imminent publication (as stated in 2021 annual report).

A2.60 Update

This working group was set up in April 2019 and is expected to complete in spring 2024. There are 4 task forces: TF1 Transformer Thermal Behaviour, TF2 Dynamic Transformer Thermal Modelling (DTTM), TF3 on benchmarking of dynamic transformer thermal models (DTTM-BP), TF4 on dynamic transformer thermal model applications.

A2.61 Update

This WG has been disbanded.

A2.62 Update

This working group was set up in November 2019 and is expected to complete in Early 2023. This is an extension following the WG A2.27 completed failure data survey with 964 major failures that occurred in 1996-2010. One of the limitations is that the distribution of transformer population was not collected. Six meetings were held, the group updated the transformer failure data survey/questionnaire, and the questionnaire circulated around global transformer users/utilities, specifically on major failures & replacements for 2010-2019 for AC power transformers $\geq 100\text{kV}$. The working group has been analysing and collecting data in parallel. Failure data are analysed in terms of failure rate, location, mode and cause, and Hazard curves to be determined for different transformer populations.

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

This working group was set up in October 2019 with the expected complete date of January 2023. Three task forces (groups) were formed to study the following three subjects: **Subject 1:** Visualize the effect of different stages in production and effect of different parameters on the consumption of insulation life. **Subject 2:** Define what relevant parameters should be consider and how they should

measure in the factory, and **Subject 3:** Use the available simulation models and results to come up with the acceptance criteria for the condition of the insulation by using the parameters that the simulations take into account. Since January 2022, each group finalized their documents in March 2022, all group documents were merged into a final draft technical brochure in May 2022.

A2.65 Update

This is a new WG approved on 16th Feb 2022 with start date and end date from May 2022 to Dec 2025 (expected date). The kick-off meeting was held virtually in June and the second meeting was on 28th August in Paris. 37 members from 15 countries. It is currently believed that transformer digital twin will involve Multiphysics modelling and advanced data analytics to provide new opportunities to extract value from the possibly large amount of available data. Potential benefits can be at transformer asset management, from design, manufacturing, operation, refurbishment, maintenance, and replacement. The skeleton of the technical brochure (TB) has been discussed with all the members. According to the structure of the planned TB, there will be 8 task forces. The Convenor has organized two meetings with the task force leaders in September and October.

A2.66 Update

We are not aware that there are any UK experts recommended from A2 into this working group.

A2.67 Update

The first meeting was held in CIGRE Paris session to kick start this working group. Shuhang Shen and Michelle Fiddis are put forward as the UK experts to attend this working group.

D1/A2.77 Update

This workin group was set up on 8th Oct 2020 and is expected to complete in 2024. It has 71 members. In general, the list of contents of the TB is ready and the Chapters on liquids and tests are completed. The group is organized as Task Force 1 – Measurement Aspects – Peter Werle, Task Force 2 - Data Handling and Categorisation – Carl Wolmarans, with Sub-Task Force 2-1 – Electrical Tests – Diego Robalino, and Task Force 3 - Modelling and Case Studies – Helena Wilhelm.

A3/A2/A1/B1.44

We are not aware that there are any UK experts recommended from A2 into this working group.

Task Force title: Power Transformer sound level on site

This task force’s convenor is Janine Dickinson and secretary is Martin A. Stoessl. It started in August 2022 with an expected complete date of December 2023. ToR developed and agreed. Task Force will explore the reasons why once a transformer is installed on a substation site, sound level measurements often do not match the sound level determined during factory acceptance testing. KMS set up for use of Task Force. The first meeting took place in Paris on 31st August 2022. The next Task Force meeting is due to take place on 3rd November 2022 where members will present their experiences of how noise measurements are undertaken on site to determine the sound power or sound level of a Transformer along with an overview of the method, challenges, restrictions, limitations, effect on measurements, variance from standards, etc.

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 | Events | 62 |
| David Walker | SP Energy Networks | Transmission | 55 |

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

8 RM Report on SC A3 Transmission and Distribution Equipment

8.1 Study Committee Scope

SC Chair: Nenad Uzelac

SC Secretary: Frank Richter

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

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

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

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

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

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

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

8.2 Strategic Advisory Groups

AG 3.01 strategic planning – Nenad Uzelac;

AG 3.02 Utility Advisory board – Robert Le Roux;

AG 3.03 Green Book – Hiroki Ito;

8.3 Preferential Subjects

The Preferential Subjects for 2022 Paris Session were:

PS 1: Decentralisation of T&D equipment:

- New assets: e.g., DC switching equipment, fault current limiters.

- Influence of system changes on existing and new equipment.
- Equipment resilience against natural disasters.

PS 2: Decarbonisation of T&D equipment:

- SF₆ - alternatives for MV and HV application and HV vacuum application.
- Life cycle management and the impact on the design of T&D equipment.
- Health, safety and environment aspects of T&D equipment.

PS 3: Digitalisation of T&D equipment:

- Advanced sensors, low-power instrument transformers, monitoring and condition assessment.
- Digital twin and equipment reliability modelling.
- Pandemic influence on equipment.

In all 52 reports were accepted and presented during the 2022 Paris Session which were summarised in the special report. The reports were categorised into 4 groups:

1. Miscellaneous T&D equipment and systems (16 reports)
2. SF₆ alternatives (18 reports)
3. Asset management, monitoring and diagnostics (9 reports)
4. Instrument transformers and digitalization (9 reports)

8.4 New Working Groups

New WGs:

- JWG B3/A3.60: User guide for non-SF₆ gases and gas mixtures in Substations
- A3.47: Lifetime Management of Medium Voltage Indoor Switchgear
- A3.48: 4th CIGRE reliability survey on transmission and distribution equipment

WGs Disbanded

- Two working groups finished their work: A3.31 (Electra Paper), A3.36 (TB830)

8.5 Technical Meetings, Seminars & Tutorials

The A3 Study Committee met on the 24th and 25th November 2021 during CIGRE Symposium Ljubljana 2021. The meeting took place via MS Teams on two days, 4 hours each.

The last meeting of the SC A3 was during Paris Session 2022, highlights detailed in section 7.

The next meetings for A3 are set to be during the Symposium during March 2023 in Muscat and during the May 2023 colloquium in Birmingham.

8.6 Technical Brochures and Publications

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

| Ref. | WG | Title |
|------------------------|--------------|--|
| TB 873 | JWG B4/A3.80 | Design, test and application of HVDC circuit breakers |
| TB 871 | A3.41 | Current interrupting in SF ₆ -free switchgear |

| | | |
|-------------------------|--------------------|--|
| TB 830 | A3.36 | Application and benchmark of multi-physics simulation tools and temperature rise calculations |
| TB 817 | A3.38 | Shunt capacitor switching in distribution and transmission systems |
| TB 816 | A3.30 | Substation equipment overstress management |
| TB 757 | A3.35 | Guidelines and best practices for the commissioning and operation of controlled switching projects |
| TB 737 | JWG A3.32/CIREC | Non-intrusive methods for condition assessment of distribution and transmission switchgear |
| TB 725 | A3.29 | Ageing high voltage substation equipment and possible mitigation techniques |
| TB 716 | A3/B5/ C4.37 | System conditions for and probability of out-of-phase |
| Electra Paper | A3.31 | Instrument transformers with digital output |
| TB to be published soon | A3.39 | Application and field experience with metal oxide surge arresters |

8.7 Last Study Committee Meeting (Highlights)

Study Committee A3 met during the Paris 2022 session on 30th August 2022. It was chaired by Nenad Uzelac who welcomed all attendees. The antitrust guidelines were read by all and agreed upon followed by introductions of everyone.

During the opening ceremony Rene Smeets (RM NL) was awarded the Cigre Fellow Member Award. This was recognized by Nenad and Rene was congratulated.

The meeting agenda was then reviewed and approved along with the minutes of the last meeting in 2021. Nenad then gave an overview of wider Cigre activities including the activities of NGN and Women in Engineering.

Robert Le Roux or presented the formation and activities to date of the utilities advisory group followed by presentations from several national committees on topics such as new membership and KMS.

Working Group convenors and members each gave a brief report on the progress of their group. Updates are detailed below.

Next Nenad opened the floor to invitations about plans for new webinars or tutorial or requests from National Committees before moving onto planning for the 2024 Paris session. New proposals were then presented for new working groups and liaison activities with other organizations. Finally plans for the upcoming events were discussed along with discussion about possible participation in the Cairns Australia session.

8.8 Current Working Groups and UK Members

| WG/JWG | Title | Convener | Secretary | UK Participation |
|----------|---|------------------|------------------|------------------|
| WG A3.39 | Application and field experience with Metal Oxide Surge Arresters | R. le Roux (IE) | F. Richter (DE) | |
| WG A3.40 | Technical requirements and field experiences with MV DC switching equipment | C. Heinrich (DE) | T. Miyamoto (JP) | |

| | | | | |
|--------------------|---|-----------------------|-------------------------|-----------------------------------|
| WG A3.41 | Interrupting and switching performance with SF6 free switching equipment | R. P. P. Smeets (NL) | A. Lathouwers (NL) | Leslie Falkingham Mark Waldron |
| WG A3.42 | Failure analysis of recent AIS instrument transformer incidents | Z. Roman (US) | Fernando Lagos (Brazil) | |
| JWG A3.43 /CIRED | Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems | N. Gariboldi (CH) | J. Mantilla (CH) | |
| JWG B4/A3.80 | HVDC Circuit Breakers - Technical Requirements, Stresses and Testing Methods to investigate the interaction with the system | J. Cao (CN) | J. Wang (CN) | |
| JWG C4/A3.53 | Application Effects of Low-Residual-Voltage Surge Arresters in Suppressing Overvoltages in UHV AC Systems | J. He (CN) | - | |
| JWG A3/A2/A1/B1.44 | Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltages | B. Rusek (DE) | - | |
| WG A3.45 | Methods for identification of frequency response characteristic of voltage measurement systems | E. Sperling (CH) | M. Freiburg (DE) | |
| WG A3.46 | Generator Circuit-Breakers: review of application requirements, practices, in-service experience and future trends | P. Novak (DE) | - | |
| JWG B4/A3.86 | Fault Current Limiting Technologies for DC Grids | Z. He (CN) | - | |
| JWG B3/A3.59 | Guidelines for SF6 end-of-life treatment of T&D equipment (>1kV) in Substations | M. Hyrenbach (DE) | - | |
| JWG B3/A3.60 | User guide for non-SF6 gases and gas mixtures in Substations | K.P. (Piet) Knol (NL) | - | |
| WG A3.47 | Lifetime Management of Medium Voltage Indoor Switchgear | A. Maheshwari (AU) | | |
| WG A3.48 | 4th CIGRE reliability survey on transmission and distribution equipment | H.Ito (Japan) | | Matthew Iles |

Updates on working groups:

A3.39 Update

In the past 2 years meetings have been held on Teams and in person to finalise the last chapters, namely the introduction and conclusion. The conclusion should be completed by early October along with reviewing of the HVDC chapter and introduction. The draft TB is to be circulated for final review of all members to be completed by the 21st October to allow a clean version to be handed over to the SC in November for comments.

A3.40 Update

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

applications, projects, switching equipment in general, products and testing. Field experience has been removed from the scope due to limited real projects in application. The Technical brochure is mostly complete and is being finalised during the next 2 meetings, expected to be finalised in November 2022. An Electra article was published in February 2022.

A3.41 Update

The working group has held 9 plenary meetings, 4 physical (Paris, Arnhem, Baden, Zuerich) and 6 online with the last on Aug 30. A workshop was held during the CIGRE Conference 2021 with B3.45 and D1.67. Draft TB submitted to SC A3 Nov. 19, 2021 (253 pages, 348 refs) with 978 SC comments. TB 871 was published on May 23, 2022 + Electra paper (June) + tutorial (IEEE SG Comm).

A3.42 Update

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

A3.43 Update

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

A3.45 Update

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

A3.46 Update

Since starting in 2020 there have been multiple remote meetings with on 2 in person meetings held recently. There has been good discussion with examples of considerably higher than 1PU peak currents with degrees of asymmetry approaching 200% depending on the power factor. The structure and progress of the technical brochure is going well with a first draft expected to be ready in mid-2023.

A3.47 Update

Work has just started with a kick-off Workshop taking place at Palais des Congrès on 20 August 2022. 05 Members attended in person and 04 members attended via web link with good discussion on scope, approach, challenges & brochure structure. There are now 16 members in the WG and there is a call for more users or utilities, although the only recent inclusion of MV has been recognised as a limitation for attracting participants. There has been recognition of alignment needed with WG A3.43 and A3.48. The meeting continued on 01 September (no update thus far). The draft TC is scheduled to be ready for SC review by August 2024.

A3.48 Update

Created in 2022 the inaugural meeting was held during the Paris 2022 session. This is the 4th survey to collect reliability data from equipment in service in 2014-2017 including performance of ageing equipment which has been in service for more than 35 years. Despite being so new a huge amount of analysis of the survey results returned to date has already been completed with Chapter 1 through 7 already prepared. Further contributions are welcomed; it is noteworthy that there has been no response from UK utilities. Considerations, conclusions and references are the main TB sections remaining with a planned publication date of March 2024. The next planned reliability survey will be on equipment in service from 2024 to 2027.

B3/A3.59 Update

The work is focusing on practical guidance on EoL treatment of equipment, not only the gas, with experiences up to now concentrating on HV GIS (>52 kV) with gas recovery on site. A huge number of MV GIS will reach EoL, with unknown processes how to handle these products and HV best practice cannot simply be transferred. Detailed help is needed in planning and execution of the diverse process to get the SF₆ back in the bottle, including information on storage, transport, recycling and destruction of SF₆. The 9th meeting of the WG was due to happen on the 15/15 September in Manchester with targeting completion of the Technical Brochure around November 2022.

B3/A3.60 Update

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

8.9 New Working Group Proposals

New WGs were proposed during the Paris 2022 session:

- Testing requirements for MV equipment – this new working group would be focussed on analyse of on-site testing requirements of MV equipment of different technologies with different insulating mediums in different countries, along with a return of service experience and reliability survey, then compare this with IEC and best practice to develop a proposal of test requirement for MV to increase reliability in service.
- Partial discharge properties of non-SF₆ insulating gases and gas mixtures – this new working group would collect and summarize the current knowledge on the partial discharge properties of major non-SF₆ insulating gases which are currently proposed by the manufacturers of MV and HV equipment. Wherever required and feasible, further studies shall be conducted within the Working Group (e.g. by testing).
- Aging effects on accuracy class of Instrument Transformers – this new working group would deliver a technical brochure on aging effects on the metrological performance of Instrument Transformers (IT) as well as Low Power Instrument Transformers (LTIP). The brochure will take into consideration the environmental conditions, degradation mechanisms of the components inside IT and LPIT, electrical operation (either sinusoidal or distorted primary quantities).
- Requirements for HV Equipment operating under Abnormal Weather Conditions – this new working group would investigate levels and frequency of non-standard environmental requirements that might affect HV equipment performance with emphasis, but not restricted, to earthquake above 8 in Richter scale, atmospheric discharges above normally expected values, extreme ambient temperatures, snow and ice (above and below standard values), heavy rains, wind above standard values including tornado, tsunami, flood, sandstorm, etc
- On-site tests for the verification of the accuracy and for the calibration of instrument transformers – this new working group would review the technical background and new

applications that recommend the performance of on-site calibration and accuracy requirements needed for each specific application along with the applicable international and regional/local technical Standards. The working group will investigate what international regulation and/or network codes and practices exist and present the international ongoing activities aimed at the on-site verification of the accuracy and calibration. It will analyse the benefits and limits of the available methodologies and technologies to indicate the technical benefits and the opportunities for the evolution of power systems and evaluate the economical impact and benefit of the on-site calibration of instrument transformers.

A3 conducted a survey of its national representatives as hot topics in their national committees in relation to SC A3 scope. The feedback was provided by 29 national committees. Of the 9 topics identified Sf6 alternatives (21) and renewables (17) were the most commonly identified hot topics, followed by digitization, asset management, transition to condition based maintenance, monitoring, sensors, resilience and lastly big data.

Regarding the new technologies 13 national committees reported digitalization of substations (and transmission and distribution equipment) as a hot topic and 8 national committees reported HV DC grid, including HV DC breakers as a hot topic or of interest. Six national committees reported topics of resilience of substations (and transmission and distribution equipment) including the resilience against natural disasters and climate change and cyber resilience.

9 RM Report on SC B1 Insulated Cables

9.1 Study Committee Scope

SC Chair: Marco Marelli, IT (to end Paris Session), Geir Clasen, NO (from Paris Session)
SC Secretary: Matthieu Cabau, FR

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 2022).

| | | |
|--------------------|-----------------------|--------------|
| Convenor | Carla Damasceno | Brazil |
| Africa | Kieron Leeburn | South Africa |
| North America | Walter Zenger | USA |
| South America | Julio Lopes | Brasil |
| Far East (Oceania) | Richard Joyce | New Zealand |
| | Shoji Mashio | Japan |
| | Xiaolong Cao | China |
| Eastern Europe | Alexsandra Rakowska | Poland |
| Western Europe | S Damsgaard Mikkelsen | Denmark |
| India | Deepal Shah | India |

There is also a Tutorial Advisory Group (Chair: Luigi Colla) – membership is shown below (September 2022).

| 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 |
| COLLA, LUIGI | Italy | 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 |

A new Advisory Group has been launched with effect from September 2022 on the topic of Cable System Statistics (Every Two Years). The Advisory Group was created based on the recommendations of TF B1.81 (How to have statistics every two years) and is focused on capturing the service experience of insulated cable systems on a more frequent basis. The introduction of a permanent Advisory Group (rather than ad-hoc Working Groups) will provide more stability to the process of collecting the service experience data, which is very widely used across the industry. In the most recent edition, the volume of data submitted to the survey (for TB 815) was actually lower than previously despite an explosion in the number of cable systems, especially HVDC and submarine, since

the previous survey (TB 378). The new Advisory Group will implement a revised data collection process which, it is hoped, will improve the range of information collected.

9.3 Draft Preferential Subjects

The Preferential Subjects for 2022 Paris Session are:

PS 1: Learnings from experiences

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

PS 2: Future functionalities and applications

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

PS 3: Towards sustainability

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

9.4 New Working Groups

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

Note that the B1.89 activity was proposed by the UK, and after several attempts and scope revisions it was accepted as a Task Force in 2021 before being approved to proceed to a full Working Group at the Study Committee meeting in September 2022. At present the UK members for the new working groups are unconfirmed and the final Terms of Reference have not been circulated.

| Number | Title | UK Member |
|--------|--|-----------|
| B1.88 | Non-SF6 GIS terminations (Conv: Pierre Mirebeau, FR) | TBC |
| B1.89 | Guidance for conducting cable systems failure analysis (Conv: TBC) | TBC |
| B1.90 | Cable Systems Electrical Characteristics (Update of TB 531) (Conv: TBC) | TBC |
| B1.91 | Transient Thermal Modelling of Power Cables (update to IEC 60853) (Conv: Frederic Lesur, FR) | TBC |

| | | |
|----------|---|-----|
| B2/B1.XX | Transition facilities between overhead and underground lines* | TBC |
|----------|---|-----|

*Note that B1 was invited to join a joint working group with B2 on this topic. The B1 participation would be subject to B2 receiving approval from the Technical Council, and B2 would provide the Convenor.

New Task Forces are shown below.

| Number | Title | UK Member |
|--------|---|-----------|
| B1.92 | Recommendation for additional testing of submarine cables (update of TB 722) (Conv: James Pilgrim, UK) | TBC |
| B1.93 | Robotic supervision of tunnels (Conv: TBC) | TBC |

9.5 Technical Panel Meetings, Seminars & Tutorials

A (mostly) Virtual Technical Liaison meeting was held on 4th November 2021, with attendance of approximately 50 persons online and a small number of WG members joining in person in London. 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.

A webinar was given by the B1 RM in February 2021 on the topic of Optimising Subsea Cable sizing. A further webinar was given by the B1 RM in September 2022 (with approx. 70 registrants) to present the key outcomes from the Paris Session and to highlight future new work items in B1.

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

9.6 Technical Brochures

The following TBs have been published since November 2021:

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

TB862 Recommendations for mechanical testing of submarine cables for dynamic applications

TB880 Power cable rating examples for calculation tool verification

9.7 Last Study Committee Meeting (Highlights)

The B1 Study Committee meeting was held on the Thursday and Friday of Paris Session, and marked the end of Marco Marelli's chairmanship of B1. The new B1 Chair is Geir Clasen of Norway.

The new WGs this year primarily aim to fill gaps in analysis (either numerical modelling of cable response, or analysis of physical evidence in failures), with one WG looking at the new technology area of non-SF6 gases in cable terminations. The new Task Forces were the subject of spirited discussion. The UK had submitted a proposal to extend the range of recommendations for the qualification of submarine cables without a lead sheath. The original proposal had been to launch a WG directly, however a number of parties felt that there was not yet sufficient experience of using 66kV systems to merit further work. A compromise was reached on the launch of a TF B1.92, which will be convened by the UK.

Many WG have been delayed due to the impact of the COVID pandemic and restrictions on physical meetings. Despite this, it is interesting to note that one WG has now been completed, ahead of schedule, using only virtual meetings. This lays down a challenge for all remaining WGs!

The volume of online meetings now required as part of the “day job” appears to have weakened the desire of many in 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. However, there are many TBs which are close to completed, including at least 3 which have already been subject to international review and for which the UK has provided comments.

9.8 Current Working Groups and UK Members

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

| Number | Title | UK Member |
|--------------|--|---|
| WG B1.61 | Installation of HV Cable Systems | Simon Lloyd (UK) |
| 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 B1.67 | 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 | 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 | None, Jingyi Wan (NGN) |
| WG B1.74 | Recommendations for a performance standard of insulated bus-bars | Ian Johnstone (UK) |
| WG B1.76 | Increasing the role of quality assurance and quality control to reduce the cable failure possibility | Roman Svoma (UK) |
| WG B1.80 | Guidelines for Site Acceptance Tests of DTS and DAS Systems used for Cable Systems Monitoring | Matthew Connell (NGN) |
| WG B1.82 | MVDC Cable system requirements | Leigh Williams |
| WG B1.83 | Grounding aspects for long HVDC land cable connections | Dongsheng Guo |
| WG B1.86 | Assessment, Prevention and Mitigation of Safety Risk in Cable Systems | Christopher Donaghy-Spargo |
| WG B1.87 | Finite Element Analysis for Cable Rating Calculations | James Pilgrim (Conv), Venkata Chalapathi (UK), Hugo Hui (NGN) |
| JWG B1/D1.75 | Interaction between cable and accessory materials in HVAC and HVDC application | Thomas Andritsch (UK) |
| JWG D1/B1.75 | Mechanism for corrosion and how to monitor it | Was: Andrew Woolridge (UK D1) Now: Tom Cartwright (UK D1) |

| | | |
|-----------------|--|----------------------------------|
| 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 – Orsted (Developer) – Panel Chair
- Roman Svoma – PowerSure Tech (Consultancy – former manufacturer) former B1 RM
- Oliver Cwikowski –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, Huang) and retirements (Gregory), it has become necessary to refresh the membership of the Technical Panel for 2022. A request for volunteers was issued in the B1 “Post Paris” Webinar on September 28th 2022, but only two volunteers have been received to date. No decision will be taken on the constitution of the panel until after the B1 Annual Technical Liaison Meeting in November 2022, as it is hoped that delegates attending in person at this event will be among the more “motivated” to participate.

Traditionally there has been one meeting per year in the summer before the SC B1 meeting. No meeting has yet been held in 2022 due to the need to revise the panel membership, and the lack of volunteers to date. The intention is to set up a panel with representation for the following sectors:

- Panel Chair
- Panel Secretary
- Member from TSO
- Member from DNO
- Member from Manufacturer
- Member from Offshore Wind
- Member from Consultancy
- Member from Academia

As raised previously the TSO/DNO B1 WG/TF and UK participation is still an issue. TSO/DNO are under-represented, with several interested parties reporting that their organisations will no longer support costs for participation in an international WG.

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)

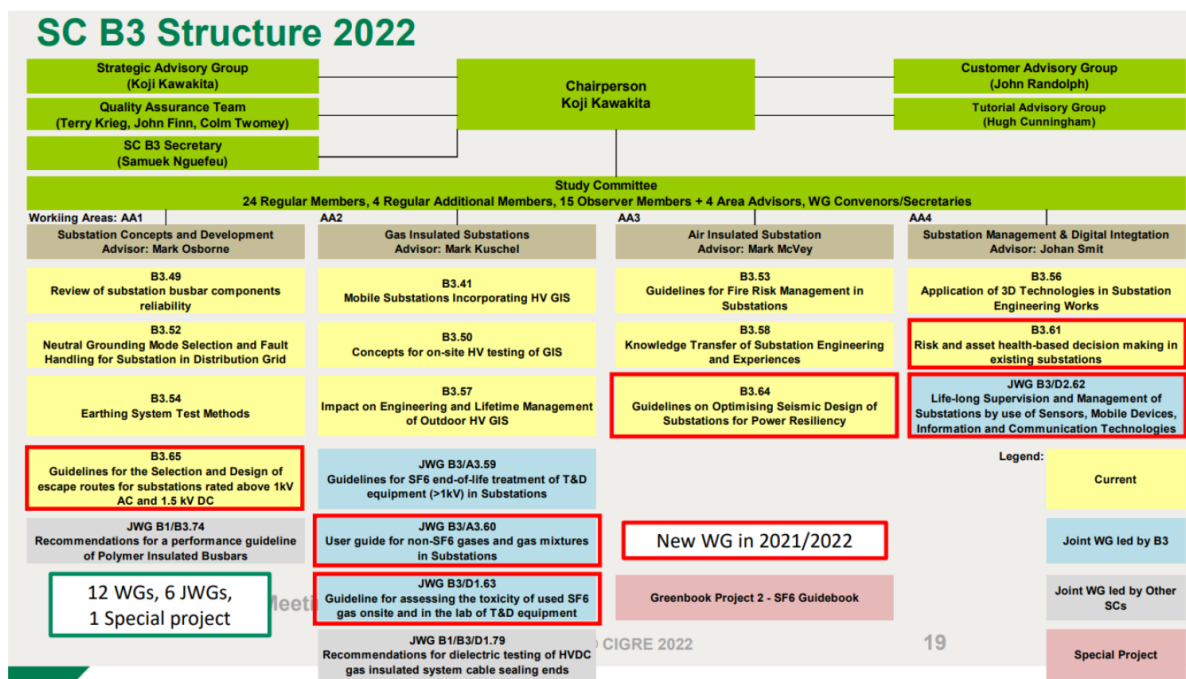
The scope of Study Committee (SC) B3 addresses topics throughout the asset management life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life. At all stages, technical, safety, economic, environmental and social aspects are addressed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

Noting the two B3 events in 2023, the Preferential Subjects for the Substation 2024 Paris Session are:

PS1 : Challenges & New Solutions in Design and Construction on T&D Substations for Energy Transition

- Design impacts on On-Offshore wind, PV, Hydrogen, EV charging infrastructure etc.
- New function in substation (energy storage, synchronous compensators, etc.)
- HV-MV DC substation and GIS/GIL application for DC network
- New design, manufacturing and construction toward circular economy

PS2 : Return on Operational Experiences for Sustainable Substation Management

- Initiatives to strengthen resilience, reliability and security
- Challenge of sustainable management (advanced asset management and end of life management)
- Lesson learned from operational experience of SF6 alternatives solutions
- New findings from user experiences on digital transformation (DX) and digital substation
- New set of competencies for new technologies, knowledge transfer and high standards of education in engineering skills

11.4 New Working Groups

| Number | Title | UK Member |
|----------|---|-----------------|
| B3/D2.62 | Life-long Supervision and Management of Substations by use of Sensors, Mobile Devices, Information and Communication Technologies | Call out |
| B3/D1.63 | Guideline for assessing the toxicity of used SF6 gas onsite and in the lab of T&D equipment above 1 kV in substations. | Tony Luija Chen |
| B3.64 | Guidelines on Optimising Seismic Design of Substations for Power Resiliency. | Call out |
| B3.65 | Escape routes from Substation rated above 1kV AC and 1.5 kV DC. (Draft TOR) | Call out |

11.5 Technical Panel Meetings, Seminars & Tutorials

The 2022 Study Committee B3 meeting was held in Paris on 01/09/2022 in the traditional face to face format. Remote access was facilitated using GoToMeeting.

The General Discussion Session 2022 was held in Paris on the 29/08/2022 in the Grand

Amphitheatre.

- 61 papers submitted – summarised in the B3 Special Report – Mark Osborne is one of the 3 Special Reporters
- 71 prepared contributions were presented, addressing the 14 questions raised over the 3 preferential subjects, 13 for PS1 and 16 for PS2 and 42 for PS3. Contributions were received from 19 different countries.
- The NGN Showcase presentation was given by NGN member Takuya Yamamura (Japan) on the 'Contribution to the reduction of global environmental impact through the introduction of environmentally friendly distribution substations.' 2 Tutorials held 'Impact of SF6 free alternatives in T&D substations and its switchgear' & 'Management of Risk in Substations TB 734'

Future Events

B3/A3 Colloquium – 8-12 May 2023, Birmingham, UK

- Theme - The role and impact for Substations and HV Equipment in delivering a Net Zero Carbon Future'
- B3 Strategic Advisory Meeting
- B3 Tutorials
- B3 Training course – modules to be agreed
- WG Meetings

CIGRE International Symposium 2023: 4-7th Sept 2023, Cairns, Australia

- Theme – The End to End Electricity System. Learning from Experience, developing practices, towards a sustainable power system
- 10 study committees meeting
- B3 study Committee meeting
- Tutorials
- 40+ Working Group Meetings

A general observation is that we need more submissions from utilities in particular their experiences, manufacturers are well represented

11.6 Technical Brochures

TB 870 Service Continuity Guide for HV GIS above 52kV (B3.51)

TB 842 Dielectric testing of gas insulated HVDC systems (D1/B3.57)

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 (B3.44)

TB 814 Low Power Instrument Transducers (LPIT) applications in HV Gas Insulated Switchgear (B3.39)

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)

The meeting was held in Paris (room 342B, it was well attended with Regular members and 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;

The emerging theme is Energy Transition (ET), this was the thread running through the whole Paris session. This focuses around how the industry will need to adjust and expand to meet the Net zero future. The key issues being;

- massive growth in capacity required to connect low carbon energy and its impact on existing networks. The technology is there but scaling up is required
- the impact that planning and engineering resource constraints have on the ability to deliver the required network in a timely manner
- Challenges around understanding and managing the growing complexity and interactions with more inverter based resources connecting to the networks.

New areas raised potentially for TOR development

- Harmonization of voltage designations and definitions across different HVDC component technologies. Proposal for a JWG led by C4
- Guidelines for Managing Black Start Resilience in substations
- Offshore Substation Operational Experience – UK convenor is being considered – Simon Waddington
- Earthing system design guidelines for high voltage systems – possible convenor Stephen Palmer
- The role of LCA in product assessment and comparison. particularly for SF6 alternatives, can be divisive.
- Fast new connections for energy transition – mobile substation would address this to some degree. Is there any procedures requiring development. Planning process is a big area which needs addressing. JWG required?

Women in Energy (WiE) – looking to get more Engineering involvement in WG activities and study committees. Support to production and editing Technical Brochures.

The energy transition requires more skills and resource, which is an ideal opportunity

Next Generation Network (NGN) professional network for early years Engineers. Active participation in national and international events. Encourage new talent into the CIGRE environment. Sponsorship to the Paris session and paper presentation in the proceedings

Technical challenges

- Challenges in Australia – high level of renewable penetration. 700MW battery energy storage (BESS) being used as a virtual line to manage constraints. Resource constraints delaying the acceleration of work. Periods of negative energy pricing. Planned use for Synchronous Compensators
- Hydro Quebec - Developments in the application of transformer neural reactors. Increase from 800A to 2000A. Exacerbates the loading and EM effects. Risk around power transformer phase unbalance.
- Germany – 4 TSOs serving the nation. 50Hertz seeing impact on Berlin of large renewable implementation. Network renewal competing with reinforcement, seeing higher loadings, which is stressing the ageing infrastructure. Large volume of GIS replacement activity on 11 GIS due to lack of spares and SF6 rationalisation. Long term replacement activity over 10+ years. looking at replacing now with SF6 as the new solution. Some opportunity to look at Sf6 alternatives (380kV)

Safety discussion in India around the use of remote cameras and AI to facilitate safety monitoring as well as security. Fundamentally looking to identify:

- Use of PPE
- Vehicle movement
- Arcing and possible fire risks
- Weather induced risks

Development of a Substation Training Course (on-line) based on the Substation Greenbook.

Fundamentals, rather than specific, provided in discrete modules typical 1-2hrs interspersed with multiple choice questions to vary the format. John Finn & Alan Wilson are part of this activity.

- 19 Modules typically taking 2 hrs each to present

- Multiple choice questions to break-up the format
- Training would be fee based – but volunteers present (expenses paid)

Technical Committee Strategic Advisory Group being established on Energy Transition

- new strategic plan established Strategic Advisory Group Industrial Forum to share relevant aspects of Energy Transition (SAG ET) and impact upon the Electrical Industry and CIGRE
- The new strategic plan would aim to make CIGRE the principal platform to capture the main developments in the electricity sector related to energy transition, hydrogen, sector coupling, and expansion into other sectors
- Each SC is expected to enhance their activities relevant to Energy Transition

A3.48 4th Reliability Survey on T&D Equipment – B3 needs to cooperate on GIS survey. Aim to publish in 2024

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 2022 award Uwe Schichler (AT)
- CIGRE Fellows 2022 award JianBin Fan (CN)

Distinguished member

Paul FLETCHER (GB), Koichi HAMAMATSU (JP), Eduard Philip KONIG (ZA), Mark McVEY (US), Akira OKADA (JP), Kyoichi UEHARA (JP), Alan WILSON (GB),

Outstanding service

Piet Knol (NL) and Jan Bednarik (IE)

Next SC meeting will be 4-7th September 2023, in Cairns, Australia.

11.8 Current Working Groups and UK Members

| Number | Title | UK Member |
|----------|---|-------------------------------|
| B3.41 | Mobile substations incorporating HV GIS | Paul Fletcher, Stefie Cray |
| 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 | TB |
| 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 | Stephen Tucker, Dongsheng Guo, Mark Osborne AA1 advisor |
| 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 |
| B3/D2.62 | Life-long Supervision and Management of Substations by use of Sensors, Mobile Devices, Information and Communication Technologies | Call out |
| B3/D1.63 | Guideline for assessing the toxicity of used SF ₆ gas onsite and in the lab of T&D equipment above 1 kV in substations. | Tony Luija Chen |
| B3.64 | Guidelines on Optimising Seismic Design of Substations for Power Resiliency. | Call out |
| B3.65 | Escape routes from Substation rated above 1kV AC and 1.5 kV DC. (Draft TOR) | Call ou |

11.9 UK Members of the Technical Panel

Delivered Technical Webinar

- April Webinar 'Asset Management and Environmental benefits of switchgear refurbishment'. Was presented by Matthew Iles from National Grid.
- Summary of Paris B3 discussion session – to be delivered at AGM – Nov 2022

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

'The role and impact for Substations and HV Equipment in delivering a Net Zero Carbon Future'

The CIGRE UK National Committee invites Study Committees B3 & A3 to hold a Colloquium in Birmingham between the 8th and 12th May 2023 at the IET Austin Court. This Colloquium brings together experts and key players in the domain of transmission and distribution Substations & Equipment from the electric power industry, including System Operators, Manufacturers, Engineers, Policy Makers, Regulators and Academics. The conference will be a unique forum to share exciting new research, to raise issues and awareness, to discuss future directions, to show innovative solutions and to network with leading professionals.

PS1 - Emerging Substation & HV equipment strategies to deliver the transition to a low carbon future

- Reducing the substation carbon footprint
- Developments and Roadmaps for alternative technologies
- Substation interventions to accommodate network growth
- What has to change?

PS2 - Impact of Net Zero on the Lifetime Management of SF6 filled equipment

- Performance & maturity of SF6 alternatives – report on industry experience
- Managing Legacy equipment - SF6-free Retrofit Solutions
- End of life management - What do we do with displaced SF6?
- Impact of emerging Legislation, regulations, and recommendations
-

PS3 – Opportunities for Sustainability and Circular Economy with Substations and HV equipment

- Threats and opportunities for Substation HV Equipment
- New Materials and Testing techniques
- Optimising substation operation and efficiency
- Evolving Asset Management philosophies.

12RM Report on SC B4 HVDC and Power Electronics

12.1 B4 Study Committee Scope

The scope of SC B4 covers High Voltage Direct Current (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 CIGRE B4 SC - Strategic Advisory Groups

SC B4 Chair: Joanne HU (Canada); SC B4 Secretary: Rebecca OSTASH (Canada)

| Number | Title | Convenor | Secretary |
|--------|-------------------------------|----------------|----------------|
| AG01 | Strategic Advisory Group | Joanna HU | Rebecca OSTASH |
| AG02 | B4 Newsletter | Hani SAAD | |
| AG03 | Communication and Website | Silvia SANZ | |
| AG04 | HVDC/FACTS System Performance | Lyle CROWE | Murray BENNETT |
| NGN | B4 NGN Group | Dave ROOP | |
| WiE | B4 Women in Energy | Rebecca Ostash | |

12.3 CIGRE B4 UK Members of the Technical Panel

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

Other Panel Members*:

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

Note*: Current list of members on the 31/10/2022. It can be evolved in future.

12.4 2022 Paris Session – B4 SC

- The Preferential Subjects for 2022 Paris Session:
 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.
- The following B4 papers for PS1-3 of Cigre 2022 Paris Session were reviewed and submitted by Cigre UK B4:
 1. Modelling and Stability Assessment of Integrated Offshore HVDC Networks
 2. Test Systems and Models for DC/DC Converters Intended for DC Transmission Grid Applications
 3. HVDC Technology Advancements for the Integration of an Offshore Wind Farm (Sofia Project)
 4. The Harmonic Loci-Based Control Design: Practical Methods in Frequency and Time Domain for a Consistent Design of VSC HVDC Harmonic Active Solutions
 5. A Novel Control Strategy of Bipolar Balance for Multi-Terminal HVDC and its Application on a Three-Terminal HVDC Project
 6. Laboratory Demonstration of a Cascaded Three-Level Neutral-Point-Clamped Converter for Medium-Voltage DC Transmission
 7. Real Time Dynamic Performance, Control Interaction and Protection Studies of Modular Static Synchronous Series Compensation Technology in the Great Britain Transmission System
- Special Reporter for B4 SC by:
 1. Kamran Sharifabadi (Norway)
 2. Ricardo Tenorio (Brazil)
 3. Christian Winter (US)

For more details of CIGRE 2022 Special Report for B4 SC, pls see the URL:
https://session.cigre.org/sites/default/files/download/b4_2022_special_report.pdf

- Tutorial B4: DC Grid Benchmark Models for System Studies on 29th August 2022.
- Workshop B1-B2-B4-C2: Extra-long Transnational Transmission Lines on 29th August 2022.

12.5 2022 B4 SC AGM Meeting (Highlights)

- The physical B4 SC AGM meeting was held on 1st September, 2022 during Cigre Paris Session. It was chaired by Joanne Hu and attended by B4 SC national regular members, working group convenors and guests.
- Key updates of Advisory Groups from Joanna Hu (AG01), Ting An (AG02), Carmen Longás Viejo (AG03), Lyle Crowe (AG04), Rebecca Ostash on behalf of David Roop (B4 NGN Group), Rebecca Ostash (B4 WiE Group).
- Introduction of the B4 Green Book on HVDC by Bjarne Andersen.
- Introduction of HVDC Compendium by Hiroyuki Furukawa.
- Working group reports were presented by Working Group (WG) convenors or representatives (See Table 1-2 within this report for completed/current WGs and Task Forces (TFs) as well as UK resources in support to those WGs and TFs.
- The 2023 B4 SC Colloquium will be held in September 2023 in Austria. For details, see URL: <https://cigre-b4-vienna2023.at/>.

12.6 CIGRE B4 UK Events

- The 2022 Cigre UK B4 Liaison Meeting was held on 4th May 2022 (Hybrid Event). For details, see URL: <https://cigre.org.uk/blog/cigre-uk-b4-hybrid-technical-liaison-meeting/>
- The 2022 Cigre JWG C6/B4.37 “Medium Voltage DC Distribution systems” Webinar was held on 18th October, 2022 (Virtual Event). For details, see URL: <https://cigre.org.uk/events/joint-working-group-c6b4-37-medium-voltage-dc-distribution-systems/>
- The Technical Zone for Cigre UK B4. For details, see URL: <https://cigre.org.uk/category/b4-zone/>

12.7 Working Groups and UK Members

- Current Working Groups and UK Members

Table 1 – Current working groups

| Number | Title | UK Member |
|---------------------|--|---|
| WG B4.94 | Application of VSC-HVDC in a System Black Start Restoration | 1. Lewis MORGAN 2. Li ZOU 3. Abdi OSMAN (NGN) 4. Xiaolin DING (Co) |
| JWG C2/B4.43 | The Impact of Offshore Wind Power Hybrid ACDC Connections on System Operations And System Design | 1. Rajat AGGARWAL |
| JWG B4/C4.93 | Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity Systems | 1. Dechao KONG (C) 2. Xiao-Ping ZHANG (S) 3. Benjamin MARSHALL 4. Andrzej ADAMCZYK 5. Xiaoyao ZHOU 6. Jinsheng PENG 7. Jiajie LUO (NGN) |

| | | |
|------------------------|--|--|
| | | 8. Sridhar SAHUKARI (O) 9. Chanditha UDALAGAMA (O) 10. Ioannis LESTAS (O) 11. Yunjie GU (O) |
| JWG C4/B4.72 | Lightning and Switching Induced Electromagnetic Compatibility (EMC) issues in DC power systems and new emerging power electronics-based DC equipment | 1. Osazee Edo IDEHEN |
| WG B4.92 | STATCOMs at Distribution Voltages | 2. Diptargha CHAKRAVORTY |
| WG B4.91 | Power Electronics-based Transformer Technology, Design, Grid Integration and Services Provision to the Distribution Grid | 1. Ahmed ABOUSHADY 2. Michael EVES 3. Alejandro Nieto CALVO 4. Taibo ZHANG (NGN) |
| WG B4.90 | Operation and Maintenance of HVDC and FACTS Facilities | 1. Patrice MOUSSET (S) 2. Malcolm MINCHIN 3. 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. Cameron MCHARDY |
| JTF 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. Panagiotis 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. Ian COWAN 3. Pablo Briff |
| 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. Benjamin MARSHALL |
| WG B4.79 | Hybrid LCC/VSC HVDC Systems | 1. Khaled AHMED 2. Emmanuel AMANKWAH 3. Dechao KONG (O) |
| 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 2. Michaël Marc Claude MERLIN |
| WG B4.64 | Impact of AC System Characteristics on the Performance of HVDC Schemes | 1. Carl BARKER 2. Dragan JOVCIC 3. Robin PREECE (Co) 4. Agusti ALVAREZ (O) 5. Andre CANELHAS (O) |

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

- Completed Working Groups and UK Members for Contribution

Table 2 – Completed working groups with TB as published or under review in 2022 and UK members for contribution

| Number | Title | UK Member for Contribution |
|------------------------------|--|---|
| WG B4.74 (TB 864) | Guide to Develop Real-Time Simulation Models (RTSM) For HVDC Operational Studies | 1. Z. SONG 2. G. LI |
| JWG B4/A3.80 (TB 873) | Design, Test and Application of HVDC Circuit Breakers | 1. D. JOVCIC |
| WG B4.83 (TB 867) | Flexible AC Transmission Systems (FACTS) Controllers' Commissioning, Compliance Testing and Model Validation Tests | 1. G. BATHURST 2. T. MILES |
| JWG C6/B4.37 (TB875) | Medium Voltage DC Distribution Systems | 1. J. Yu (C) 2. J. LIANG (S) 3. A. MOON 4. G. LI 5. N. MACLEOD 6. W. LIU 7. S. JUPE |
| JWG C4/B4.52 | Guidelines For Sub-Synchronous Oscillation Studies in Power Electronics Dominated Power Systems | 1. A. PASHAEI 2. E. LAVOPA |

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), Cedric Moors (BE)

New Network Requirements (TG.53), Nirmal Nair (NZ)

Tutorial/IEC Liaison, K-P. Brand (Switzerland)

IEEE Liaison, Richard Hunt (US)

Communication Officer, A. Apostolov (US)

13.3 Cigre Centennial 2021 - Preferential Subjects

The Paris Session 2022 for Study Committee B5, Protection and Automation was held on 30th August (PS3) and 2nd September (PS1/PS2) in Paris local time (CET). Presentations related to papers from the three selected preferential subjects:

- **PS1** - Addressing protection related challenges in network with low-inertia and low fault-current levels
- **PS2** - Applications of emerging technology for protection, automation and control
- **PS3** - Integration of intelligence on substations (Joint PS with B3)

The meeting was chaired by the Study Committee B5 Chair, Rannveig S. J. Løken, Mr. Richard Adams as SC B5 Secretary and special reporters as below.

PS1 - Protection related challenges in network with low-inertia and low fault-current levels

Special reporter: Sean McGuinness (IE) - 12 Papers from 10 Different Countries.

Highlights:

- **Many independent efforts identify similar issues**
- **Changes in relay settings can mitigate issues**
- **Simulation can be advantageous**
- **Most important lesson – understand your grid and relays**

PS2 - Applications of emerging technology for protection, automation and control

Special reporter: T. Bi (CN) Presented by Nirmal Nair (NZ)- 27 Papers from 23 Different Countries.

Highlights:

- Challenges – DSAS and LPIT, virtualization, staff training and availability, up take of technology, technology obsolescence, time sync, utility adoption – moving beyond pilots
- Benefits – centralied P&C, reduction in engineering and installation time, remote maintenance, and testing
- Large scale REN adoption has provided opportunity to trial, test and adopt new PAC technologies.

PS3 - Integration of intelligence on substations (Joint PS with B3)

Special reporter: P. Kreutzer (CH) - 24 Papers from 11 Different Countries

Highlights:

- Hybrid solutions makes testing more complex – need appropriate tools, user friendly
- Backwards compatibility in products and tools
- Standardisation
- Collaboration between users and suppliers
- Reduce cost and time through whole project
- Challenges – Oscillations, reduced inertia – leading to protection with discrete protection in grid level and with system level WAMS to guide local decision

13.4 New Working Groups

| Number | Title | UK Member |
|----------|---|--|
| B5.77 | Requirements for Information Technologies (IT) and Operational Technology (OT) managed of Protection, Automation and Control Systems (PACS) | RM: Daniel Dantas, Nationalgrid CM: Chee-Pinp TEOH, GE CM: Simanand Gandhi-Jeyaraj |
| B5.78 | New requirements of network protection and control for renewable energy integration | RM: Haiyu Li, UoM CM: Ricardo Bouchet, GE CM: Bojana Djukic, SPEN |
| B5/C4.79 | Protection Roadmap for Low Inertia and Low Fault Current Networks | RM: Venkatesh Chakrapani, GE CM: Ryan Young, RWE CM: Adam Dysko, UoStrath. |

13.5 Technical Panel Meetings, Seminars & Tutorials

- Cigre UK Centennial Technical Presentation – 100 years in PAC – Past, Present, Future – Nov 21 – Presented by John Wright, GE
- IET DPSP conference March 22 – Chair John Wright GE
- Paris 22 Session Aug/Sep 2022
- B5 Technical panel Meeting – Oct 22
- B5 / D2 Joint Liaison Meeting – Oct 22

- Post Paris Technical Session / AGM – Nov 22

13.6 Technical Brochures

| Reference | Working Group | Title |
|-----------|---------------|--|
| 845 | B5.52 | Analysis and comparison of fault location systems in AC power networks |
| BG 13 | Green Book | IEC 61850 Principles and Applications to Electric Power Systems |

13.7 Last B5 Study Committee Meeting (Highlights)

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

The meeting included the discussion of strategic directions, future events & activities, review of on-going WGs, Green Book development as well as Communications and Liaison with other technical bodies such as IEC, IEEE etc. At the meeting, the following 3 new working groups were selected for 2022:

- **New WG1** – Obsolescence management for PACS
- **New WG2** – Education, Qualification and Continuing Professional Development of Engineers in Protection, Automation and Control
- **New WG3** – Protection Principles to be applied in Distribution Networks in the Future

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.

There is a technical book/standard reference list hosted by AU B5 in KMS, which may be of interest to B5 members. It was decided that it would be useful to request a copy of this to be added to B5 KMS space

Next Event: Cairns Symposium, 4 – 7th September 2023

13.8 Awards

- No UK Awards for B5

13.9 Current Working Groups and UK Members

| Number | Title | UK Member |
|--------|---|--|
| B5.55 | Application of Travelling Wave Technology for Protection and Automation | Convener: Peter Crossley (UK) Vladimir Terzija, (UK) |
| B5.56 | Optimization of Protection Automation and Control Systems | RM Peter Watson, WSP |
| B5.57 | New challenges for frequency protection | Convenor: Vladimir Terzija, (UK) CM: Bojana Djukic, Scottish Power, |

| | | |
|----------|---|---|
| B5.58 | Faster protection and network automation systems | RM: Abraham Varghese, GE |
| B5.59 | Requirements for Near-Process Intelligent Electronic Devices | RM : John Wright, GE |
| B5.60 | Protection, Automation and Control Architectures with Functionality Independent of Hardware | RM - Abraham Varghese, GE CM- Veronika Koseleva, J. Murphy & Sons Limited UK |
| B5/C4.61 | Impact of Low Inertia Network on Protection and Control | Convenor: Ray Zhang (NG UK) Sec: V. Terzija, UK CM: Rasoul Azizipanah , RINA Tech UK CM: Xin Zhang National Grid (UK) |
| B5.63 | Protection, Automation and Control System Asset Management | CM-John Wright from GE |
| B5.64 | Methods for Specification of Functional Requirements of Protection, Automation, and Control | RM-Dr Tom Charton from National Grid, CM - Steven Blair - Synaptec |
| 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) |
| B5/D2.67 | Time in Communication Networks, PAC Applications – Time Sources and Distribution Methods | CM: chee-pinp.teoh - GE |
| B5.68 | Optimisation of IEC 61850 PACS Eng. process & tools | RM: Linwei Chen – NG CM: Suresh Kalaichelvan - GE CM: Mark Stockton - SSE |
| B5.69 | Experience and Recommendations for Implementation of Process Bus in PACS | RM: Thomas Charton - NG |
| B5.70 | Reliability of PACS of power systems – Evaluation Methods and Comparison of Architectures | RM: Chris More / Dave York - Siemens CM: Haiyu Li - UoM CM: Hengxu Ha, - GE |
| B5.71 | Communication Requirements for Inter-Substation and Wide Area Applications | CM: Shimeh Jahangiri, Selinc RM: Mark Stockton, SSE |
| 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, ARUP CM: Dr Jianing Li, Uni Of Birmingham CM: Dr Daniel Gheorghe, Reactive Technologies |
| 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 |
| B5.74 | Busbar Protection Considerations When Using IEC 61850 Process Bus | UK RM: Mohseen Mohemmed, SSE UK CM: Robert Leone, Siemens UK CM: Rasoul Azizipanah, RINA |
| B5.75 | Documentation and version handling related to Protection, Automation and Control functions | UK CM: Piotr Sawko, GE |
| B5.76 | Architecture, Standards and Specification for metering system in a Digital Substation and Protection, Automation and Control (PACS) Environment | UK RM: Ian Nicoll, elexon UK CM: Joao Jesus, GE |

13.10 UK Members of the Technical Panel

Chairman: John Wright

Secretary: Gen Li

- Academia by Haiyu Li / Xiao-Ping Zhang
- Transmissions by Mark Stockton / Thomas Charton / Craig McTaggart
- Distributions by Sean Stack / Colin Scoble
- Manufacturers (OEMs) by Robbie Smith (Replaced Danny Lyonette) / Dave York (replaced 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 - Omicron

14RM Report on C1 System Development and Economics

14.1 Study Committee Scope

SC Chair: Antonio Iliceto
SC Secretary: Peter Roddy

The scope of Study Committee C1 is to study Economics and system analysis methods for the development of power systems: methods and tools for steady state and dynamic analysis, planning issues and methods in various contexts, asset management strategies, in order to support electricity system planners worldwide to anticipate and successfully manage system changes to address the arising needs, opportunities and uncertainties while respecting multiple constraints.

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 Paris session 2024 proposed and aligned with C6.

14.4 New Working Groups

Several new joint working groups were set up this year with B2 and C5 reflected below, further proposals for a number of new working groups were made at the Paris session and earlier this year and these are to be confirmed.

14.5 Technical Panel Meetings, Seminars & Tutorials

- Paris General Session August 2022 → Workshop 'EXTRA-LONG TRANSNATIONAL TRANSMISSION LINKS'
- Support on Kyoto Symposium and Paris 22 session paper review
- Cairns Symposium in September 2023 - C1 involvement
- Oman symposium 2023

Technical Brochures

Technical Brochures for C1.23, C1.37 and C1.44 being reviewed and finalised for publication.

14.6 Last Study Committee Meeting (Highlights)

Study Committee (Aug 22) – Face to face during Paris session

- Updates from all active working groups and recently closed working groups
- Update on C1 session and webinars/tutorials
- Green Book on Asset Management has been published – short summary provided
- Discussed and agree new Working Groups
- Discussed and agreed preferential subjects for 2024
- Excellent attendance – further details to follow

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 | TBC |
| C1.37 | Optimal transmission and distribution investment decisions under growing uncertainty | Geev Mokryani (University of Bradford) |
| 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 (Arup) 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 | Spyros Skarvelis-Kazakos |
| C1/4.46 | 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) Spyros Skarvelis-Kazakos |
| C1.48 | Role of green hydrogen in energy transition: opportunities and challenges from technical and economic perspectives | James Crouch (Burns McDonnell) Callum Dell (WSP) |
| C6/C1.33 | Multi-energy system interactions in distribution grid | Eduardo Martinez-Cesena (University of Manchester) |
| B2/C1.86 | Approach for Asset Management of Overhead Transmission Lines (new) | UK member TBC |
| C5/C1.35 | Integration of hydrogen in electricity markets and sector regulation | UK member TBC |

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**

UK Regular Member – Ronan Jamieson

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

15.2 Strategic Advisory Groups

TD 1: Real-time System Operation and Control

TD 2: System Operational Planning and Performance Analysis

TD 3: Control Centre Infrastructure and Human Resources for System Operation

15.3 Preferential Subjects

The Paris 22 Session had the following preferential subjects on

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 |
|--------------|---|-----------|
| JWG C2-B4.43 | The impact of Offshore Wind Power hybrid AC/DC connections on System Operations and System design – convener Christer Norlander | TBC |

Under consideration

New WGs:

- System Operational Resilience Indexes
- Digitalization

New JWG's:

- System Operation & Cybersecurity (JWG w/ D2?)
- Influence of Changing Climate Policies on System Operation (JWG w/ C3?)

15.5 Technical Panel Meetings, Seminars & Tutorials

- C2 paper sessions – Paris 2022
- Large Disturbances Workshop – Paris 2022.
- Tutorial – Impact of High Penetration of Inverter-Based Generation on System Inertia of Networks (WG C2/C4.41) – April 2022 – CIGRE International Symposium – Kyoto – Japan

15.6 Technical Brochures

TB 833 Operating strategies and preparedness for system operational resilience – WG C2.25

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

TB 851 Impact of High Penetration of Inverter-based Generation on System Inertia of networks – JWG C2/C4.4

Published Reference Paper – refer to Cigre Paris session as too many to list here

15.7 Last Study Committee Meeting (Highlights)

Paris Session 2022 - A summary of the committee discussion is as follows

The Group Discussion Meeting of SC C2 during the CIGRE Session have once more revealed the challenges and the increasing complexity that system operations is facing and will face in the future. There are major areas where developments are happening:

- Importance of focusing on simulation of real-life conditions for operator training including also the psychological aspect of operator training tools.
- About effective and efficient use of synchro-phasor data in power system operation, there is a general opinion that are more pragmatic approaches such as linear programming, swarm optimization and graph theory algorithms, depending on the network topology.
- Artificial Intelligence (AI) is generally seen as a helpful function in control rooms but more advancements and maturity need to occur and should be mainly used to simplify and pre-process information available to dispatch operators. There also needs to be transparency and clear explanation on its behavior.
- Flexibility, in all aspects of system operation, will be needed to meet the challenges of decarbonizing the power system.
- Mechanisms to provide ongoing validation of AI and other advanced tools is necessary to maintain trust in the tools.
- Topology optimisation, special protection schemes and other tools to extend the capability of the power system have a key role to play, but care is needed when the characteristics of the power system are changing rapidly during the energy transition.

In conclusion, system operations and control will keep on developing innovative solutions and concepts to operate the system today and in the future

UPCOMING EVENTS

- 2023 Symposium Proposal: Australia (September)

- 2024 Paris Session

15.8 Current Working Groups and UK Members

| Number | Title | UK Member |
|--------------|--|---------------------|
| WG C2.18 | Wide Area Monitoring Protection and Control Systems – Decision Support for System Operators | None |
| WG C2.24 | Mitigating the Risk of Fire Starts and the Consequences of Fires near Overhead Lines for System Operations | None |
| WG C2.26 | Power system restoration accounting for a rapidly changing power system and generation mix | Dan Auty |
| WG C2.39 | Operator Training in Electricity Grids at Different Control Levels and for Different Participants/Actors in the New Environment | Dozie Nnabufie |
| WG C2.42 | The Impact of the growing use of machine learning/Artificial Intelligence in the operation and control of Power Networks from an Operational perspective | Ewa Krywkowska |
| JWG C2/C5.06 | The Impact of Electricity Market Interventions by System Operators during Emergency Situations | Christopher Challan |

15.9 UK Members of the Technical Panel

RM – Ronan Jamieson (Baringa)

16RM Report on SC C3 System Environmental Performance

The Regular Member is on Maternity leave, no information was provided the time the report is written.

17RM Report on SC C4 System Technical Performance

17.1 Study Committee Scope

SC C4 Chair: Incoming – Marta Val Escudero (IE), Outgoing – 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.

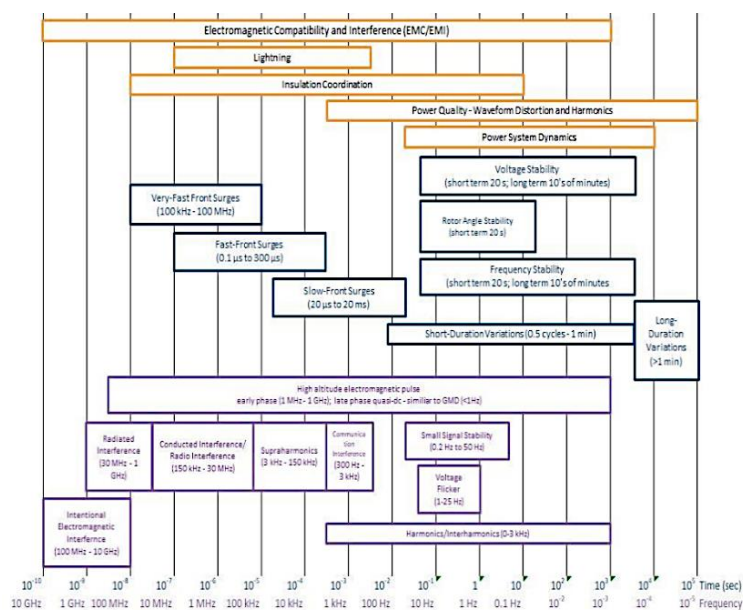


Figure 17.1: Time Frame with the Range of Phenomena Investigated by SC C4.

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 43 countries. At the 2021 SC C4 online meeting on Friday, September 2nd, the composition of the SC was confirmed as follows:

- Chair and Secretary - Incoming Chair: Marta Val Escudero (MVE), Outgoing Chair: Dr Zia Emin
- 24 Regular Members and 2 Additional Regular Members
- 18 Observer Members

Error! Reference source not found. shows the organisational structure of the CIGRE SC C4. It comprises 3 Advisory Groups (AGs), as follows:

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

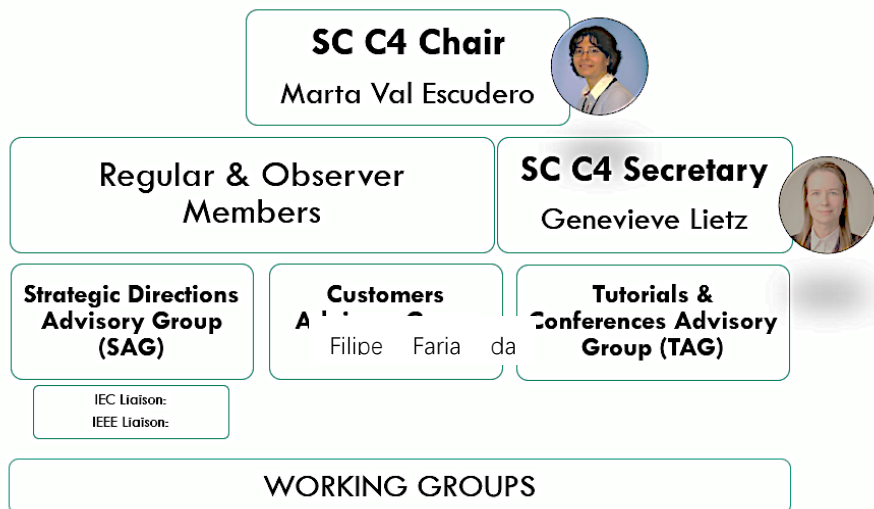


Figure 17.2: Organisational Structure of SC C4.

Awards

The following individuals associated with SC C4 work in the past or currently (some members work across SCs) were recognised with various CIGRE awards:

- Marta Val Escudero (IE): Technical Council Award;
- Maria Teresa Correia de Barros (PT): Distinguished Member Award;
- Kostas Velitsikakis (NL): NGN Significant Contribution Award;
- Genevieve Lietz (AU): Women in Energy (WiE) Award;

- Zia Emin (UK): Honorary Member Award

17.3 CIGRE SESSION 2022 – Preferential Subjects

The Preferential Subjects (PS) for the CIGRE 2024 Paris Session were discussed in the 2022 Annual SC C4 Meeting and are expected to be finalised:

PS 1: Challenges, Opportunities and Advances in Power System Dynamic Analysis

PS 2: Challenges, Opportunities and Advances in Power Quality (PQ) and Electromagnetic Compatibility (EMC) Analysis

PS 3: Challenges, Opportunities and Advances in Insulation Coordination and Lightning Research

17.4 Current Working Groups and UK Members

SC C4 presently consists of some **42 active (J)WGs** performing highly technical work aligned with its strategic fields. These WGs are composed of over 600+ individual technical experts from 60+ countries around the world, some serving in more than one WG. The number of active WGs by topic is as follows:

| Number | Title (RAG Status) | UK Member |
|-----------------------|---|--|
| <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>JWG C4.40/CIRE</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 Thomas, Dave Djokic, Sasa Vujatovic, Davor |
| <u>JWG C4.42/CIRE</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 Munji, Kiran 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 C4.49</u> | Multi-frequency stability of converter-based modern power systems | Mills, David Ding, Xiaoling Shore, Nigel Emin, Zia |

| | | |
|---------------------------|---|--|
| <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 | Vujatovic, Davor-Convenor Emin, Zia Ghassemi, Forooz |
| <u>JWG A1/C4.52</u> | Wind generators and frequency-active power control of power systems | |
| <u>JWG A2/C4.52</u> | High-frequency transformer and reactor models for network studies | Vujatovic, Davor Jamil, Shakin |
| <u>JWG C4/B4.52</u> | Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems | Lapova, Elisabetta Pashaei, Afshin |
| <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 C4.57</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 | Li, Rui Vozikis, Dimitrios Nieto Calvo, Alejandro Larkins, Andrew Vaheeshan, Jeganathan Abiri Jahromi, Amir |
| <u>WG C4.61</u> | Lightning transient sensing, monitoring and application in electric power systems | Siew, Wah-Hoon |
| <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 | Emin, Zia Shore, Nigel – Convenor Koo, Kah-Leong Pampana, Ramesh Blair, Steven Ghassemi, Forooz |
| <u>WG C4.64</u> | Application of Real-Time Digital Simulation in Power Systems | Ponnalagan, Bharath Wijesinghe, Sarath |
| <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 | Fabian Koehler |
| <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 | Fabian Koehler |
| <u>WG C4.71</u> | Small signal stability analysis in IBR dominated power system | Tatiana Assis Can Li |
| <u>JWG C4/B4.72</u> | Lightning and Switching Induced Electromagnetic Compatibility (EMC) issues in DC power systems and new emerging power electronics-based DC equipment | Oheidhin, Gearoid |
| <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 | |
| <u>WG C4.73</u> | Insulation Coordination of HVDC Overhead Lines | |
| <u>JWG B5/C4.79</u> | Protection Roadmap for Low Inertia and Low Fault Current Networks | |
| <u>JWG B4/C4.93</u> | Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity System | Dechao Kong – Convenor Peng, Jinsheng |

The number of the above-mentioned 42 active (J)WGs by topic is as follows:

- Power Systems Performance Models and Numerical Analysis (PMNA): 15 (J)WGs
- Power quality (PQ): 6 (J)WGs
- EMC/EMI: 5 (J)WGs
- Insulation Coordination (IC): 6 (J)WGs
- Lightning (L): 10 (J)WGs

17.5 New Working Groups

During the 2021 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, 7 **new WGs** were formed in SC C4 since October 2021 as listed below and work is in progress to propose further WGs:

- **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”
- **WG C4.71:** “Small signal stability analysis in IBR dominated power system”
- **JWG C4/B4.72:** “Lightning and Switching Induced Electromagnetic Compatibility (EMC) issues in DC power systems and new emerging power electronics-based DC equipment”
- **WG C4.73:** “Insulation Coordination of HVDC Overhead Lines”
- **JWG B5/C4.79:** “Protection Roadmap for Low Inertia and Low Fault Current Networks”
- **JWG B4/C4.93:** “Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity Systems”

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 2021 as a result of work done by SC C4 WGs and JWGs:

- **TB 851:** “Impact of High Penetration of Inverter-based Generation on System Inertia of networks”, JWG C2/C4.41, 2021.
- **TB 855:** “Effectiveness of line surge arresters for lightning protection of overhead transmission lines”, WG C4.39, 2021.
- **TB 881:** “Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter-connected generation”, WG C4.56, 2022.

The following **TBs are expected to be finalised** and submitted for publication in 2022/2023:

- 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”
- 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”
- JWG C4/B4.52 “Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems”
- JWG C4/C2.58/IEEE “Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems”
- JWG A1/C4.66 “Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators”

SC C4 has also produced C4.47 **Reference Paper** and 3 others with shorter summaries in Electra and longer versions in CIGRE Science & Engineering Journal (CSE) since October 2021.

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 ToR was sent to all members to seek additional contributors. 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 2022 Annual SC C4 Meeting was held online on Friday, September 2, during the CIGRE 2022 Paris Session. Participants included SC C4 Regular Members, AG Members and WG Conveners. The meeting agenda covered, among others, the following:

- Review of SC C4 Membership & Structure
- Study Committee Chairman's Report
 - The schedule and highlights of 2019-2022 Technical Council (TC) meetings
 - The involvement of women in CIGRE
 - Key items related to WGs (e. g. WGs statistical information, process of creating new WGs, membership and management)
 - The structure of CIGRE Awards and how to nominate a person for a CIGRE Award
 - Other topics related to the CIGRE awards to SC C4 members in 2022
- Advisory Group 1 - Strategic Directions (SAG)
 - Summary of the membership and status of AG1 membership
 - Summary of the status of current WGs and JWGs
 - A recap of the Gap Analysis Task Force
 - Discussion regarding various WG issues; Task Force ToRs; Liaisons
 - Discussions for 6 new and 3 disbanded WGs
 - Strategic Plan 2022-2026
 - SC C4 System Phenomena Timeframes
 - Institutional Liaison (IEC, IEEE, etc.)
- Advisory Group 2 - Customers (CAG)
 - SC C4 Task Force (TF) ToR in “Statistics on Power Quality (PQ)”
 - Subject matter of non-standard waveforms rests with C4 but also related to other SCs.
 - Educational webinar initiative; Future support of NGN
- Advisory Group 3 - Tutorials & Conferences (TAG)
 - New policy on Tutorials
 - Review of recent events (Kyoto (Japan) Apr. 2022, Paris (France) Aug. 2022)
 - WG outputs as tutorials (1 new Tutorials)
 - Future events – 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 2024 Session: Preferential Subjects
 - Preferential Subjects 1 – 3 (PS 1 – 3) for the SC C4 2024
 - Special Reporters
- Next SC C4 Meetings
 - CIGRE Symposium 2023 in Cairns, Australia
 - CIGRE Session 2022 in Paris, France
- AOB
 - Farewell from Dr Zia Emin as outgoing Chair

17.8 Technical Panel Meetings, Seminars & Tutorials

Past Events: Since October 2021, SC C4 has supported the following events:

Kyoto 2022 Symposium: SC C4 led **4 sessions** in the symposium covering the main technical direction areas and was also able to support two other sessions led by other study committees. Furthermore, SC C4 delivered **2 tutorials**:

- **WG C4.39:** “Effectiveness of Line Surge Arresters for Lightning Protection of Overhead Transmission Lines”
- **JWG C2/C4.41:** “Impact of high penetration of inverter-based generation on system inertia of networks”

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

- **The SC C4 Group Discussion and Paper Session:** SC C4 selected **59 papers** aligning with the **3 Preferential Subjects (PS)** for the 2022 CIGRE Session. 2 out of the 59 selected papers were submitted as part of Next Generation Network Young Member showcase competition:
 - **PS1** – Challenges and advances in power quality and electromagnetic compatibility
 - 19 papers, 6 questions answered through 11 contributions with presentations and 7 spontaneous contributions with discussions
 - **PS2** – Challenges and advances in insulation coordination and lightning research
 - 11 papers, 4 questions answered through 5 contributions with presentations and 10 spontaneous contributions with discussions
 - **PS3** – Challenges and advances in power system dynamics
 - 29 papers, 11 questions answered through 24 contributions with presentations and 29 spontaneous contributions with discussions
- **The SC C4 Workshop** entitled: JWG C4/B4.52 and WG C4.49 – “Oscillatory instabilities and interactions in inverter based resource (IBR) dominated power systems”, August 30. Its agenda is shown below:
 - Multi-Frequency Oscillations in Power Electronic Based Devices
 - Practical Experience with Multi-frequency Instability
 - Review of Analysis tools
 - Time-domain Simulation for Multi-frequency Stability Analysis
 - Instability mitigation methods
 - Actions on control layer and operational measures
 - Installation of additional equipment
 - Recommendations and guidelines
 - Recommended stability analysis procedure
 - Best practice for stability investigation
 - Guidelines for Subsynchronous Oscillation Studies in Power Electronics Dominated Power Systems
 - Detailed Analysis of Subsynchronous Oscillations
 - SSO Mitigation, Monitoring and Protection
 - Industry practices, challenges and experiences related to SSO issues
 - Screening of Potential SSO Risk
- The SC C4 Tutorial entitled: WG C4.46 – “Evaluation of Temporary Overvoltages in Power Systems due to Low Order Harmonic Resonances”, August 27, with the following Agenda:
 - Introduction and Motivation
 - Harmonic TOV stresses in selected equipment
 - Modelling Guidelines and Selected Cases
 - Assessment Methods
 - Comparison of Assessment Methods
 - Mitigation Strategies
 - Summary and Recommendations

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

- **2023 CIGRE Symposium**
 - Cairns (Australia): “Renewables and challenges of integration and the impact of renewable generation on the Grid”, September 2023.
- **2023 CIGRE International Colloquium**
 - Sendai (Japan) :Recent Overhead Transmission Line Technology and Environmental Measures, International Colloquium SC B2/C/C4, October 2023.
- **2024 CIGRE Paris Session, France**
- **TBD International Colloquium on Lightning and Power Systems (ICLPS)**

17.9 UK SC C4 Technical Panel Members and Meeting

The 2022 CIGRE UK Study Committee C4 Technical Panel Liaison Meeting will be held in conjunction with the CIGRE UK SC C4 Technical Event on December 7th and will be led by SC C4 UK Regular Member, Spyros Karamitsos. It will aim 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 modelling methods and study tools for the analysis of the transforming power system. The 2022 CIGRE UK Event's Agenda will also include updates on the Technical Brochures published in the last, along with a status update on the active SC C4 Working Groups where the UK has an interest as well as latest work items approved by the C4 Study Committee during the Paris 2022 session and possible work items that could be proposed in the future.

Three UK SC C4 Papers were presented at the CIGRE PARIS 2022 POSTER SESSION, all at PS3:

- 10202: "Converter Driven Oscillation in Power Systems with High Penetration of HVDC Interconnectors", X. Ding, X.WU, C.Li, J. Liang
- 10204: "Implications of Reduced Fault Level and its Relationship to System Strength: A Scotland Case Study", S.Gordon, Q.Hong, K. Bell
- 10205: "Real Time Simulation and Demonstration of Black Start on Transmission Networks using Embedded Synchronous Generators", B. Ponnalagan, I.L. Cowan, M.H. Rahman, B. Marshall, O.D. Adeuyi and N. Miller



Photograph of CIGRE UK SC C4 Paper Authors at CIGRE PARIS SESSION 2022 (Professor Liang Jun, Ben Marshall, Xiaolin Ding, Spyros Karamitsos, Samuel Gordon)

The UK SC C4 technical panel to be confirmed for 2022-2023. The goal will be to organise a CIGRE UK SC C4 Technical Panel and hold a successful CIGRE UK SC C4 Liaison Meeting and Technical Event including a (J)WG Update Session and invite Keynote and Guest Speakers from industry, utilities, and academia to maintain member engagement.

18RM Report on SC C5 Electricity Markets and Regulation

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

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

19.1 Study Committee Scope

SC Chair: Kurt Dedekind, replacing Christine Schwaegerl, starting from 01/09/2022

SC Secretary: Evert de Haan, replacing Geza Joos

Communications Officer: Harry Evans

Mission: To facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of **distribution systems and distributed energy resources (DER)**. To add value to this information and knowledge by means of synthesizing state-of-the-art practices and developing recommendations.

Technological field of activity: innovative equipment and systems for DER and distribution technology deployment; customer integration and empowerment; enabling technologies for DER integration and application; storage technologies and multi-energy technologies, rural electrification and off-grid systems. Distribution generation, from conventional (diesel, gas turbines, CHP) to renewable resources (wind and solar) based generation, energy storage systems (battery energy storage, thermal and inertial storage), and demand response (controllable and curtailable loads).

Areas of attention include:

- Enabling technologies: active network management, micro-grids, virtual power plants, distribution management systems (ADMS, DERMS), DER monitoring and control, aggregation systems, platforms, block-chain applications.
- Innovative solutions: smart inverters and power electronic interfaces and interconnection device applications, MV/LV DC supply systems, distribution system modernization
- Storage technologies: electrochemical electric battery energy storage systems, flywheels, flow batteries, and new storage technologies, hydropower, hydrogen, multi-energy solutions (with thermal storage), power2X applications (power to heat, power to gas ...), electric vehicles.
- Consumer integration and empowerment: Demand side integration and participation, demand response, load management, smart load, new customer sectors such as electric vehicles, smart home and smart meter applications with impact on distribution systems.
- Smart cities: integrated distribution system technologies, power, control and information and communication technology deployment for flexibility, integration of multi-energy systems.
- Rural Electrification, islanded power systems and individual customer off-grid systems and solutions.

19.2 Strategic Advisory Groups (to be updated)

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)

Preferential Subject 1: *Flexibility Management in Distribution Networks*

- Energy storage systems with the associated provision of their grid services

- Evolving planning and operational objectives and criteria with increased electrification, coupled with the changes in end-to-end technology behaviours
- Electric Vehicle integration and impacts

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

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

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

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

19.4 New Working Groups

| Number | Title | UK Member |
|----------|---|--|
| WG C6.45 | The impact of distributed energy resources (DER) on the resilience of distribution networks | Working with the Convenor Nasser Usman to select UK member. |
| WG C6.42 | Electric Transportation Energy Supply Systems | <i>Approved in 2020</i> New Convenor, Prof. Liana Cipcigan of UK replacing Prof Geza Joos |

19.5 Technical Panel Meetings, Seminars & Tutorials

The following tutorials were presented by SC C6 during 2022:

- “Electric Vehicles as Distributed Energy Resource (C6.40)” – CIGRE Conference in Paris 01/09/2022
- “Medium Voltage DC distribution systems (C6/B4.37)” – online 18/10/2022
- “Flexibility provision from distributed energy (C6.34)” -CIGRE symposium 2022 in Kyoto, Japan

19.6 Technical Brochures

The following brochures were published 2022:

- JWG C6/B4.37 - ‘Medium Voltage DC distribution systems’
- JWG C1/C6.37/CIRED - ‘Optimal transmission and distribution investment decisions under increasing energy scenario uncertainty’ TB863

The following brochures are being finalized for publication in 2022-23:

- C6.40 - ‘Electric Vehicles as Distributed Energy Resource’
- C6.35 - ‘DER aggregation platforms for the provision of flexibility services’
- C6.43 - ‘Aggregation of battery energy storage and distributed energy resources (DER), including solar PV’
- C6.36 - ‘DER benchmark models for quasi-static time-series power-flow simulations’. Under review

19.7 Last Study Committee Meeting (Highlights)

The last SC C6 meeting took place hybrid (in-person and online) on 1st September 2022 in Paris CIGRE 2022. Minutes from the meeting has been published.

The meeting covered the following topics:

1. Welcome and introduction
2. Report of the Chair (by Christine Schwaegerl and Kurt Dedekind)
3. Summary of recent SC C6 events
4. Final reports of terminated WGs (by the WG convenors)
5. Report of Advisory Groups (by the AG convenors)
6. Status of On-going WGs (by the relevant convenor)
7. Status of WGs led by other SCs with expected C6 contribution (by the relevant convenor)
8. SC C6 Green Book
9. SC C6 Strategy
10. New and Planned WGs
11. 2024 Paris General Session
12. Next SC Meeting, Future Events and Activities
13. Organizational Issues and other business

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) Jun Liang (Secretary) 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 | Liana Cipcigan (new Convenor) 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 |
|--------------------|---------------------------|--|
| Jun Liang | Cardiff University | RM C6 UK |
| 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: Simon Sutton (UK)

SC Secretary: Gordon Wilson (UK)

The scope of SC D1 is concerned with the monitoring and evaluation of:

- new and existing materials for electrotechnology,
- diagnostic techniques and related knowledge rules,
- emerging test techniques which may be expected to have a significant impact on power systems in the medium to long term.
- support of other study committees in their analysis of recently introduced and developing materials, emerging test techniques and diagnosis techniques

20.2 Strategic Advisory Groups

AG D1.01 Liquids and Liquid Impregnated Insulation Systems (Qiang Liu)

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

AG D1.03 Solid Materials (Jerome Castellon)

AG D1.04 Gases (Karsten Juhre)

Tutorial AG (Ivanka Atanasova-Hoehlein)

Strategic and Customer AG (Simon Sutton)

20.3 Draft Preferential Subjects

The Preferential Subjects for 2022 Paris Session were:

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 |
|----------|---|-----------|
| A2/D1.67 | Guideline for online dissolved gas analysis monitoring | |
| B3/D1/63 | Guideline for assessing the toxicity of used SF ₆ gas onsite and in the lab of T&D equipment above 1 kV in substations | |
| A2/D1.66 | Breathing systems of liquid filled transformers and reactors | |

20.5 Technical Panel Meetings, Seminars & Tutorials

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

- 04/11/21 – Joint B1/D1 meeting.
- 17/02/22 – Joint A2/D1 meeting.

Both events were attended by 30-40 people.

20.6 Technical Brochures

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

- TB861 Improvements to PD measurements for factory and site acceptance tests of power transformers
- TB856 Dielectric performance of insulating liquids for transformers
- TB850 Harmonised test for the measurement of residual methane in insulating materials
- TB849 Electric performance of new non- SF₆ gases and gas mixtures for gas-insulated systems

20.7 Last Study Committee Meeting (Highlights)

- New chairman and secretary appointed at Study Committee meeting in Paris 2022.
- Next meeting will be held in Cairns in September 2023.

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 |

| Number | Title | UK Member |
|-------------|---|--|
| | | Ian Cotton |
| D1.65 | Mechanical properties of insulating materials and insulated conductors for oil insulated power transformers | |
| D1.66 | Requirements for partial discharge monitoring systems for gas insulated systems | Mark Waldron |
| 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 |
| B1/B3/D1.79 | Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends | |
| B1/D1.75 | Interaction between cable and accessory materials in HVAC and HVDC applications | Thomas Andritsch |
| D1/B1.75 | Strategies and tools for corrosion prevention for cable systems | |
| D1/A2.77 | Liquid Tests for Electrical Equipment | |

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

20.9 UK Members of the Technical Panel

There is no UK Technical Panel for D1.

21 RM Report on SC D2 Information Systems & Telecommunication

21.1 Study Committee Scope

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

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

SC D2 mission is:

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

21.2 Strategic Advisory Groups

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

21.3 Draft Preferential Subjects for 2022 Paris Session

PS 1: IT applications to improve the resilience of electric power systems:

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

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

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

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

- Building scalable and resilient networks with management, automation and orchestration solutions and methods.

- Integration of current and new wireless technologies in meeting the requirements of power utility applications.
- Techniques and methods in building resilient networks to support critical utility applications

21.4 New Working Groups

Proposals and ideas:

- Cost-Benefit Challenges for PACS Cybersecurity Certification
- Monitoring, Maintenance and Control of Communication Networks & Services – From Situational Awareness to Network Control
- Remote access telecommunications technologies and design principles
- Service differentiation strategies for a shared telecommunications network in power utilities
- Cross-certificate signing by multi-utility certificate authorities
- Supplier security assessment
- Update on cyber-physical security metrics development

Approved/under review in 2022:

| Number | Title | UK Member/Status |
|----------|---|------------------|
| D2.57 | CIM methodology | ToR review |
| D2.56 | Interdependence and Security of Cyber-Physical Power System | Approved |
| B3/D2.62 | Life-long Supervision and Management of Substations by use of Sensors, Mobile Devices, Information and Communication Technologies | Approved |
| A2/D2.65 | Transformer Digital Twin – concept and future perspectives | Approved |

21.5 Technical Panel Meetings, Seminars & Tutorials

- One day conference: “The application of data analytics to enhance power system performance” - 27/05/2022, London.
- CIGRE Paris session 29/08 – 02/09/2022, Paris, France.

Future events planned for 2022/23:

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

21.6 Technical Brochures

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

- TB 866: Enabling software defined networking for electric power utilities
- Webinar material: Electric Utilities’ Cybersecurity for Contingency Operations – An Overview
- Future Connections newsletter #8: “Application of 5G Technology to Smart Grids”
- Future Connections newsletter #9: “Interdependence and Security of Cyber-Physical Power System”

- Electra article: “Results of AGD2.03 Survey on the current state of telecommunications in power utilities”
- Electra Article: “An open source driven transformation in the power industry”

21.7 Last Study Committee Meeting Highlights

During the last SC meeting as part of the 2022 Paris session an overview of last year’s D2 activities was provided including:

- Participation in the Kyoto Symposium 5 – 7/04/2022 – 27 papers and two tutorials: “Enabling Software Defined Networking for EPU Telecommunications Applications” (D2.43) – “Advanced Consumer Side Energy Resource Management Systems” (D2/C4.47)
- SEERC conference 31/05 – 01/06/2022, Vienna, Austria. Tutorial – “Cyber Security Management – a key player in the EPU resilience strategy”

In 2022/23 the SC D2 aims to focus on the following objectives:

- Active participation at the Cairns Symposium
- Increased cooperation with other SCs
- Timely delivery of WG outputs
- Delivery of webinars and tutorials
- Preparation of a bi-monthly D2 newsletter

As part of the Paris session representatives from IEC, IEEE and CIGRE presented a workshop on cyber security standardisation: “Standardization of cybersecurity in power utilities digital infrastructures – a joint vision from IEC, IEEE and CIGRE”

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

21.8 Current Working Groups and UK Members

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

| WG | WG Title | WG Convenor |
|----------|--|---------------------------------------|
| | | GB representative |
| WG D2.56 | Interdependence and Security of Cyber-Physical Power System | QINGLAI GUO (CN) |
| | | Wentao Zhu (GB) |
| WG D2.55 | Application of 5G Technology to Smart Grids | KUNLUN GAO (CN) |
| | | Lin Jiang (GB) |
| WG D2.54 | Regulatory approaches to enhance EPU's cybersecurity frameworks | Tbc. |
| | | Mohammed Zumla (GB) |
| WG D2.53 | Technology and Applications of Internet of Things in Power Systems | ZHENGYUN SUN |
| | | Ester Hwang (GB) |
| WG D2.52 | Artificial Intelligence Application and Technology in Power Industry | KUNLUN GAO (CN) |
| | | Fraser Cook / Giulio Riccardi (GB) |
| WG D2.51 | Implementation of Security Operations Centers (SOC) in Electric Power Industry as Part of Situational Awareness System | V. KARANTAEV (RU) |
| | | Shimeh Jahangiri / Gareth Taylor (GB) |
| WG D2.49 | Augmented reality / Virtual reality to support Operation and Maintenance In Electric Power Utilities | S. H. KHALAJ (IR) |
| | | Douglas Gray / Richard Moore (GB) |
| | | Y. Chen (CN) / A.KULKARNI (GB) |

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

21.9 UK Members of the Technical Panel

UK D2 Technical Panel Chair: Thomas Charton
D2/B5 liaison officer: Gareth Taylor
Further positions to be filled during 2022/23