Australian Technical Committee of CIGRE
2021 Report

This Australian Technical Committee report provides an introduction to the specific reports from the individual Australian Panel Conveners on the activities of their international Study Committees, Working Groups and Australian Panels for the calendar year 2021.

Contents

David Bones
Retiring Chair of the Australian Technical Committee

December 2021

Role of the Australian Technical Committee

The Australian Technical Committee (ATC) comprises the 16 CIGRE Australia representatives on the CIGRE international Study Committees (SC). Each member of the ATC also convenes an Australian Panel (AU) matching the scope of their corresponding CIGRE international Study Committee.

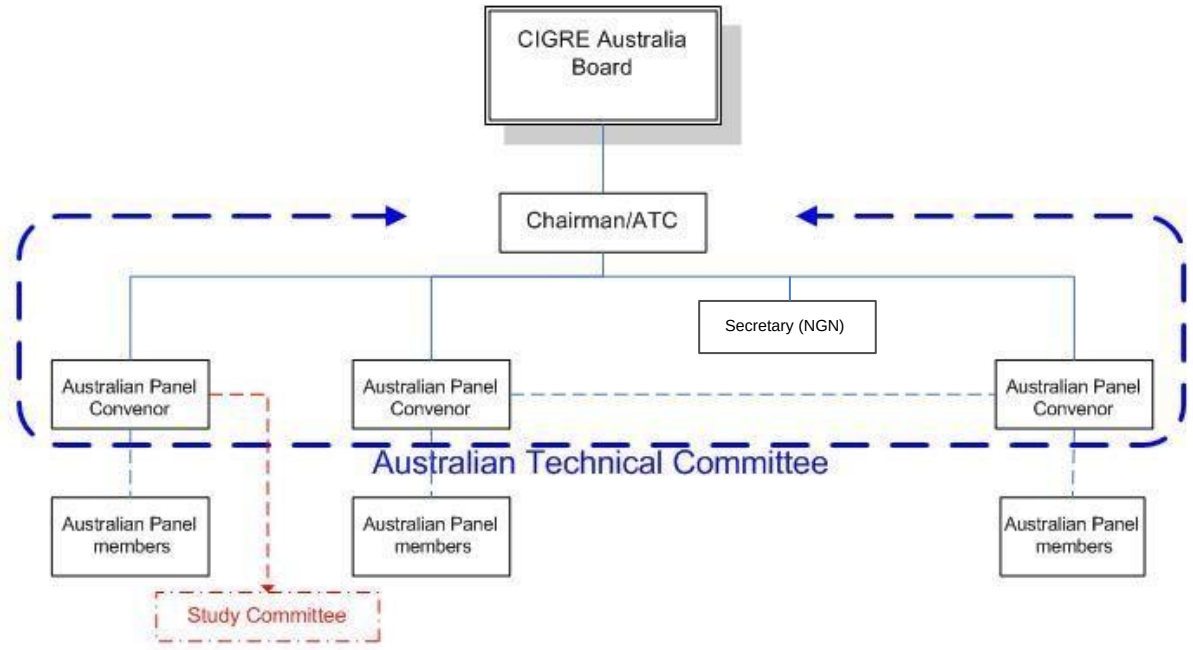
The Technical Committee provides a forum for the ATC members to:

- Represent their Australian Panels to CIGRE Australia;
- Exchange ideas with other ATC members;
- Coordinate joint activities; and
- Report on particular issues in their area(s) of expertise, both local and international.

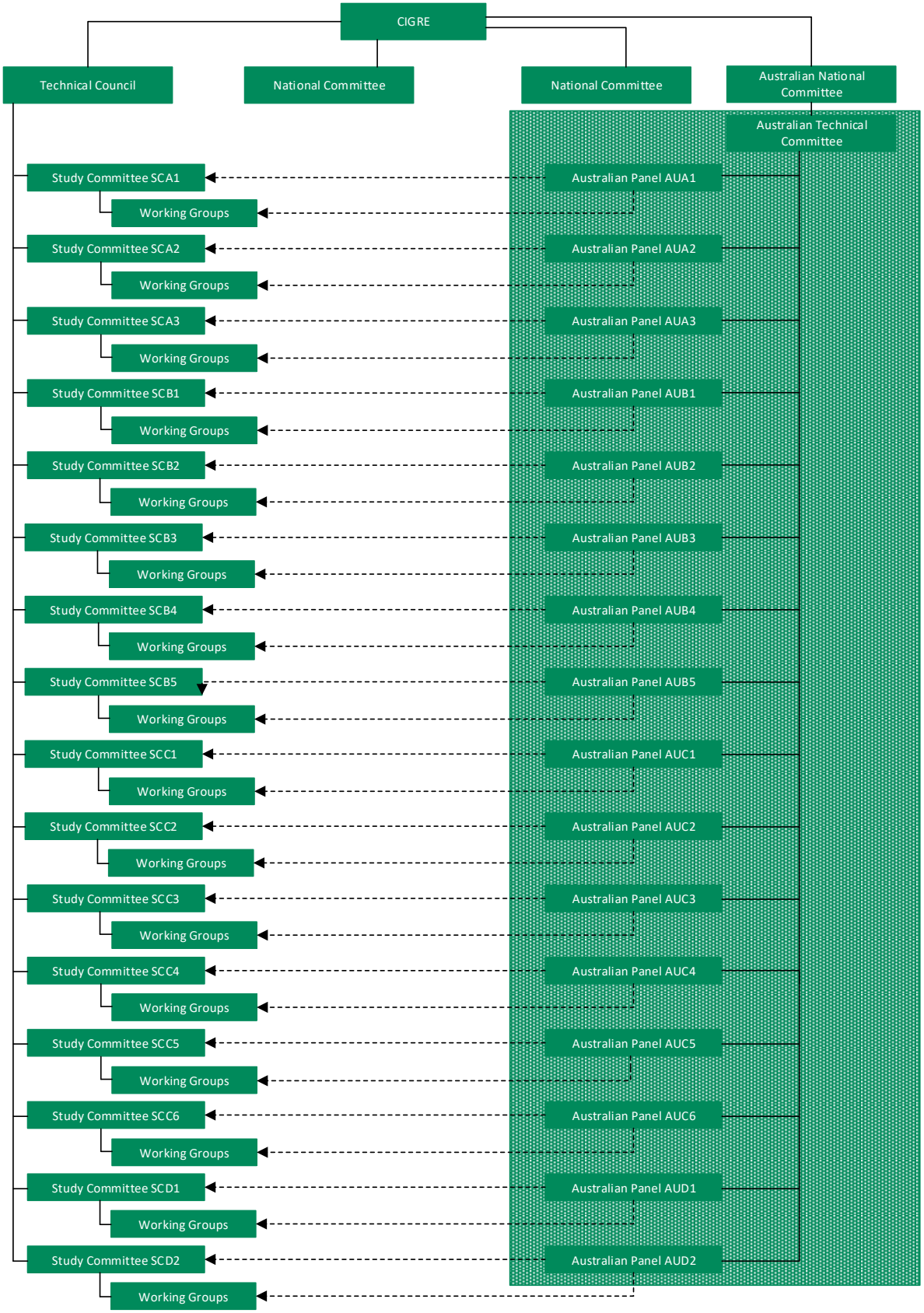
The Australian Technical Committee is convened by the ATC Chairman. The Chairman is also a member of the CIGRE Australia Board. The CIGRE Australia Executive Manager provides administrative support to the ATC and a linkage between the CIGRE Australia Board and the Australian Panels for all financial and administrative decisions. The ATC Secretary, is an NGN member which provides an avenue for the NGN to contribute and understand the technical activities occurring within Australia. In addition all 16 Australian Panels have an NGN liaison fostering NGN involvement in Australian Panel activities.

The membership of the Australian Panels comes from individual and collective CIGRE members in Australia and New Zealand. Panel members are experts in the particular technical areas relevant to each Panel. Typically, a Panel has in the order of 20 members although a number of the panels have larger membership. The largest panel currently has 37 members and the smallest has 9 members. The number of panel members increased across 2021 by approximately 9%.

The ATC structure, including the linkage to the Australian Panels is illustrated in the organisation chart shown below.



As illustrated in the figure below the ATC structure mirrors the international structure of CIGRE. This structural alignment enhances the ability of our panels to contribute to and leverage the research activities undertaken through the various international Working Groups and Study Committees.



The ATC conducted most activities virtually during 2021 due to COVID-19 travel restrictions. During the year we held regular teleconferences to maintain contact and share knowledge regarding the planning for the 2021 e-session. During those meeting Alex Cruickshank (Convenor SC C5) was able to provide valuable updates from the international Technical Council.

ATC Membership

Australian Panel Conveners are normally appointed for a six-year term. It is normal practice for approximately one third of Australian Panel Conveners to retire at the Annual General Meeting in odd numbered years. In 2021, six new Panel Conveners were appointed replacing the following conveners who have completed their six year team:

- Ross Willoughby – AUA2. Ross has provided outstanding leadership of the transformer panel and has been a driving force behind bring CIGRE learning to the local industry through the transformer seminar and has also lead and contributed to a number of working groups during his term as convenor
- Wayne Pepper – AUA3. Wayne has effectively led the local panel, providing effective links between the international work of CIGRE and the local industry. Wayne has supported the Study Committee, taking on special reporter and poster session roles during Paris Sessions.
- John McCormack – AUB2. John had been an active supporter of younger engineers and has worked closely with the NGN to find ways of involving young engineers in the work performed by the panel and working groups. John has also been an active contributor to the Study Committee serving on the strategic and customer advisory group.
- James Hart – AUC3. James provided a significant contribution leading the local panel and contributing internationally. James has led working groups and supported Paris sessions taking on the special reported role and contributing to tutorials. A particular contribution included leading the refreshing of the CIGRE advice on the health effects of Electromagnetic Fields
- Andrew Halley - AUC4. Andrew for his leadership of one of the more active panels particularly if we measure by contribution of papers to the Paris sessions. C4 always seems to set the bar with respect to the number of papers submitted. Andrew have made significant contributions to tutorials and has taken on the special report role to support Paris sessions. Together with Babak other Panel members Andrew helped coordinate the 2020 system strength seminar which set records for the best attended virtual events that CIGRE Australia has been involved with.
- Victor Tan – AUD2. Victor effectively led the D2 panel and contributed to the work of the Study Committee. Victor has been a very active contributor taking on special reporter roles and encouraging Australian input into various working groups. While stepping down from the leadership of the AU panel, Victor will not be lost to CIGRE as he has been appointed to take over as the Study Committee Chair from the 2022 Paris session.

CIGRE Australia enjoys excellent access to the international technical activities of CIGRE through Alex Cruickshank's role as the SC C5 Chairman and member of the CIGRE Technical Council. With Alex in this role and Victor Tan taking on the role of SC D2 Chairman from the 2022 Paris Session, CIGRE Australia is enjoying an extended period of influence over the technical direction of CIGRE an will have four three Study Committee Chairmen from Australia with overlapping terms on the international Technical Council (Phil Southwell, Terry Krieg, Alex Cruickshank and Victor Tan).

Peter Wiehe is the Secretary for Study Committee A1 Rotating Machines and a number of Australian Panel Conveners and Panel Members are active members of advisory groups within their respective Study Committee. The full membership of the ATC during 2021 is shown in attachment 1.

Australian Panels

Locally, ATC members have convened meetings of their Australian Panels. Due to COVID trave restrictions most meetings during 2021 were held virtually. These meetings form an important communication forum for Panel members. In addition a number of Australian Panels have provided a number of virtual seminars, tutorials and webinars across 2021. Several webinars with a collaboration between the NGN and Australian Panels.

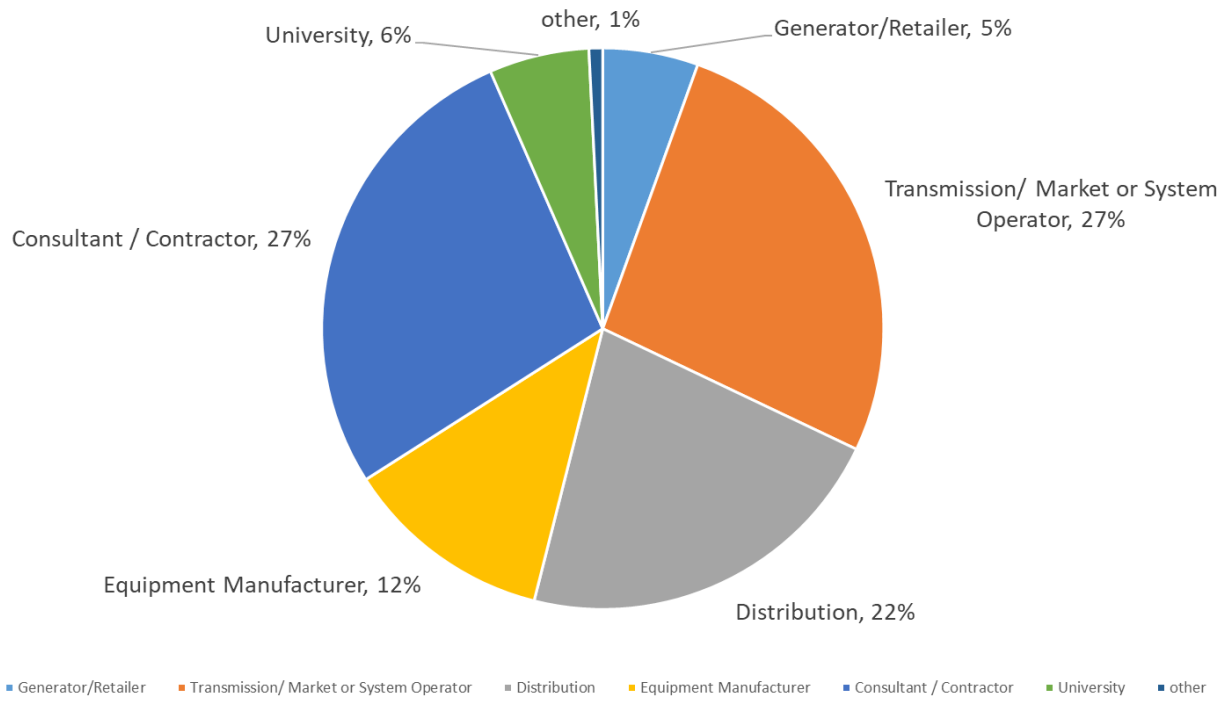
Membership of Australian Panels increased across 2021, with total panel member numbers increasing by 9%. Sector representation is shown in the following figure. The distribution of panel members across different industry segments did not very significantly between 2020 and 2021.

A dedicated NGN liaison is appointed for each Panel. The NGN liaison works with the Panel convener to identify ways to involve the NGN in panel activities.

The ATC maintains a calendar that forms the basis of a rotational system that balances the location of the 16 annual panel meetings in each Australian State and in New Zealand, although such face to face meetings were not possible during 2021.

Each Australian Panel Convener has detailed the activities and membership of their Panel and the key activities undertaken during the year by the international Study Committee and its Working Groups. The Panel reports and are listed in attachment 2 and copies are made available to members as part of the consolidated 2021 ATC report.

Each Panel Convener also delivered a presentation at the ATC Seminar held 26 November 2021. The hybrid event combined a face-face meeting hosted by Energy Queensland at their office in Newstead, Brisbane and a virtual meeting accessible to all members. The recorded presentations are available via the CIGRE Australia Utube Channel [1].



Working Groups

Working Groups are established to perform specific technical activities, which they are expected to carry out within specified timeframes. The outputs of Working Groups include technical brochures that become industry reference documents detailing state of the art, industry best practice and the direction of the industry. Working groups also generate webinars reporting key findings and tutorials. Across 20221 a total of 35 technical brochures were published. All of those brochures are available for CIGRE Australia members via the e-cigre (https://e-cigre.org/). CIGRE to expand to formats used for the dissemination of technical information, during 2021, 13 webinars were also made available via e-cigre.

As at 30 June 2021, Australian Panel convenors reported 276 active Working Groups. Historically CIGRE Australia members have participated in about 55% of active working groups. Statistics compiled by the ATC across 2021 indicate that approximately 53% of active work groups have CIGRE Australia members. Further details are provided in the annual reports prepared by each Australian Panel Convener regarding the involvement of panel members in international working groups.

1 https://aus01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fyoutu.be%2F66P6ZcuSD1I&data=04%7C01%7Cdavid.bones%40ghd.com%7C0ea89274b6ad432ff8bf08d9f44214e0%7C5e4e864c3b824180a5155c8fb718fff8%7C0%7C0%7C637809387862132466%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C2000&sdata=h7Aumfr4h7U0%2FCfkCJHdBEXjYYnaIhRdEB%2FQYXOIW4M%3D&reserved=0

CIGRE Australia members are also convening a number of Working Groups. CIGRE Australia supports the Australia's contribution to working groups by providing a limited amount of funding annually to support travel and accommodation costs associated with attending working group meetings. The CIGRE Australia Board has endorsed a KPI sufficient to fund travel for 10 working group meetings annually. The funding of travel for working groups is in addition to the funding for Australian Panel Conveners to attend SC meetings. Due to COVID-19, travel for working group meetings was suspended for 2021.

The following table lists the working groups convened by Australian members during 2021.

WG/TF No	WG or TF Name	Convener
A2-58	Site Installation and Pre-commissioning of Power Transformers and Shunt Reactors	Ross Willoughby
B2-50	Safe handling of fittings and conductors	Peter Dulhunty
B2-67	Assessment and Testing of Wood and Alternative Material Type Poles	Nathan Spencer
B2-73	Prevention of vegetation fires caused by OHL systems	Peter Dulhunty
B2/C1 - 77	Risk Modelling of OHL for Severe Weather Events	Asif Bhangor
B3-54	Earthing System Testing Methods	Stephen Palmer
C1-41	Closing the Gap in understanding between stakeholders and electrical energy specialists	Phil Southwell
C2-24	Mitigating the risk of fire starts and the consequences of fires near overhead lines for System Operations'	Frank Crisci
C2-26	Power system restoration accounting for a rapidly changing power system and generation mix	Babak Badrzadeh
C4-56	Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter-based resources	Babak Badrzadeh
C4-65	Specification, Validation and Application of Harmonic Models of Inverter Based Resources.	Jason David
C5-33	Block chain applications in power markets	David Bowker
C6/C2-34	Flexibility Provision from Distributed Energy Resources	Pierluigi Mancarella
D1/B1 - 75	Strategies and tools for corrosion prevention for cable systems	Joe Tusek
D1-50	Traceable measurement techniques for very fast transients	Dr Yi Li
D1-69	Guidelines for test techniques of High Temperature Superconducting (HTS) systems	Richard Taylor
D2.43	Enabling software defined networking for EPU telecom applications	Victor Tan

Some of the conveners listed in the preceding table have prepared a report on the key outcomes from their working group during 2021. These reports follow the Australian Panel Annual Reports and are

also listed in attachment 2 of this report. Information on other working groups can be found in the annual Australian Panel reports.

Study Committee Meetings in Australia

CIGRE Australia did not host any Study Committee meetings in 2021.

CIGRE Paris Sessions

The 2021 Paris Session ran as a virtual event due to COVID. Despite the virtual format CIGRE Austral members provided significant contributions including:

- Convening and contributing to Study Committee Discussion Sessions
- Presenting at the major disturbance workshop
- Presenting Tutorials and
- Taking on the role of special reporter.

The prospect of further travel restrictions impacting the 2022 session contributed to a significant reduction in the number of papers submitted from CIGRE Australia members. 9 papers were submitted for the 2022 session. This is a significant reduction from the 30 papers submitted for the 2020 Session.

Seminars, Conferences and Training

Due to COVID-19 travel restrictions, no face-face seminars/workshops were organized by Australian Panels in 2021. Planning is underway to enable the following seminars in 2022/2023, subject to COVID restrictions:

- **Transformer Workshop –** planned for April 2022 has been cancelled due to COVID
- **SEAPC -** The South East Asia Protection, Automation & Control Conference (SEAPAC) rescheduled to March 2023
- **CIDER -** Conference on Integration of Distributed Energy Resources (CIDER) scheduled for 10 and 11 May 2022 in Adelaide

During 2021 in addition to supporting the Paris e-session a number of virtual seminars and workshops were organized by Australian Panels. Summaries are provided in the annual reports for the Australian Panels.

Health of Technical Activities – ATC KPI

The ATC uses a set of measures to monitor the sustainability and health of the 16 Australian Panels. The set of measures is referred to as the ATC KPI and is illustrated in the following table. The KPI measures:

- The strength of the technical contribution delivered by the 16 Australian Panels and
- The sustainability of the structure of the panels

The table below shows the performance against each measure in 2020 and 2021. Colours are used to identify whether targets have been achieved:

Green	indicates target was met or exceeded
Yellow	indicates target was achieved for a majority of panels
Red	indicates target was no achieved in a majority of cases

Measure	Targets	Aug 2020	Aug 2021
Technical contribution	10 working groups pa, (projected outcome based on YTD commitment)**	GREEN	GREEN
	10 In The Loop (ITL) WG articles pa, (projected outcome based on YTD commitment)*	GREEN	GREEN
	3 technical seminars pa, achieving positive feedback (preparation on track and positive feedback post event)***	GREEN	YELLOW
	Annual reports provided to members for each Panel and funded WG (templates in Aug, reports before AGM)	GREEN	GREEN
	55% WG have Australian member	GREEN	GREEN
	20 papers for Paris session	GREEN	RED
	9 substantive roles during Paris session	GREEN	GREEN
Sustainable structure	All panels have active NGN liaison	GREEN	GREEN
	All panels have convenor and identified successor	YELLOW	GREEN
	Panel membership reflects all industry sectors	YELLOW	YELLOW
*Focus shifted to supporting Corona Times			
**Restrictions on international travel have limited WG sponsorship opportunities			
***Some events delayed, others proceeded as Webinars recognizing travel restrictions due to COVID-19			

Most measures relating to the technical contribution were achieved during 2021. COVID impacted the ability to run physical events and did not allow international travel in support of working group activities.

The measures relating to the sustainability of Australian Panels continued to improve across 2021, with suitable successors identified for all six retiring panel convenors. While there has been growth in panel membership across 2021, there remains opportunities for some panels to broaden there membership to reflect all relevant portions of the power industry.

Thank You

On behalf of the ATC and CIGRE Australia, I thank those member organisations in Australia and New Zealand who have support the CIGRE technical activities during 2020.

I thank the members of the ATC for their efforts and contributions.

I also thank the CIGRE Australia office for their support of the work of the ATC and Australian Panels.

David Bones

Chair of the Australian Technical Committee

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Attachment 1 – 2020 Members of the ATC

	Chairman ATC	David Bones
	Secretary ATC	Phil Coughlan / Alex Price
A1	Rotating electrical machines	Tri Tran
A2	Power transformers and reactors	Ross Willoughby succeeded by Matthew Gibson
A3	Transmission and distribution equipment	Wayne Pepper succeeded by David Pita
B1	Insulated cables	Russell Wheatland
B2	Overhead lines	John McCormack succeeded by Asif Bhangor
B3	Substations and electrical installations	Crina Costan
B4	DC systems and power electronics	John Wright-Smith
B5	Protection and automation	Peter Bishop
C1	Power system development and economics	Christian Schaefer
C2	Power system operation and control	Greg Hesse
C3	Power system environmental performance	James Hart succeeded by Brett Hayward
C4	Power system technical performance	Andrew Halley succeeded by Babak Badradeh
C5	Electricity markets and regulation	Greg Thorpe
C6	Active distribution systems and distributed energy resources	Ray Brown
D1	Materials and emerging test techniques	Yi Li
D2	Information systems and telecommunication	Victor Tan succeeded by Louise Watts
	SC C5 Chairman	Alex Cruickshank
	Executive Manager CIGRE Australia	Terry Killen

Attachment 2 – Annual Reports by the ATC

Australian Panel Annual Reports

- CIGRE_Annual_Report_AU_A1_2021.pdf
- CIGRE_Annual_Report_AU_A2_2021.pdf
- CIGRE_Annual_Report_AU_B1_2021.pdf
- CIGRE_Annual_Report_AU_B2_2021.pdf
- CIGRE_Annual_Report_AU_B3_2021.pdf
- CIGRE_Annual_Report_AU_B4_2021.pdf
- CIGRE_Annual_Report_AU_B5_2021.pdf
- CIGRE_Annual_Report_AU_C1_2021.pdf
- CIGRE_Annual_Report_AU_C2_2021.pdf
- CIGRE_Annual_Report_AU_C3_2021.pdf
- CIGRE_Annual_Report_AU_C4_2021.pdf
- CIGRE_Annual_Report_AU_C5_2021.pdf
- CIGRE_Annual_Report_AU_C6_2021.pdf
- CIGRE_Annual_Report_AU_D1_2021.pdf
- CIGRE_Annual_Report_AU_D2_2021.pdf

Reports on Working Groups supported by ANC of CIGRE

- CIGRE_Working_Group_Report_WG_A2.58_2021.pdf
- CIGRE_Working_Group_Report_WG_B4.92_2021.pdf
- CIGRE_Working_Group_Report_WG_D1.60_2021.pdf
- CIGRE_Working_Group_Report_WG_D2.43_2021.pdf

AU A1 Rotating Machines

1. Study Committee Scope

The A1 Study Committee is responsible for the field of Rotating Electrical Machines and includes in its scope all such machines for power generation, large motors and non-conventional electrical machines. It also includes a brief to cover the application of materials technology that relevant to electrical machines.

2. Specific Activities of the Study Committee

A1 Study Committee has four active advisory groups, focussing on particular issues as follows:

A1-01 Turbine (Turbo) generators.

Most activity is focussed through working groups as described below. Through this activity, A1-01 continues to aim to develop a set of guidelines to give background to generator owners in dealing with identified issues in the maintenance and monitoring of high-speed turbo generators.

A1-02 Hydro generators

Activity is focussed through working groups as described below. A1-02 continues to aim to develop a set of guidelines to give background to generator owners in dealing with identified issues in the maintenance and monitoring of hydro-electric machines.

A1-05 Non-conventional rotating machines

The focus of the group is wind turbine generators and superconducting machine developments. There are two working groups currently working in this area on aspects of operation, monitoring, reliability and availability of wind generators.

A1-06 Power station motors and drives.

The scope of this group is power station motors >1kV and >500kW. Activity is focussed through working groups as described below. A number of working groups have been formed to look into benefits of High Efficiency Motor, the effects of VSD (Variable Speed Drive) on motors and impact of flexible operation on motors.

3. Preferential Subjects

Due to the Covid-19 pandemic, the 2020 Preferential Subjects and submitted papers will be used for 2021 Discussion Group Meeting. Special Reporters was compiled in Special Report for the 2021 Group Discussion Meeting.

Preferential subjects selected by the Study Committee for in 2021 Paris Virtual Centennial session on 18th to 27th August were:

PS 1: Generation Mix of the Future

- Effect and risk of an increasing renewable power mix on existing legacy generators, generator auxiliaries, and motors
- Evolution and trends in designs of machines for renewable generation
- Improvement in designs and maintenance practices to comply with new and future grid requirements
- Role of synchronous compensators in supporting power generation networks

PS 2: Asset Management of Electrical Machines

- Experience with refurbishment, replacement, conversions, power up-rating and efficiency improvement of generators and motors.
- Optimised condition monitoring, diagnosis, prognosis and maintenance practices to improve reliability and extend operational life.
- Operational and project experience: installations, failure analysis; robotic inspections; recovery options; cost and time reduction initiatives; and effects of torsional

electromechanical oscillations for synchronous compensators, wind turbine generators, turbo-generators, hydro-generators, and motors.

PS 3: Developments of Rotating Electrical Machines and Operational Experience

- Latest design, specification, materials, manufacture, maintenance and performance and efficiency improvements of electrical machines.
- Condition monitoring techniques and equipment

4. Proposed New Working Groups

A new Working Groups A1-70 - "Dielectric Distribution Factor Measurements on Stator Windings" was formed in June 2020. Convenor is Mrs. Monique Krieg-Wezelenburg (NL). The main scope of this new working group is to investigate whether this test method adds value in the process of assessing the condition of the stator windings. This investigation would complement the work that has already performed as published in TB-769 "Dielectric Dissipation Factor Measurements on New Stator Bars and Coils.

5. Specific Activities of the Australian Panel

Due to Covid-19 restriction, AU A1 regular annual face to face panel meeting was not possible. Instead a teleconference meeting is planned for February 2022.

2021 SC A1 Activities Update

- 11 WG at final stage (A1-33, A1-42, A1-43, A1-44, A1-48, A1/C4-52, A1-54, A1-56, A1-59, A1-60, A1/C4-66)
- 3 Technical Brochures being finalised:-
  - WG A1-33 Guide for Cleanliness and Storage of Generators
  - WG A1-48 Guidance on High-Speed Testing of Turbo Generator Rotors
  - WG A1-54 Impact of Flexible Operation on Large Motors
- 9 WG in progress (A1-45, A1-55, A1-58, A1-61, A1-62, A1-64, A1-67, A1-68, A1-70)
- 6 WG Started (A1-53, A1-63, A1-69, A1-71, A1-72, A1-73)
- 26 Technical Papers
- SC A1 Chairman Summary at Paris Session
  - Working groups status review,
  - Technical Council meeting and activities,
  - Study committee scope and strategic directions – More focus on wind generation and synchronous condensers,
  - 2022 paper submission and review process.
- One Tutorial was presented at Paris Virtual session 18/08/2021
  - "Impact of Flexible Operation on Large Motors" - A1-54 presented by John Doyle, Tom Beckwith and Peter Wiehe.

6. Meeting Report: Australian Panel

- Annual AU A1 panel meeting in Feb 2022 is via teleconference.

7. Invitations for SC or WG's to meet in Australia

Currently there are no invitations for SC A1 meetings to be held in Australia.

8. ANC Members on Working Groups

The following are all the current AU representatives on Working Groups.

WG	Title	Australian Member
A1-42	Influence of Key Requirements to Optimize the Value of Hydro-generators	Kapila Nanayakkara Peter Wiehe
A1-44	Guidelines on Testing of Turbo and Hydro-Generators	Peter Wiehe Kris Bryla
A1-48	Guidance on the Requirements for High Speed Balancing / Overspeed Testing of Turbine Generator Rotors Following Maintenance or Repair	Len Gunn
A1-55	Survey of Split Core Stators	Peter Wiehe
A1-56	Survey on Lap and Wave Windings and their consequences on Maintenance and Performance	Peter Wiehe
A1-59	Survey on Industry Practices and Effects associated with the Cutting out of Stator Coils in Hydro-generators	John Iles
(A1/C4)-66	Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators	Fabian Spescha
A1-70	Dielectric Dissipation Factor Measurements on Stator Windings.	Peter Wiehe Tri Tran

9. Membership of the Australian Panel in 2020-2021

Name	Organisation	Type
Tri Tran (Convenor)	AGL	Utility
Peter Wiehe (Guest)	Acutel Consulting	Consultant
Marc Ransome	Hydro Tasmania	Utility
Hossein Rahimpour	Ampcontrol ETM	Consultant
Damien VERMEER	Beca	NGN
Kapila Nanayakkara	Snowy Hydro	Utility
Len Gunn	Origin Energy	Utility
Franco Rabines	CS Energy	Utility
Simon Nawrot	Delta Electricity	Utility
Viet Trinh	ElectraNet Pty. Ltd	Transmission Utility
Phil Onions	Stanwell Corporation	Utility
Fabian Spescha	AEMO	AEMO
Johan Strydom	Synergy	Utility
Ashok Ojha	Alinta	Utility
Andriy Kotokhov	MachineMonitor	Consultant

Convener: Tri Tran
Email: tri.tran@agl.com.au
Phone: 0407 185 048

AU A2 Transformers and Reactors

1. Study Committee Scope

The scope of SC A2 covers:

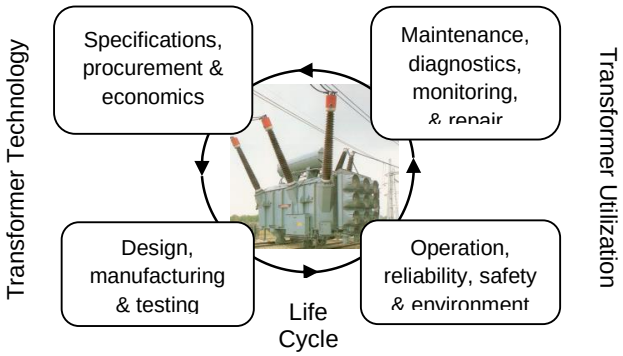
- All kinds of power transformers, including HVDC transformers converter and phase-shifting transformers;
- All kinds of reactors, including shunt reactors, series reactors, and HVDC smoothing reactors;
- All transformer components, including bushings, tapchangers, and other transformer accessories.

2. Specific Activities of the Study Committee

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

1. Specification, procurement and economics
2. Design, manufacturing and testing
3. Operation, reliability, safety and environmental impact
4. 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.



Major meetings:

Virtual Centennial Session: SC A2 held its Group Discussion Meeting over 2 days on 24 – 25 Aug.
The Preferential Subjects discussed were:
PS 1 Transformer technologies to enable integration of distributed renewable energy resources
PS 2 Advances in dielectric design and testing
PS 3 Improved reliability for transformers

3. Preferential Subjects

There are currently 4 proposals for preferential subjects for the 2022 Paris Session (3 are to be finally selected by SC vote):

***1: Operational experience and new requirements of power transformers for on- and off-shore windfarms*.**

- Operational experience: problems, maintenance, condition assessment, monitoring, failure rate, failure rate, lifetime, lessons learnt
- Requirements in design, test, insulation, monitoring, maintenance
- Difference in requirements and experience for on-shore and off-shore applications, wind turbine, step-up, in-tower and secondary substation transformers
- Future outlook: size and design of wind transformers for future applications

2: Beyond the Mineral Oil-Immersed Transformer

- Alternative technologies for improved safety and environmental performance: gas-insulated transformers, ester-immersed transformers, dry-type transformers and solid-state transformers
- Operational experience with transformers using these new technologies
- Advantages and limitations, impact on specifications
- Possible applications, business cases

3: Best Practices in Transformer Procurement

- Return of Experience: Factory qualification process, design reviews, implementation of new specifications
- Quality control: manufacturing check points, sub-supplier qualification, validity period for type tests
- Testing: Enhancements to standards, special tests, short-circuit test, paper DP measurement
- Dealing with non-conformities, performance guarantees, warranty

4: Trends in Transformer Maintenance

- New approaches of maintenance: Online versus offline, use of robots and drones, innovative work methods and diagnostics
- Case studies of condition-based, risk-based and predictive maintenance approaches
- Total life cycle cost strategies, mid-life refurbishment, life extension alternatives, comparative financial analysis of different strategies

4. Proposed New Working Group and Green Books

The formation of a JWG A2/D1 on “Breathing Systems of Liquid Filled Transformers and Reactors” is awaiting approval by central TC. Ross Willoughby has expressed his interest to participate in this working group.

The A2 Green Book on Transformer Procurement has progressed well in 2021, with most chapters having completed their final review. It is anticipated that all chapters will be published in 2022.

A new A2 Green Book on Transformer Life Management is also proposed and is in the early stages of planning with chapter headings already decided. Australia and Japan both expressed the need to include discussion on the end of life of these assets.

5. Specific Activities of the Australian Panel

AU A2 Webinar

AU A2 had proposed to hold an interactive workshop in Melbourne in March 2021, in conjunction with Techcon Asia Pacific. Due to COVID-19, that event is postponed to Wednesday 4 April, 2022.

The workshop presentations have already had their delivery postponed twice (2020 and 2021). To avoid presentation material becoming dated or the risk of non-availability of the speakers, it was decided to deliver the presentations in a Webinar. The Webinar title was “Transformer Reliability – An Interactive Webinar”

18May (3h15m) the following presentations were shown:

- CIGRE Tutorial from WG A2.62 on their International Reliability Survey (Dan Martin)
- Specification Enhancements to Improve Long term Reliability (Michael Jordanoff)
- Improving Reliability through Specification, Design and Construction (Lagath Ganepola)
- Excerpt from CIGRE Tutorial for TB 765 “Understanding and Mitigating Corrosion” on aspects relevant to transformers and reactors (Joe Tusek)

20 May (4h) the following presentations were shown:

- Testing – winding resistance, demagnetising, dissipation factor (Florian Predl & Wenyu Guo)
- Impulse testing. FAT and actual service stress (Yi Li)
- Lessons learned from 16 transformer refurbishments (Robert Li)
- Improving reliability through refurb/replacing OLTCs, bushings and oil (Michael Jordanoff)
- Improving reliability through OLTC retrofits (Alan Brown)
- In-service trials of new Voltage regulating distribution transformers (Thomas Smolka)
- On-line diagnosis of winding failure using Parl\k's Vector approach (Paul Guy)

26 May (1h30m) involved an open discussion panel session were delegates could pose on-line questions on the meeting chat line. The expert panel comprised Dr Dan Martin, Michael Jordanoff, Lagath Ganepola and Dr Thomas Smolka.

Joint AU/NZ A2 Webtutes

6 October (1h) – "Transformer Dynamic Thermal Behaviour"

Members of CIGRE WG A2.60 provide a review of the ongoing IEC and CIGRE activities associated with dynamic thermal behaviour, and the modelling and testing of power transformers. Dejan Susa, presented a two part tutorial on the updates and restructure introduced in the upcoming major revision of the four parts of IEC 60076 standards covering the thermal aspects of power transformers (i.e. Parts -1, -2, -7 and -14). The second part of the tutorial discussed the evolution of the IEC 60076-7 loading guide thermal model and test methods for the thermal and dynamic thermal rating models parameterisation. Tim Gradnik then presented the activities and progress of the CIGRE Working Group A2.60, focussing on review of the state-of-the-art tools and approaches to power transformer dynamic thermal modelling, development of an open-sourced dynamic transformer thermal benchmarking platform and future improvements of the standard IEC modelling and parameterisation. Seamus Allan gave some examples of how utilities and asset managers are utilising thermal models in their day-to-day work, illustrating why the work of A2.60 and IEC60076 is important and applicable. Finally, Yuriy Odarenko provided a manufacturer's perspective.

This webtute was hosted free of charge by AU A2 Seccretary Tara-lee MacArthur and NZ A2 Panel convener Dan Martin, with the Q & A moderated by NGN member Judith Marks. Approximately 85 people attended online.

2 December (1h) – "Transformer Failure Investigation"

This webtute looked at how to conduct a failure investigation to find out what happened, and then if necessary update the asset management strategy to prevent this from happening again. Ross Willoughby spoke about the approach and guidelines for conducting a failure investigation, discussing the dos and don'ts and where vital information is missed. Matt Gibson, a senior engineer at Ausgrid, covered the process to investigate a transformer trip through to updating the asset management strategy. Jon Brown, a principal engineer at Transpower, provided case studies of failures, and what to look out for.

The webtute was hosted free of charge by AU A2 Seccretary Tara-lee MacArthur and NZ A2 Panel convener Dan Martin, with the Q & A moderated by NGN member Judith Marks. Approximately 85 people attended either online or in-person at Energy Queensland office New Farm QLD.

6. Meeting Report: Australian Panel

Meetings for AU A2 in 2021 have been conducted as teleconferences due to COVID. Various travel restrictions by employers and state governments have made it impossible to convene any AU A2 face to face meetings in 2021.

5 October (1h) – Membership changes. Virtual Centennial Session – presentation summary of GDM. Review PS paper subjects. Update from member of WG A2.60 on dynamic thermal behaviour. Update on current status of SC A2 activities.

7 October (2h) – Round the "room" group discussion on member issues, as well as ideas for future webtutes and the transformer workshop topics for 2022.

7. Invitations for SC or WG's to meet in Australia

There are no current invitations for future SC A2 meetings or working group meetings to be held in Australia.

8. ANC Members on Working Groups

The following are all the current AU CIGRE members on Working Groups.

WG	Title	Australian or NZ Member
A2/C4.52	High Frequency Transformer Models for Non-Standard Waveforms	Yuriy Oderanko
A2.54	Power Transformer Audible Noise Requirements	Nil
A2.55	Transformer Life Extension	Paul Guy
A2.56	Power Transformer Efficiency	Nil
A2.57	Effects of DC Bias on Power Transformers	Nil
A2.58	Installation and Pre-Commissioning of Transformers and Shunt Reactors	Ross Willoughby (Convener) Matt Gibson
A2.59	On-Site Assembly, On-Site Rebuild, and On-Site High Voltage Testing of Power Transformers	Ross Willoughby (observer)
A2.60	Dynamic Thermal Behaviour of Transformers	Seamus Allan
A2.62	Analysis of Transformer Reliability	Dan Martin
A2.63	Transformer Impulse Testing	Arun Mathur
A2.64	Condition of cellulose insulation in oil immersed transformers after factory acceptance test	Alan Vietch
A2/D1.77	Liquid Tests for Electrical Equipment	Nil
TF	The Condition of Transformer Solid Insulation at End-of-Life	Nil

The following are all the current AU representatives on SC A2 Advisory Groups.

WG	Title	Australian or NZ Member
AG-2	Tutorial	Tara-Lee Macarthur (convener)
AG-3	Power Transformer Technology	Ross Willoughby (member)
AG-4	Power Transformer Utilization	Ross Willoughby (member)
AG-6	Green Book – Transformer Procurement	Tara-Lee Macarthur (secretary)
AG-6	Green Book – Transformer Procurement	Ross Willoughby (member)

9. Membership of the Australian Panel

Name	Organisation	Type
Seamus Allan	Dynamic Ratings	Supplier
Kenneth Budin	Budin Philipp	Consultant
Kris Bryla	Origin Energy	Generator
Mark Cotton	AusNet Services	Transmission
Santosh Dhakal	TasNetworks	Transmission
Carlos Gamez	Western Power	Transmission
Lagath Ganepola	Powerlink Queensland	Transmission
Matthew Gibson	Ausgrid	Distribution
Wenyu Guo	Omicron Electronics Australia Pty Ltd	Manufacturer/Contractor
Ray Holzheimer	Transformer Innovation Centre	University
Michael Jordanoff	Transpower NZ	Transmission
Robert (Yi) Li	TransGrid	Transmission
Tara-Lee Macarthur	Energy Queensland	Distribution
Deepak Maini	Wilson Transformer Co. Pty Ltd	Manufacturer
Dan Martin	ETEL Transformers NZ	Manufacturer
Robert Milledge	Hitachi ABB Powergrids Australia Pty Ltd	Manufacturer
Sam Mulquiney	Essential Energy	Distribution
Peter New*	Snowy Hydro	Generator
Shawn Nielsen	Queensland University of Technology	University
Phil Onions	Stanwell Corporation Ltd	Generator
Arne Petersen	AP Consulting – Transformer Technology	Consultant
Marko Prokic	ElectraNet	Transmission
Tapan Saha	University of Queensland	University
Thomas Smolka*	Reinhausen Australia	Maunfacturer/Contractor
Tri Van Tran	AGL	Generator
Joe Tusek	Verico AIS	Contractor
Walter Wasinger	Wasinger Transformers	Consultant
Sanika Willard*	CutlerMerz	Consultant (NGN Liaison)
Kerry Williams	K-BIK Power Pty Ltd	Consultant
Ross Willoughby	Reinhausen Australia	Consultant

- Peter New retired from the panel mid year and was replaced by Daniel Fusco.
- Thomas Smolka retired from the panel mid year and has returned to Germany.
- The NGN Liaison allocated to AU A2 was Mrs Sanika Willard of Cutler Merz. Sanika retired mid year and the NGN has not yet nominated a replacement

Convener: Ross Willoughby
Email: willoughby.ross@icloud.com
Phone: 0417 712 879

AU A3 Transmission & Distribution Equipment

1. Study Committee Scope

The Study Committee (SC) A3 is responsible for the theory, design, construction, and application of medium, high and ultra-high voltage equipment components, equipment, and equipment systems or both AC and DC systems from distribution through highest transmission voltage levels. This includes the behaviour and interactions with, and duties imposed by the network and other system equipment under normal and abnormal conditions, testing and testing technologies, quality assurance, reliability and maintenance, environmental impact, disposal and recycling.

This equipment includes all devices for switching, interrupting, or limiting currents (circuit breakers, load switches, disconnect switches, earthing switches, fault current limiters, etc.) independent of technology. It also includes surge arresters, capacitors, busbar and equipment insulators, instrument transformers, bushings, and all other high voltage equipment not specifically covered under another equipment study committee's scopes.

Emphasis is on all kind of insulation and interrupting media in air, gas and solid insulated equipment in indoor as well as in outdoor substations.

2. Specific Activities of the Study Committee

The study committee has a strategic plan which is aligned to the four key strategic directions provided by CIGRE Technical Committee, namely:

- Prepare strong and smart power system of the future
- Making the best use of the existing equipment and system
- Answer the environment concerns
- Develop knowledge and information

Specific activities (working groups - WG/ joint working groups - JWG) of study committee in alignment with the above strategic directions are listed below:

Prepare strong and smart power systems of the future

- WG A3.31: NCIT with digital output

Making the best use of existing equipment and system

- WG A3.39: Metal-oxide surge arrester field experience
- WG A3.40 Technical requirements and field experiences with MV DC switching equipment
- WG A3.42 Failure analysis of recent AIS Instrument Transformer Incidents
- WG A3.43 Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems.
- WG A3.44 Limitations in operation of High Voltage Equipment resulting from Frequent Temporary Overvoltages.
- WG A3.45 Methods for identification of frequency response characteristics of voltage measurement systems.
- WG A3.46 Generator circuit breakers (GCB): review of application requirements, practices, in-service experience, and future trends.

Answer the environment concerns

- WG A3.41 Interrupting and switching performance with SF6 free switching equipment

Develop knowledge and information

- All working groups, tutorials and green book

The study committee has established permanent advisory groups to address co-ordination and strategic issues. These include:

- AG.A3.01 Strategic Planning
- AG.A3.02 Tutorials
- AG.A3.03 Green Book

These advisory groups are supported by coordination activities with various other industry standard and technical groups such as IEC, IEEE, CIRED, Current Zero Club. A brief summary of these advisory groups is provided below.

AG.A3.01: The Strategic Planning Advisory group monitors industry developments and crosschecks them with the Study Committee's strategy. It advises the Study Committee on issues that impact on the activities of the Committee and ensures the Committee responds effectively to these developments. This Advisory Group coordinates the Working Groups and supports them in technical and organizational aspects. The Strategic Planning Advisory Group consists of the Study Committee Chairman, Working Group Conveners and others nominated by the Study Committee Chairman. It meets once a year between the Study Committee meetings.

AG.A3.02: The Tutorials Advisory group has the task of arranging for the dissemination of the technical information developed within the Study Committee and its Working Groups. It plans, develop, manage and deliver workshops, colloquia and tutorials in coordination with local organizations. This advisory group has a renewed focus and will further enhance the visibility of the work undertaken by the study committee and its working groups and their dissemination to the industry. Currently the tutorials are available on the following subjects:

- Reliability of High Voltage Equipment
- Fault Current Limiters
- Surge Arrestors
- HV Vacuum Switchgear
- Use and Application of Optical Instrument Transformers
- Circuit Breakers – Standards, Guidelines and Selection
- Recent Developments in Distribution Switchgear Standards
- Statistical Analysis of Electrical Stresses of HV Equipment in Service
- High Voltage Circuit Breakers
- Modelling and testing of Transmission and Distribution Switchgear
- Switching phenomenon for UHV and EHV Equipment
- Management of Ageing High Voltage Substation Equipment and possible mitigation techniques
- Non-intrusive condition monitoring of MV/HV equipment

AG.A3.03: The "Green Book" Advisory group have completed their task, with the publishing of the A3 Green Book titled Switching Equipment, which was released in 2018. A second edition is currently being planned with additional topics being written.

In addition to the work undertaken by the advisory groups, various active working groups progressed as below.

WG A3.31 Accuracy, Calibration & Interfacing of Instrument Transformers with Digital Outputs.

The use of digital output for ITs (magnetic or electronic) requires development & adaptation of the accuracy testing procedures and the development of appropriate methods for in factory and on-site calibration which may become more frequent with the deregulation of electric power companies. The redundancy of various equipment and links will also need to be considered to achieve the high reliability and availability levels required for a modern electrical network. The accuracy testing & calibration activity is the main focus of this Working Group. A working group report was the outcome and was published in late 2021 as WGR_319_2.

WG A3.36 Application and Benchmark of Multi Physic Simulations and Engineering Tools for Temperature Rise Calculation

This working group will study a benchmark of multi-physics simulation and simplified engineering tools to predict temperature rise tests, describing the state of the art techniques regarding MV and HV switchgears and defining the critical parameters that affect the accuracy of thermal modelling. It will also show the benefits of simulation, whilst benchmarking more simplified tools, which can be used by non-experts and are adjusted by tests or advanced simulation techniques. The brochure was completed in 2021 and published as TB830.

WG A3.39 Metal-oxide surge arrester (MOSA) field experience.

The working group is looking at the long term field experience of metal-oxide surge arresters in installations from 66kV to 1100kV. Data has shown that some higher failure frequency for old designs, even though many were installed within the last 10 years. The WG will investigate the detailed field experience observed in different countries. The draft TB is scheduled to be completed in mid-2022.

WG A3.40 Technical requirements and field experiences with MV DC switching equipment.

The working group will first collect available field experience of LVDC and MVDC switching equipment used in different applications and investigate whether their technical requirements and testing considerations can meet the recent requirements under changing the MV and LV network conditions due to the massive penetrations of DER and Energy Storage systems. The use of MVDC switching equipment in different system configurations such as a point-to-point or multi-terminal MV grid will be examined and to understand the switching phenomena in MVDC grids. The draft TB is due in 2022.

WG A3.41 Interrupting and switching performance with SF_6 free switching equipment.

This working group will collect available interrupting and switching performance data with different SF_6 free gas alternatives, and evaluate the expected lifetime and consider long term stability and impact on the maintenance works related to switching. It will review the advantages and disadvantages of all SF_6 free solutions in comparison with the state of the art solution based on SF_6. The final brouchure will provide a guideline to utilities to keep in mind which factors when they use SF_6 free gas as an alternate solution. The final report is due in 2022.

WG A3.42 Failure analysis of recent AIS Instrument Transformer (IT) Incidents.

This working group will collect failure data regarding instrument transformer age, application type and design details, along with the failure cause, operating conditions and imposed field stresses.. It will collect field experience with the type of insulator and the utilites' policy with respsect to life management, sub-population replacement, inspection and diagnostics, reporting, risk assessment and specifications. It will analyse the failures, simulation of resultsand determine the most probable root causes, and recommend specifice requirements for IT's, additional type and routine tests and advanced diagnostic techniques. The final report is due in 2023.

WG A3.43 Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems.

This working group will take the work performed by JWG A3.32 and focus on intergration of various condition monitoring systems into the maintenance and operation process of T&D switchgear. The working group will address the need to combine the data from various sources such as sensing systems, diagnostics and historic data, evaluate them automartically and provide the specific recomendations to the equipment users. These require the development of anyalytical tools which would be custom tailored to the specific switchgear equipment but expressed in simple and general ways. The final report is due in 2023.

WG A3.44 Limitations in operation of High Voltage Equipment resulting from Frequent Temporary Overvoltages.

This is a joint working group with SC's A1, A2, A3, and B1 looking at the operation of HV equipment subject to temporary power frequency overvoltages. The working group will look at user experience where equipment is frequently subject to temporary overvoltages, looking at failure statstics and mitigation measures, along with consulting with manufacturers regarding the capability and limitations of equipment to sustain temporary overvolatge condituions. The final report is due in 2023.

WG A3.45 Methods for identification of frequency response characteristics of voltage measurement systems.

This working group is looking at the frequency response of conventional and non-conventional instrument transformers used in voltage measurement. With increased power generation from sources which utilise electronic converters, voltage signal frquencies can range from DC to 10kHz; how these voltages are measured and represented by the instruments transformers will be examined. The need to for correct measurement results up to the high frequency range is required in order to attain the required power quality parameters and protect the installed high voltage quipment in service. The working group will look at carrying out tests comparing the output of voltage transformers with different frequencies, along with obtaining unser experiences. The final report is due in 2023.

WG A3.46 Generator circuit breakers (GCB): review of application requirements, practices, in-service experience, and future trends.

This working group will gather information to and produce a brouchure to serve as an educational resource on GCB topics, including history of development and applicatiomn peculiarities. Topis such as busbar dimensioning, heat dissipation, loss of service continuity, short-circuit calculations, voltage transients, condition monitoring, requirements for FAT and SAT will be included. Case studies of different GCB installations will also be included. The final report is due in 2023.

3. Preferential Subjects

The A3 preferential subjects for 2022 Paris Session are:

- Decentralisation of T&D Equipment
  - New Assets, e.g DC switching equipment, fault current limiter
  - Influence of system changes on existing and new equipment
  - Equipment resilience against natural disasters
- Decarbonisation of T&D Equipment
  - SF6 alternatives for MV and HV application and HV vacuum application
  - Lifecycle management and the impact on the design of T&D equipment
  - Health, Safety and Environment aspects of T&D equipment
- Digitalisation of T&D equipment
  - Advanced sensors, non-conventional instrument transformers, monitoring and condition assessment
  - Digital Twin and equipment reliability modelling
  - Pandemic influence on equipment

4. Proposed New Working Groups

During the A3 Study Committee meeting held in November 2021 as part of the Ljubljana Symposium a call for new working groups was made by the study committee chairman.

A new working group A3.47 was approved in December 2021 focused on Lifetime Management of Medium Voltage Switchgear. This working group will have an Australian Convenor. The Terms of Reference document was instigated and written by members of the AU A3 panel.

5. Specific Activities of the Australian Panel

Australian Panel A3 members have decided to continue focus on the following key areas in 2020-21 period:

- **SF_6 gas management –** Provide practical information on design factors which contribute to SF_6 leakage for high voltage equipment from a practical experience perspective. Provide information on techniques to detect SF_6 gas leakage and mitigation techniques. Review current practices for the different utilities with regards to leak repairs.
- **Adoption of new equipment technology in Australia and New Zealand** – Evaluate processes, procedures and impediments to adoption of new technology and collaborate on evaluation of key new technologies for adoption and leverage outcomes for all members. The idea is share information from leading innovators and gain from learnings from early adopters of technology for mutual benefit.
- **Asset based condition scoring and assessment of probability of failure for risk assessments** – Evaluate methods used for health and condition scoring and associated likelihood of failure assessments, Evaluate ageing models and their application for assessment of likelihood of asset failure. Provide guidance to AP A3 members on options for asset-based condition scoring and assessment of probability of failure for risk assessments.
- **Medium Voltage Switchgear Asset Management -** Aged equipment and internal arc – Removing oil CB's and retrofitting with vacuum CB's – Installing internal arc-fault mitigation schemes to existing switchgear – Condition assessment methods of aged switchgear – Justification and cost-effective replacement of switchboards. A new working group A3.47 – Lifetime Management of Medium Voltage Switchgear was approved in December 2021. The Terms of Reference document was written by members of the AU A3 panel.

6. Invitations for SC or WG's to meet in Australia

Currently there is no intention for the A3 Study Committee to meet in Australia. The next non-Paris year study committee meetings will be held in Russia (2023). As there is limited AP-A3 involvement in existing working groups, it is not likely that working groups will be holding meetings in Australia due to the travelling distances involved, and increased use of online meeting platforms.

7. ANC Members on Working Groups

The following are all the current AP representatives on A3 Working Groups.

WG	Title	Australian Member
A3.42	Failure analysis of recent AIS Instrument Transformer Incidents	Wayne Pepper
A3.43	Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems	Ankur Maheshwari Charbel Antoun
A3.45	Methods for identification of frequency response characteristics of voltage measurement systems.	Sean Elphick
A3.46	Generator circuit breakers: review of application requirements, practices, in-service experience and future trends	Munyaradzi Chadilwa

8. Membership of the Australian Panel

Name	Organisation	Type
Wayne Pepper (convenor)	Ausgrid, NSW	Distribution
Cameron Yates	AusNet Services, VIC	Transmission & Distribution
Ankur Maheshwari	AMCL	Consultant
David Pita	Powerlink, QLD	Transmission
Matthew Ridgely	Energy Queensland, QLD	Distribution
David Roby	Hitachi-ABB, NSW	Vendor
Hitesh Parekh	Hitachi-ABB, NSW	Vendor
David Eccles	TasNetworks, TAS	Transmission & Distribution
John Shann	Transpower, NZ	Transmission
Xiang Heng	GE Energy, NSW	Vendor
Andrew Wilkinson	Electranet, SA	Transmission
Mark Garrett	Essential Energy, NSW	Distribution
Kerry Williams	K-Bik Power Pty Ltd, QLD	Consultant
Charbel Antoun (member of WG A3.43)	TransGrid, NSW	Transmission
Harsh Gupta	AusNet Services, VIC	NGN
John Wright-Smith	AMSC	Vendor

Convener: **Wayne Pepper**

Email: **wpepper@ausgrid.com.au**

Phone: **0408 667 076**

AU B1 Insulated Cables

1. Study Committee Mission

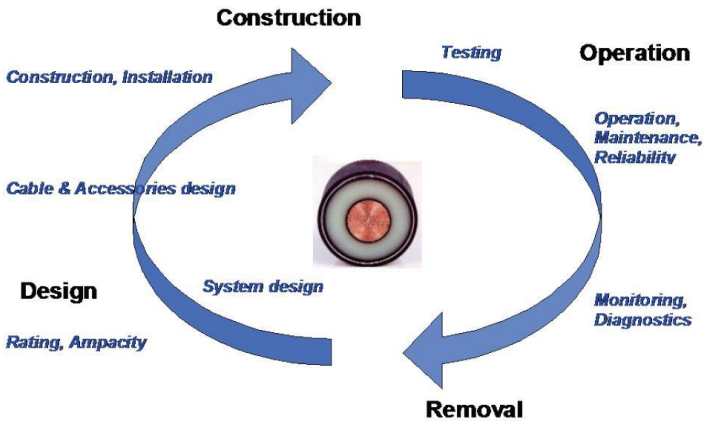
To facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of insulated cables. To add value to this information and knowledge by means of synthesizing state-of-the-art practices and developing recommendations.

The two technological fields of activity are

- AC and DC insulated power cable systems for power transmission, distribution and generation connections on land and in submarine applications.
- Power cable systems associated with micro-grids and the integration of distributed resources.

2. Study Committee Scope

Within its technical field of activity, the Study Committee SC B1 Insulated Cables, 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.



3. Specific Activities of the Study Committee

3.1 History

The first Study Committee dealing with Power Cables was founded in 1927 under the designation of SC 2.
It became SC 21 in 1967 and SC B1 in 2002, one of the five SC's dealing with subsystems (SC "B").
In 2017, SC B1 celebrated 90 years of existence during its meeting in New Delhi, India.
For the Celebration of the 75th anniversary of the Study Committee in Paris (2002), Chairman Aldo Bolza recalled that Insulated cables were addressed by CIGRE from the very beginning, starting with a discussion in the 1921 Session under the heading "construction of lines" and the sub heading "underground and submarine lines". The main subjects foreseen for such discussion were

- utilization limits of single and multi-core cables for AC and DC,
- determination of electric constants
- after-laying tests.

Nearly 100 years later, all these topics are still present in the main areas of activity of the Study Committee on Insulated Cables.

3.2 Study Committee Meetings

The Study Committee (**SC**) meets annually with the most recent being on-line, in place of the regular country based meeting, in August 2021.

The SC continues to focus on its two technological fields of activity while beginning to incorporate an end-to-end approach to electricity networks, bringing MV and LV cable designs into the mix. Traditionally CIGRE has had a transmission voltage focus however the ever-increasing development of micro-grids and distributed generation systems, like wind and solar farms, has necessitated the need to offer expertise in these fields.

The SC strives to be actively involved in the Asia Oceania Regional Committee (AORC) meetings. These are seen as alternatives for the Asian and Pacific area B1 members who are not able to attend the European based meetings. The AORC provides a means to introduce cable experts from countries in the region to CIGRE and the work of SC B1. The meetings are arranged and run in much the same way as a Working Group meeting with 2 delegates and 2 invited experts from each country,

There are 535 experts working for the SC. It is believed that the last 10 years of activity within the B1 committee was the most important in the Insulated Cable Committee history.

Overall SC B1 activities are very well attended with:

- All 43 SC members (29 regular and 15 observer) attended this year's SCB1 meeting.
- National Committees from the 24 represented countries have been very active during the year

3.3 2021 SC B1 Plenary Meeting

At the time of the 2021 SC B1 meeting, the Study Committee is comprised of 45 people: the Chairman, the Secretary, 24 regular members, 13 Observer Members, 6 Additional Members.

SC B1 has dedicated a large part of its activities to technical work and has issued a large number of documents, including recommendations to prepare IEC standards. Some recent examples are TB 490, 623 and 722 on Testing of submarine cables, TB 496 and 622 on Testing of HVDC extruded Cable Systems and TB 538 on Testing of HTS Cable Systems.

The field of activity of SC B1 is the development and operation of all types of AC and DC insulated cable systems for Land and Submarine Power Transmission. It covers MV (one active Working Body is dedicated to MV cables, with most of the existing WGs being applicable to MV, HV and EHV applications.

Within this field of activity, all stages within the life cycle of cable systems are addressed: theory, design, applications, manufacture, installation, testing, operation, maintenance, remaining life management, upgrading and removal.

3.4 Working Groups

Each year, new Working Groups are launched to address each of the four Technical Directions of CIGRE:

- Technical Direction 1: The electrical power system of the future,
- Technical Direction 2: Making best use of the existing power system,
- Technical Direction 3: Focus on environment and sustainability,
- Technical Direction 4: Communication on power system issues for decision-makers.

New work items are discussed and decided upon by the SC members present at the Annual Study Committee Meeting. The Terms of Reference (ToR) surrounding these work items are usually prepared by a Task Force (**TF**), which is formed for a 12 month term. If the TF determines that the subject is worthy of further work by the SC, a Working Group (**WG**) is created, with a convenor and international experts making up the group.

The proposals of New Work Items submitted to the Study Committee are prepared by the Customer Advisory Group (**CAG**) and formally established by the Strategic Advisory Group (**SAG**) of the Study Committee. Each Region of the World is represented in the CAG to gather the needs of the Regional Target Groups. At each CIGRE Session, questionnaires are proposed during the Group Discussion Meeting to identify the needs of the Target Groups of the Study Committee.

At the end of June 2021, SC B1 has

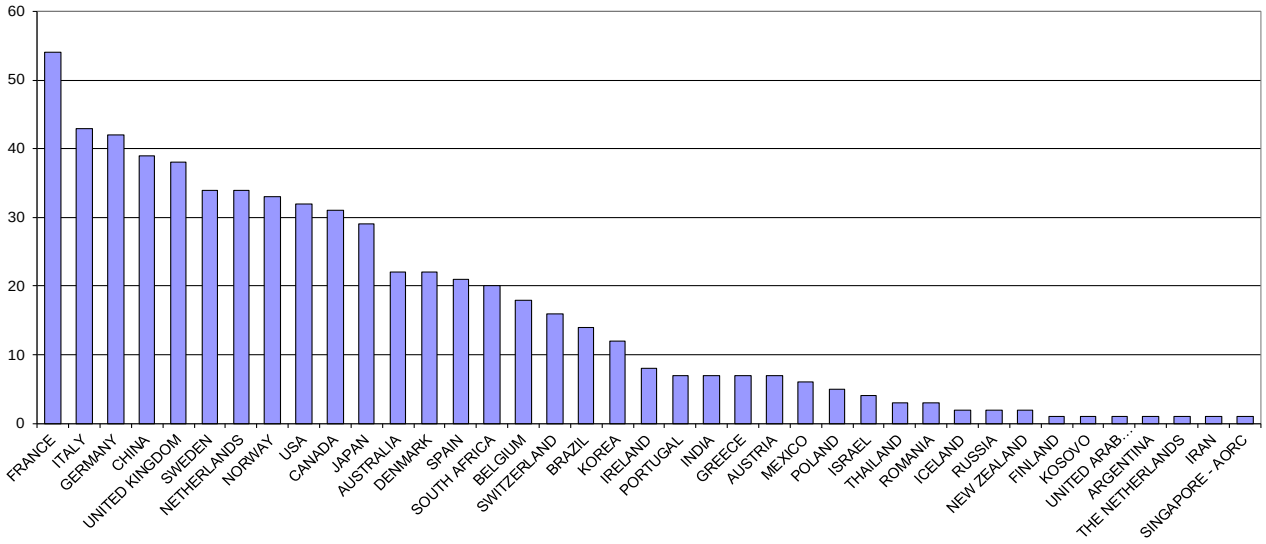
- 19 active Working Groups, 4 active Joint Working groups (with other SCs), 4 active Task Forces

3.5 Study Committee Statistics

Some statistics from the SC show Australia's commitment to the work of CIGRE. We are well represented.

3.5.1. Country Participation

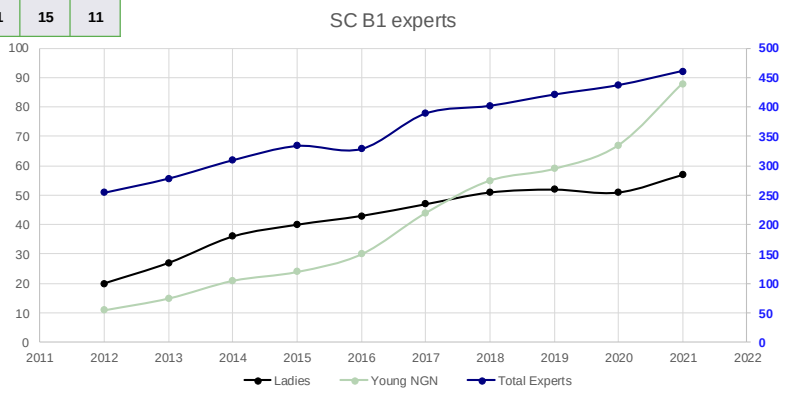
In a more detailed analysis, the 535 participations are coming from the following countries



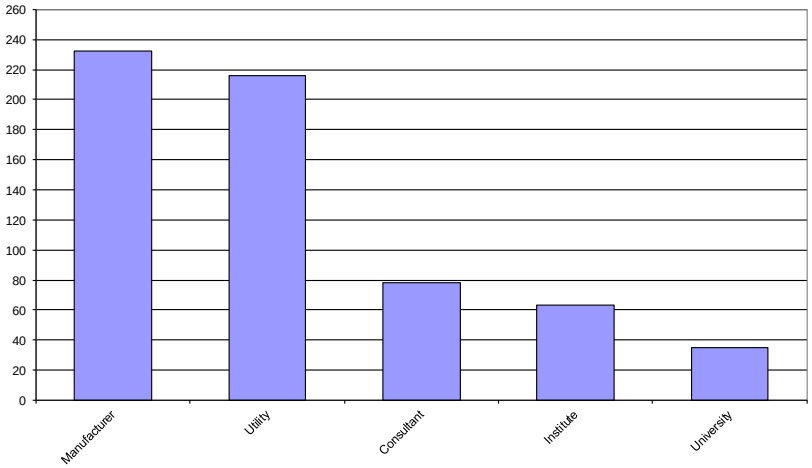
While the number of experts from Australia being involved in the SC WGs and TFs remains strong, there is always room for learned people to become involved in the committee's national and international activities.

3.5.2. Number of B1 experts : Total

	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
Experts	461	437	421	402	389	329	334	310	279	255
Ladies	57	51	52	51	47	43	40	36	27	20
Young NGN	88	67	59	55	44	30	24	21	15	11



3.5.3. SC B1 Composition per Affiliation



3.6 Preferential Subjects for SC B1

The preferential subjects agreed for 2022 are:

PS 1 : Learning from experiences

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

PS 2 : Future functionalities and applications

- Innovative cables and systems, exploring the limits
- Role and requirements of power cables in tomorrow's grids
- Prospective impacts from the Internet of Things, Big Data and Industry 4.0 on power cable systems

PS 3 : Towards sustainability

- Environmental challenges impacting current, planned and future cable systems
- Safety considerations, cyber and physical security, including case studies
- Projects and initiatives to promote access to affordable, reliable, sustainable distribution and transmission cable lines for all

3.7 Publications

The brief of every B1 WG is to finish within a 3 year period, to produce a Technical Brochure and a Tutorial.

3.7.1. Publications during 2020

Excluding the executive summary of a TB), Reference papers, Technical brochures, CSE papers, Future Connections.

Working Group	Name of the Publication	Publication details
---	Submarine cables, there's power under water!	Future Connection – January 2020
WG B1.50	Sheath bonding systems of AC transmission cables - design, testing, and maintenance	TB 797 – March 2020
WG B1.44	Guidelines for safe work on cable systems under induced voltages or currents	TB 801 – April 2020
WG B1.57	Update of service experience of HV underground and submarine cable systems	TB 815 - September 2020

3.7.2. Publication Plan for 2021

Working Group	Name of the Publication	Publication details
WG B1.60	Maintenance of HV Cable Systems	TB 825 – January 2021
WG B1.38	After laying tests on AC and DC cable systems with new technologies	Expected in Q3 2021
WG B1.56	Cable ratings verification	Expected in Q4 2021
WG B1.54	Behavior of cable systems under large disturbances (earthquake, storm, flood, fire, landslide climate change)	Expected in Q4 2021
WG B1.62	Recommendations for testing DC extruded cable systems for power transmission at a rated voltage up to and including 800 kV	Expected in Q4 2021
WG B1.66	Recommendations for testing DC lapped cable systems for power transmission at a rated voltage up to and including 800 kV	Expected in Q4 2021

3.7.3. Green Book progress

"Accessories for HV Extruded Cables" (1st edition was in 2014)
Has now been published in Chinese Language.

"Electricity Supply System of the Future" has been published with one Chapter prepared by B1 members.

"Accessories for Extruded High Voltage and Extra High Voltages Cable Systems"
This is in progress, two volumes, first volume ready to be published by Springer within 1H-2021.

Future GBs from B1 are under discussion

- "Cable System Design" (initially planned to start in 2020, now delayed)
- "Current Rating Calculations", to be planned for 2022 or later.

3.8 Proposed New Working Groups

Currently there are four new working groups and two new task forces for SC B1 in 2021. They are:

Working Group	Title	Convener
WG B1.82	MV DC cables topics	Paul KNAPP (US)
WG B1.83	Grounding aspects for long HVDC land cable connections	Christian REMY (FR)
WG B1.86	Guidelines for safety issues associated to cable systems (title can slightly change)	Julio LOPEZ (BR)
WG B1.87	Finite Element Analysis for Cable Rating Calculations	James PILGRIM (GB)
Task Force	**Title**	**Convener**
TF B1.88	Non-SF6 GIS terminations	TBA
TF B1.89	Guidance for conducting cable systems failure analysis	TBA

3.9 Latest Tutorials

WG	Brochure No.	Title
B1.45	TB 756	Thermal monitoring of cable circuits and grid operators' use of dynamic rating systems
B1.48	TB 770	Trenchless Technologies
B1.50	TB 797	Sheath Voltage Limiters and Bonding Systems (Design, Testing, Operation and Monitoring)
B1.52	TB 773	Fault Location on Land and Submarine Links (AC & DC)
B1.57	TB 815	Update of Service Experience of HV Underground and Submarine Cable System
B1/B3.49	TB 784	Standard design of a common, dry type plug-in interface for GIS

3.10 SC B1 Public Website

Creation of the new B1 public website : https://b1.cigre.org

Explanation of the content of the website

- Structure
- Publications: technical brochures, overview can be created with Excel file to search for key words in TB titles...

Tutorial request: automatic emails are sent to TAG Convener

4. Specific Activities of the Australian Panel

The AU B1 panel continues to grow, currently having 37 members, with 4 new representatives joining over the past 12 months. This continues to be exciting times for the panel.

The AU Panel has representatives from both AU and NZ. Historically with CIGRE's focus having been on transmission voltage levels, the very few companies within NZ having transmission lines had joined the AU panel to be able to converse with like-minded experts. Now with CIGRE's broadened approach to end-to-end expertise, which incorporates MV and LV assets, we have worked with CIGRE NZ to establish the NZ B1 panel. NZ B1 focuses on MV and LV cable topics.

To help with the flow of information to and from the SC, we have invited the NZ B1 convenor and secretary to become members of AU B1 panel

There is considerable cable activity throughout both countries with the growth in renewables and the panel believes that there is a need in the industry to educate people on the basics of cable technology and to establish links between those people and the expertise of CIGRE.

The panel had plans to run a 2 day cable conference, possibly in several capital cities, presenting a series of short presentations on a wide range of topics, however with Covid 19 travel restrictions we were forced to go on-line.

This was not to be a deep dive into the technical details but more an awakening of what people should be looking for. The target audience are Project Managers, network designers and planners.

We decided to do this in a tutorial format to promote Q&A from the audience.

Over the past 12 months we have held four on-line webTutes, covering topics for the wider community on cable design, ratings, installation and testing – these have been well received

Extended involvement of AU NGN members has been welcomed by the panel.

Continued support of both the CIGRE AORC Council and the AORC B1 panel.

Topics of interest are:

1. There is interest with the distribution utilities in implementing more robust condition assessment electrical testing (Tanδ & PD) measurements to support managing MV cable assets. Guidelines on choosing equipment and services and integrating those with the asset management process would be of interest.
2. ISO55001 is of interest. Both AU and NZ utilities foresee that guidelines or specialist knowledge on integrating cable maintenance decisions with asset management will be of interest.
3. Continued connections for Solar and Wind farms at HV and EHV levels.
4. Continued growth in use of fibre optic cables for measuring and monitoring cable performance
5. Submarine cables, DC links, long AC links to off-shore windfarms

4.1 Summary of Past/Future Event(s)

Event Name	Date	City	Web site link	Comments
AU/NZ B1 web tutorials	2020-07-14 2020-11-06 2020-12-01 2021-04-20	On-line	https://cigregroups.org/display/AUNZB12020	Run jointly between AU B1 and NZ B1 panels
AUB1 on-line meeting	2021-05-19 2021-09-30	On-line	https://cigregroups.org/display/AUB1/2021+05+On-line	On-line panel meeting 95% attendance 2x 2.5hr sessions
AU B1 on-line meeting	2021-09-30	On-line	https://cigregroups.org/display/AUB1/2021+09+On-Line	On-line panel meeting after Paris session
AU B1 MV Hybrid cable configuration forum	2021-11-25	On-line		Considerable interest to share different designs used by some utilities

4.2 Invitations for SC or WG's to meet in Australia

An invitation has been accepted by SC B1 to meet in Cairns - Australia in 2023 for the CIGRE Symposium.

Currently SCB1, SCC4, SCC5, SCC6 and SCD2 will be attending and possibly SCB5.

AU B1 will hold their 2023 meeting in Cairns at the same time. The symposium will give an ideal opportunity for networking with the international SC B1 members. Everyone is encouraged to attend.

4.3 AU B1 Members currently on Working Groups

The current SC B1 working groups and their AU corresponding members are shown below.

Australia boasts representatives on 22 out of the 27 active TF's, WG's and JWG's.

Working Group	Title	AU / NZ Representative
WG B1.54	Behaviour of cable systems under large disturbances (earthquake, storm, flood, fire, landslide, climate change) Final report expected Q4 of 2021.	Richard J. Russell W.
WG B1:58	Asset Management in MV Cables Networks	Dave L.
WG B1:61	Installation of HV Cable Systems	Peter R.
WG B1.67	Loading pattern on cables connected to windfarms	Kerry P.
WG B1.68	Condition evaluation and lifetime strategy	Rob B.
JWG B1/C4.69	Recommendations for the insulation coordination on AC cable systems	Tony A.
WG B1.71	Guidelines for safety risk management in cable system	Greg C.
WG B1.72	Cable ratings verification (2nd part)	David S.
WG B1.73	Recommendations for the use and the testing of optical fibres in land cable systems	Graeme B.
JWG B1/B3.74	Recommendations for a performance standard of insulated busbars	David Platt
JWG D1/B1.77	Strategies and tools for corrosion prevention for cable systems	Tony A.
JWG C3/B1.24	Environmental impact of decommissioning of underground and submarine cables	Nang H.
WG B1.76	Enhancing Quality Assurance/Quality Control Procedures for (E)HV Cable Systems	Peter N.
WG B1.80	Guidelines for Site Acceptance Test of DTS and DAS systems	Jeffery C.
TF B1.81	How to have statistics every 2 years	Andrew W.
WG B1.82	MVDC Cable Systems Requirements	Craig Harrison
WG B1.83	Grounding Aspects for long HVDC land cable connections	Tony A.
WG B1.86	Guidelines for safety issues associated with cable systems	Nic M.
WG B1.87	Finite Element Analysis for cable rating calculations	Chandima E.
TF B1.89	Guidance for conducting cable systems failure analysis	Rob B.

4.4 Membership of the Australian Panel as at November 2021

Name		Position	Organisation	Type
Russell	Wheatland	Convener	AusNet Services	Utility
Peter	Robinson	Secretary	Cable Systems Engineering	Consultant
Mohanad	Al-Hasani	Representative	Vector NZ	Utility
Ryan	Atkinson	Representative	TasNetworks – Marinus Link	Utility
Tony	Auditore	Specialist	Voltoni Limited	Consultant
Ken	Barber	Representative	Istanapark P/L	Consultant
Graeme	Barnewall	Representative	Essential Energy	Utility
Rob	Bradley	Representative	Ausgrid	Utility
Peter	Butterfield Rossi	Representative	ElectraNet	Utility
Jeffree	Cairns	Representative	Transgrid	Utility
Greg	Caldwell	Representative	Energy Queensland	Utility
Billy	Cheung	Representative	Power Water Corporation	Utility
Phillip	Coughlan	NGN	Level Crossing Removal Project	Service
Andre	Cuppen	Representative	Unison Networks (NZ B1 conv)	Utility
Chandima	Ekanayake	Representative	University Queensland	
Joska	Ferencz	Representative	Basslink	Asset Owner
Steve	Frazer	Representative	SA Power Networks	Utility
Jarad	Hughes	Representative	TasNetworks	Utility
Nang	Huynh	Representative	Western Power	Utility
Mark	Jansen	Representative	Powercor Network Services	Utility
Richard	Joyce	Representative	Transpower	Utility
Seong Woo	Ju	Representative	Taihan	Manufacturer
Henry	Kent	Representative	Energy Action	Consultant
Dong-Churl	Lee	Representative	Select Solutions	Service Provider
Albert	Majadire	Representative	Prysmian Group	Manufacturer
David	Mate	Representative	Endeavour Energy	Utility
Nic	Moffa	Representative	Protop Engineering Service	Consultant
Peter	New	Representative	Snowy Hydro Ltd	Utility
Sujay	Orpe	Representative	Transpower (NZ B1 Sec)	Utility
Colin	Peacock	Representative	Pavocon	Consultant
Goran	Pevec	Representative	LS Cable & Systems	Manufacturer
Tim	Popkiss	Representative	Intertech Engineering	Consultant
Kerry	Prickett	Representative	UDCS Consulting	Consultant
Robert	Sevior	Representative	RANS Electrical	Consultant
David	Spackman	Representative	Spackman Consulting	Consultant
Eddie	van der Draai	Representative	Powerlink	Utility
Yohan	Weerasinghe	Representative	Cablegrid	Utility

Convener: **Russell Wheatland** **Email:** russell.wheatland@ausnetservices.com.au
Phone: 0418 175 590

AP B2 Overhead Lines

1. Study Committee Scope

The CIGRE Study Committee (SC) B2 Overhead Lines Terms of Reference (ToR) is to study:
The design, construction and operation of overhead lines including the mechanical and electrical (in cooperation with SC C3 and SC C4) design of line components (conductors, ground wires, insulators, accessories, structures and their foundations), validation tests, the study of in-service performance, the assessment of the state of line components and elements, the maintenance, the refurbishment as well as upgrading and uprating of overhead lines.

2. Specific Activities of the Study Committee

The SC consists of a number of advisory and working groups.

- Strategic Advisory Group (SAG) reviews SC performance and develops strategy for future direction of the SC; reviews/endorses proposed ToR for publications; and General Session preferential subjects are critiqued and new WG's approved.

- Customer Advisory Group (CAG) reviews customer survey to assess the introduction of customer suggested study activities and to ensure alignment with these activities. The ToR for new WG's are reviewed by the CAG and relevant TAG, and recommended to the SC.

- Four Technical Advisory Groups (TAG) to assist in the coordination of new Working Groups (WG), oversees progress on publications and review content of proposed tutorials.

Australia has maintained its membership on the SAG and CAG, and in 2018 gained the position of TAG07 convenor. SC/TAG Convenors & Australian membership as at October 2021 are:

Committee	Position		AU Members
SAG	**SC Chairman** **SC Secretary**	Herbert Lugschitz (Austria) Wolfgang Troppauer (Austria)	John McCormack
CAG	**Convenor**	Kjell Halsan (Norway)	John McCormack
TAG04 Electrical Performance	**Convenor**	Javier Iglesias (Spain)	John McCormack
TAG05 Tower, Foundations and Insulators	**Convenor**	Joao Da Silva (Brazil)	John McCormack
TAG06 Mechanical Behaviour of Conductors & Fittings	**Convenor**	Pierre Van Dyke (Canada)	Peter Dulhunty John McCormack
TAG07 Asset Management, Reliability, Availability	**Convenor**	John McCormack	Peter Dulhunty Robert Lake Asif Bhangor Nathan Spencer Michael Lee

SCB2 committee changes in 2022

- Chairman: Herbert Lugschitz will be replaced by Pierre Van Dyke.
- CAG/SAG representative: John McCormack will be replaced by Asif Bhangor as new AU rep.

SC Activities in 2020 include

- Paris convention on-line, Aug 2021
- 4 new WG's established
- 9 new ToR under consideration (including one proposed by the AUB2).
- 4x TB publications (see appendix A)

3. Preferential Subjects: Paris 2022

PS 1 Challenges & New Solutions in Design and Construction of new OHL

- Design for reliability, availability, future climate parameters, more frequent extreme loads, design against theft, vandalism, terrorism
- AC/DC Hybrid Lines, multi-purpose utilization (e.g. renewables, telecommunication)
- OHL challenging construction projects: multiple circuits lines, high towers, long spans, heavy wind and ice, high altitudes, geology, access to site, no proper machinery, long lines and variation in reliability criteria etc.

PS 2 Latest Techniques in Asset Management, Capacity Enhancement, Refurbishment

- Preparedness and countermeasures for natural disasters and other emergencies
- Decisions of replacement based on monitoring, maintenance, operation, historical data
- Strengthening of existing lines to improve reliability, ampacity, lifespan

PS 3 Environmental and safety aspects from OHL (joint PS with C3?)

- Safety of workers in construction and maintenance of lines (equipment, methods, etc.)
- Reducing environmental impacts from new and existing OHL – for B2 and C3
- Reserved for C3 topic

4. New/Proposed Working Groups

New WG	Title	Australian Convenor/ Secretary	Target Complete	AUB2 Rep
WG82	Foundations for Difficult Soils		2023	1x Member, 1x CM
WG83	Mitigation of Electrically Induced Audible Noise from OHL AC & DC		2023	3x Member/Specialist
WG84	Conductor Vibration - evaluation of methodologies		2023	1x Member
WG85	Emergency Restoration of OHL	Bin Lin (Secretary)	2024	1x Member, 1x CM

	Proposed WG	Status	TAG	AUB2 Rep
	Asset Management Principles	Final draft under review	TAG 07 Asset Management	2 x member/specialist
	Live Work Safe Management Guidelines	ToR approved	TAG 07 Asset Management	2 x member/specialist
	Ice on OHL	CAG review	TAG 05/06 Structure/Mechanical	2 x member/specialist
	Safety for OHL Construction	CAG review	TAG 07 Asset Mgt	1x member (Australian convenor)
	Construction methodology	Under Development	TAG 05 Structures	
	Performance of elastomer fittings - life expectancy	Under Development	TAG 06 Mechanical	
JWG	Guide for improving bird safety & associated performance on OH distribution line	Under Development	TAG 07 Asset Management	
	Damping for long spans	Under Development	TAG 06 Mechanical	

5. Australian Panel Activities Report 2021

i) General

- Annual Panel Meeting & "Asset Management" case studies
- Distribution/review ToR, WG surveys,
- Nomination of WG & CM members to new B2 WG's
- Support of WG convened by AUB2 members
- Attend AORC meeting Nov 2021 (on-line)
- Continuing engagement with distribution utilities for increased involvement
- Continuing engagement with research facilities for involvement opportunities
- Participation & interaction with NGN
- Nomination of reviewers for 3x draft TB's
- Review of CSE paper; Slovenia SCB2 symposium papers.

ii) Future Activities:

- 2022 panel meeting, Western Power, Perth
- 2023 panel meeting, Energy Qld, Cairns (combine with I/N SC meeting) tbc
- AORC, 2022
- SCB2 2021 Nov, Slovenia
- SCB2 2022 August, Paris
- SCB2 2023 Japan
- Proposal to engage with Asset Management Council & OHL Asset Managers postponed due to COVID 19 constraints

6. AUB2 2021 Meeting Report

- 3x 3 ½ hour on-line panel meetings

- 1x closed meeting for panel members only
- 2x open meetings; Total attendance including guests – over 60 persons
- Guests from NZ, Japan and Bangladesh.
- Open meetings comprised WG reports, presentations & case studies from panel members/guests.
- New item:

7. Invitations for SC or WG's to meet in Australia

Nil

8. AUB2 Members on Working Groups

WG	Title	Australian Convenor	WG Members	Reviewer	CM
WG50	WG B2.50 Safe handling of fittings and conductors	Peter Dulhunty (Australia)			
WG57	WG B2.57 Composite Insulator				Steve Redhead
WG58	WG B2.58 Vibration Modelling of HTLS conductors			Sarah Sun	Jack Roughan
WG59	WG B2.59 Forecasting Dynamic Line Ratings			Brent McKillop	Michael Lee
WG60	WG B2.60 Affordable OHL for Sub-Saharan Countries		Michael Lee Kulkarni Raghavendra		Elias Elkoury
WG61	WG B2.61 Transmission Line Structures with Fibre Reinforced Polymer (FRP) Composites		Francis Lirios	Peter Dulhunty	Asif Bhangor Tony Gillespie
WG62	WG B2.62 Design of Compact HVDC Overhead Lines				Asif Bhangor
WG63	WG B2.63 Compact AC Transmission Lines				
WG64	WG B2.64 Inspection and Testing of Equipment and Training for Live-Line Work on OHL		Alexandra Price	John McCormack	Simon Leitch John Mc

WG65	WG B2.65 Sub-surface Corrosion in OHL Supports, Anchors and Foundations				Elias Elkhoury
WG66	WG B2.66 Safe handling and installation guide for high temperature low sag conductors				Michael Wilson, Transpower
WG67	WG B2.67 Assessment and testing of wood and alternative material type poles	Nathan Spencer	Peter Dulhunty		Glen Ford
WG68	WG B2.68 Sustainability of Conductor & Fittings		Andrew Taylor (P&W), john Mak		
WG69	Coatings for Power Networks		Francis Lirios	Anne Williams	
WG 70	Aerial Warning Markers		Jack roughan; Peter Dulhunty		Sarah sun Glen Ford
WG 71	Inter-phase spacers		Sarah Sun, jack roughan,		
WG 72 JWG D2	Condition Monitoring of OHL In Uninhabited Areas		Rob Lake Stephen Brooks		
WG 73	Prevention of vegetation fires caused by OHL systems	Peter Dulhunty	Francis Lirios, John Mak David Mate, Grant Bailey (specialist), Trevor Blackburn Linden Bronleigh, Simon Ling (Western Power), Henry Hawes (specialist), Frank Crisci (SAPN - specialist), Glen Ford, Andrew Johnson (Energy QLD), Michael Lee Ian Flatley (Groundline), Abrar Aziz (Middleton Group), Martin van der Linder (Noja)		Greg Chapman

WG 74	UAV for maintenance of OH distribution lines		John Mordacz (Energy Qld)		
WG 75 JWG C4	Insulated conductors on overhead MV & LV distribution lines		Stephanie Phillips		Linden Bronleigh
WG 76	Lightning performance and grounding of OHL		Anne Williams (aurecon) Glen Stapleton (PLQ)		J McCormack
WG 77 JWG C1	Risk Modelling of OHL for Severe Weather Events	Asif Bhangor (Australia)	John McCormack, others tbc		
WG 78	Use of HT Conductor on new lines				
WG 79	Enhancing OHL Rating Prediction by Improving Weather Parameters Measurements		Josh Smith (Enet) Hoang Tong (transgrid)		
WG 80	Numerical Simulations of electric fields on AC & DC insulator strings				
WG 81	Increasing Strength Capacity of Ex OHL Structures		Raju Upadhyaya Frank Salandra		Bing Lin, Farid Faiz, Frank Yao
WG 82	Foundations in Difficult Soils		Frank Yao		Graeme Paterson
WG 83	Audible Noise		Hoang Tong Tony Gillespie Rodney Urban		
WG 84	Conductor Vibration – evaluation of methodologies		Sarah Sun		
WG 85	Emergency Restoration		Bing Lin (Secretary)		
WGxx	Asset Management (commencing 2022)				
WGxx	Live Work Safety Guidelines (commencing 2022)		J McCormack Adrian Parker		

9. AUB2 Membership

Total Members: 33 (4 new members)

Total Specialists: 11

Total NGN reps: 3

Other (SCB1 rep) 1

Company	Name	Surname	Panel Role	type	Specialist on WG
AECOM	Iqbal	Kalsi	member	consultant	
APD	Arun	Arora	member	consultant	
APD	Frank	Yao	NGN rep	consultant	
Aurecon	Steve	Redhead	member	consultant	
Aurecon	Anne	Williams	specialist	consultant	WG76
Ausgrid	Glen	Ford	member	utility	
Ausnet	Francis	Lirios	member	utility	
Ausnet	Stephanie	Phillips	Panel secretary NGN Rep	utility	
Beca	Farid	Faiz	member	consultant	
	Gary	Brennan	past panel convenor	consultant	
CPP	Frank	Salandra	specialist	consultant	WG 81
Downer	Graeme	Paterson	member	contractor	
Dulhunty Poles	Peter	Dulhunty	member	supplier	
ElectraNet	John	McCormack	convenor	utility	
ElectraNet	Raju	Upadhyaya	specialist	utility	WG81
ElectraNet	Josh	Smith	specialist	utility	WG79
ElectraNet	Raghavendra	Kulkarni	specialist	utility	WG65
Endeavour Energy	David	Mate	member	utility	
Energy Qld	Steve	Brooks	member	utility	
Energy Qld	John	Mordacz	specialist	utility	WG74
Energy Qld	Alex	Price	member	utility	
Enerven	Andrew	Mansour	member	utility	
Essential Energy	Damien	Lloyd	member	utility	
Fortitude	Adrian	Parker	specialist	consultant	WG on Live Work
Gillespie Power Consultancy	Tony	Gillespie	member	consultant	
Hydro Tasmania	vacant			utility	
Jack ROUGHAN	Jack	Roughan	member	supplier	
Jacobs	Asif	Bhangor	member	consultant	
Jacobs	Bing	Ling	NGN rep	consultant	
Jacobs	Urban	Rodney	specialist	consultant	WG 83
Ken Barber	Ken	Barber	B1 rep	consultant	
Michael Lee	Michael	Lee	member	consultant	
URI Engineering	Nathan	Spencer	member	consultant	

Prysmium	vacant			supplier	
PSC	Robert	Lake	member	consultant	
PLQ	Alan	Delac	member	utility	
PLQ	Glen	Stapleton	member	utility	
PWC	Andrew	Taylor	member	utility	
Sarah SUN	Sarah	Sun	member	supplier	
TasNetworks	Brent	McKillop	member	utility	
Transgrid	Matthew	Heath	member	utility	
Transgrid	Hoang	Tong	specialist	utility	WG79
Transgrid	Sanu	Maharaj	guest	utility	
Transpower	Simon	Leitch	guest	utility	
Transpower	Michael	Wilson	member	utility	
UGL	Elias	Elkoury	member	consultant	
UNINSW	Trevor	Blackburn	specialist	research	WG73
Western Power	Mark	Montemayor	member	utility	
WSP Australia	vacant		member	consultant	
ZTT	Dean	Farr	member	supplier	

Convener: **John McCormack**
Email: **mccormack.john@electranet.com.au**
Phone: **0418 400 866**

AP B3 Substations and Electrical Installations

1. Study Committee Scope

Our Mission

SC B3 aims to facilitate and promote the progress of engineering and exchange of information and knowledge in the field of substations and electrical installations. SC B3 acts to add value to this information and knowledge by means of synthesizing state-of-the-art practices, developing recommendations and providing best practice.

Scope of SC B3

The activities cover the design, construction, maintenance and ongoing management of substations and the electrical installation in power stations excluding generators.
SC B3 serves a wide range of target groups in the Electric Power Industry whose needs include the technical, economic, environmental and social aspects in varying degrees.
Major objectives include increased reliability and availability, cost effective engineering solutions, managed environmental impact, effective asset management and the adoption of appropriate technological advances in equipment and systems to achieve these objectives.

2. Specific Activities of the Study Committee

Paris Centennial Event: Held online between 18 and 27 August 24 2021, 46 papers from 24 countries, 1 paper from Australia.
Preferential subjects:

PS 1. Design and Technologies

• Impact on design and installation of disruptive and emerging technologies
• Mitigating environmental, Health, Safety and security impacts
• Rapid deployment and cost-effective contemporary solutions for electrification of developing communities

PS 2 Optimised Management

• Best practice in design of assets by optimising their life in a cost-effective way
• Service continuity for maintenance, refurbishment and replacement
• Evolution of skills and managing competency

PS 3 Integration of Intelligence

• Applications of new technologies, e.g. internet of things, virtual reality, augmented reality
• Challenges and expectations for digital substations

SC.B3 activities during the Paris Centennial Event Activities included:

24 Regular Members
4 Additional Members
17 Observer Members
= 45 total

Fri Aug 20: A3/B3 **Workshop**, "The impact of SF6-free alternatives in T&D substations and its switchgear switching equipment"

Mon Aug 23: 58th Annual **Study Committee Meeting --** 41 countries represented; 60 on-line participants

Tue Aug 24: **Tutorial** "Management of Risk in Substations", TB734

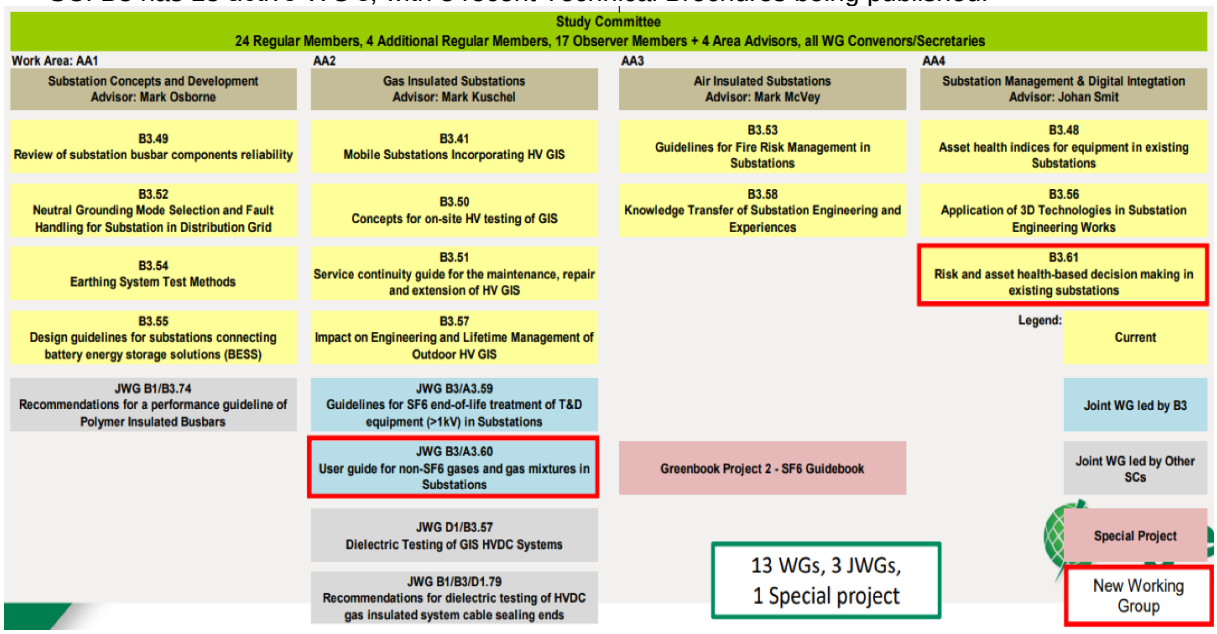
- 120 GoToWebinar attendees

Thu/Fri Aug 26-27: **Group Discussion (and WG Showcase)**

- 150 on-line attendees (max.)
- 34 presenters
- 51 spontaneous contributions via web chat
- B3 Showcase slides presented by 9 WG conveners

3. SC. B3 Activities in the Existing and the New Working Groups

SC. B3 has 13 active WG's, with 3 recent Technical Brochures being published.



New Technical Brochures:

CIGRE member free download from e-cigre: https://e-cigre.org/

- **814** – "LPIT Applications in HV GIS"
  WG B3.39
- **823** – "Substation servicing and supervision using mobile devices and smart sensing"
  WG B3.44
- **834** -- "Reliability analysis and design guidelines for LV AC auxiliary systems"
  WG B3.42

cigre SC B3

4. Australian Panel Working Groups Activities

The following members contributing to the SC.B3 WGs:

- WG B3.52 Neutral Grounding Method Selection and Fault Handling for Substations in the Distribution Grid
- Bill Carman as Correspondent Member
- WG.B3.53 (new): Guidelines for fire risk assessment and mitigation in substations
- Michael Verrier, Terry Lee as Members and Derek Perkins as Correspondent Member
- WG.B3.54 Earthing System Testing Methods

- Stephen Palmer WG Convener
- WG B3.55 Design guidelines for substations connecting battery energy storage solutions (BESS)
- Crina Costan: as Correspondent Member
- WG B3.56 Application of 3D Technologies in Substation Engineering Works
- Todd Margitich: Member
- WG. B3.46: Guidelines for Safe Work Methods in Substations
- Perry Tonking as Correspondent Member and Kerry Williams as Member
- WG. A3.46 Generator Circuit Breaker
- Crina Costan is a member of this working group
- WG.B3.50, 51 and 57: HV GIS based WGs
- Andreas Laubi is a member of these three WGs.
- WG.B3.43 Risk and Asset Health Based Decision Making in Existing Substations
- Chris Beckett is our recommended member for this new WG.

5. Year 2021 Panel Activities Include:

- Support of WG convened by APB3 members
- Contributions and members to IEEE, IEC and AS panels
- Continuing engagement with distribution utilities for increased involvement
- Encourage participation & interaction with NGN
- Two-day AP.B3 annual meeting on the 30th of November and the 02nd of December with 4 guest speakers
- Two task force teams created with AP.B3 at the beginning of June 2021
- Liaison with the Australian Standards Committees

6. Future Activities: SCB2 & International Symposiums

- 2022 Symposium in Kyoto, Japan: 3-8 April 2022
- 2022 CIGRE Paris 28th of August to the 02nd of September 2022
- 2023 Symposium in Cairns.

7. Membership of the Australian Panel

There are 33 members from the following areas of expertise and disciplines:

- Transmission
- Distributions
- HV Equipment Suppliers
- Energy Consultancies
- Independent Consultants
- Contracting Companies

	Name	Company
1.	Alan Crombie	UGL
2.	Alan Goodridge	Peracon
3.	Andy McMahon	Transpower
4.	Andreas Laubi	Aurecon

5.	George Bergholcs	ElectraNet
6.	Evan Stevenson	Endeavour
7.	Doug Ray	Vector
8.	Pieter Oliver	Western Power
9.	Michael Verrier	TasNetworks
10.	Ping S Wang	GE Grid
11.	Tara-Lee Macarthur	Energy Queensland
12.	Stephen Palmer	Safearth
13.	Peregrine Tonking	PWC
14.	Terry Krieg	Powernetwork Consulting
15.	Chris Gonzalez	Siemens
16.	Wu Hang	Aecom
17.	Daniel de Groot	Entura
18.	Mark Pritchard	SA Power Networks
19.	Evan Lamplough	Transgrid
20.	Dasgupta Raj	NT PWC
21.	Malcolm Busby	WSP
22.	Brett Roberts	Ausgrid
23.	Fay Nunn	BHP
24.	Marco Surace	APD
25.	John Szmalko	Jacobs
26.	Joseph Pinheiro	Powerlink
27.	Hao Tian	ABB
28.	Chris Grinter	AusNet
29.	Crina-Miana Costan	TS Consulting
30.	James Warr	CPP
31.	Daniel Stafford	NGN - Jacobs
32.	Alex Pejkinoski	Jemena
33.	Zafir Ahmed	Jacobs

Convener: **Crina-Miana Costan**

Email: **crina.m.costan@gmail.com;**

AU B4 DC and Power Electronics

1. Study Committee Scope

The Study Committee B4 (SC B4) facilitates and promotes the progress of engineering, and the exchange of information and knowledge, in the field of DC and power electronics. It adds value to this body of information and knowledge by assessing the state-of-the-art practices and developing recommendations.

2. Specific Activities of the Study Committee

The study committee activities include following:

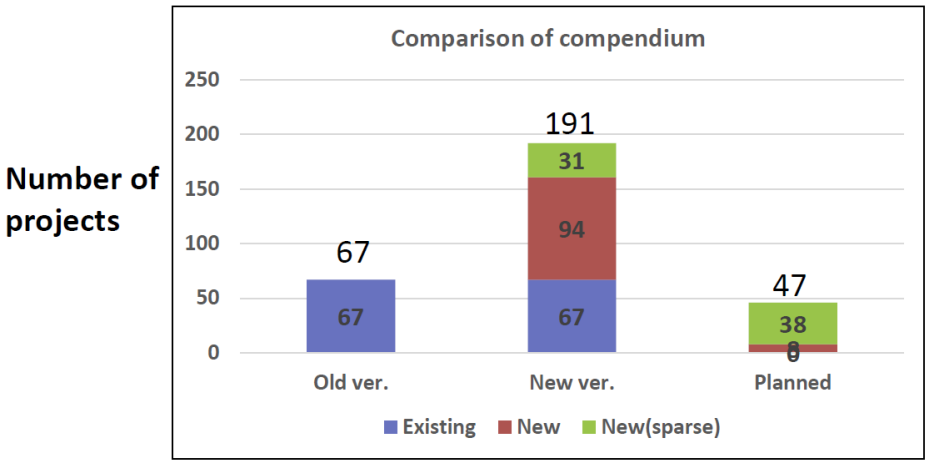
- PS1: HVDC systems and their applications:
  - Planning and implementation of new HVDC projects including need, justification, design, integration of renewables, environmental and economic assessment
  - Application of new technologies including cyber security and advanced controls to address emerging network issues, DC grid, Multi-Terminal HVDC and hybrid HVDC systems
  - Refurbishment and upgrade of existing HVDC systems, service and operating experience of converter stations including offshore converters, and implication of converter equipment resulting from the conversion of ac to dc circuits
- PS2: DC for distribution systems
  - DC applications in distribution systems
  - New concepts, technologies and designs of equipment
- PS3: FACTS and Power Electronic (PE)
  - Planning and implementation of new FACTS and other PE devices including need, justification, design, 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

Specific B4 Study Committee activities over the last 12 months have included:

- HVDC Performance Survey - The study committee is continuing to survey the performance of HVDC transmission systems. The survey has been carried out by the Advisory Group B4.04 since 1970 and resulted in a reliable and independent database on the performance of existing HVDC links and technologies. The results for the years 2017-2018 are currently being collated for publication in 2021.
- Performance of SVC/STATCOM - The collation of data and analysis of performance of FACTs devices, particularly SVCs and STATCOMs is underway. The results for the years 2017-2018 are currently being collated for publication in 2021.
- Green Books
  - Green book on FACTS has been published by Springer.
  - Green Book on Electricity Supply of the Future – SC B4 completed a chapter on HVDC and FACTS. The Green Book, which comprises of submissions from all study committees is expected to be published prior to Paris 2020.
- HVDC Compendium – The Study Committee is coordinating the collation of an online compendium of all HVDC systems installed around the world, with key characteristics shown for each.
  - The compendium is being updated and revised and is expected to be available on e-cigre by 2021.

- Figure 1 shows the addition of more projects in service and planned projects I the new compendium, increasing the number of projects from 77 (in the old compendium) to 191.

Figure 1 - Comparison of Content - Old vs New Compendium



3. Preferential Subjects

The preferential subjects for the 2021 Paris Technical Session for the B4 Study Committee were agreed and accepted as:

- PS 1 HVDC systems and their applications
  - Planning and implementation of new HVDC projects including, need, justification, design, integration of renewables, environmental and economic assessment;
  - Application of new technologies in HVDC, HVDC Grids / Multi-Terminal HVDC, and hybrid dc systems;
  - Refurbishment and upgrade of existing HVDC systems; and
  - Service and operating experience of converter stations including off shore platforms.
- PS 2: DC and Power Electronic (PE) for distribution systems
  - DC deployed in distribution systems;
  - PE and FACTS devices applied in distribution projects including the economics and reliability;
  - New concepts and designs; and
  - Power electronics interfacing generation and storage to the network.
- PS 3: FACTS
  - Planning and implementation of new projects including, need, justification, FACTS devices for renewables, environmental and economic assessment;
  - Application of new technologies in FACTS and other PE equipment;
  - Refurbishment and upgrade of existing FACTS and other PE systems; and
  - Service and operating experience.

4. Working Groups that have Completed Their Assignments

Recognitions of WGs that have completed their assignments

- C2/B4.38 - Capabilities and requirements definition for Power Electronics based technology for secure and efficient system operation (TB 821)
- B4.76 – DC/DC converters in HVDC Grids and for connections to HVDC systems (TB 827)
- B4.70 – Guide for Electromagnetic Transient Studies involving VSC converters (TB 832)
- B4.75 - Feasibility Study for assessment of lab losses measurement of VSC valves (TB 844)
- B4.74 - Guide to Develop Real Time Simulation Models (RTSM) for HVDC Operational Studies (TB xxx) – *completed internal review*
- B4.78 - Cyber Asset Management for HVDC/FACTS Systems (TB xxx) – *completed internal review*
- B4.83 - Flexible AC Transmission Systems (FACTS) controllers' commissioning, compliance testing and model validation tests (TB xxx) – *completed internal review*
- C6/B4.37 - Medium Voltage DC distribution systems (TB xxx) – *undergoing internal review*

5. Working Groups

The main changes in direction observed in SC B4 over the last 10 years include:

1. More application of VSC HVDC;
2. More feasibility and development on HVDC grids;
3. More PE applications in other areas with joint effort with other SCs
4. Application of DC technologies started to extend to distribution
5. Fewer LCC HVDC WGs
6. Fewer FACTS WGs.

	1.1. B4.64	Impact of AC System Characteristics on the Performance of HVDC schemes	Jef Beerten
	1.2. B4.69	Minimizing loss of transmitted power by VSC during	Dennis Woodford
	1.3. B4.71	Application guide for the insulation coordination of Voltage Source Converter HVDC (VSC HVDC) stations	Mojtaba Mohaddes
	1.4. B4/B1/C4.73	Surge and extended overvoltage testing of HVDC Cable Systems	Markus Saltzer
	1.5. B4.79	Hybrid LCC/VSC HVDC Systems	Hong Rao
	1.6. C4/B4.52	Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems	Chandana Karawita
	1.7. B4/A3.80	HVDC Circuit Breakers - Technical Requirements, Stresses and Testing Methods to investigate the interaction with the system	Junzheng Cao
	1.8. B4.81	Interaction between nearby VSC-HVDC converters, FACTs devices, HV power electronic devices and conventional AC equipment	Kamran Sharifabadi
	1.9. B4.82	Guidelines for Use of Real-Code in EMT Models for HVDC, FACTS and Inverter based generators in Power Systems Analysis	Garth Irwin
	1.10. B4.84	Feasibility study and application of electric energy storage systems embedded in HVDC systems	Hani SAAD
	1.11. B4.85	Interoperability in HVDC systems based on partially open-source software	Staffan Norrga
	1.12. B4/A3.86	Fault Current Limiting Technologies for DC Grids	Zhiyuan He
	1.13. B4.87	Voltage Source Converter (VSC) HVDC responses to disturbances and faults in AC systems which have low synchronous generation	Carl Barker
	1.14. TF B4/B1 88	Insulation coordination procedure for DC cable systems in HVDC stations with Voltage Source Converters (VSC)	Kees Koreman
	1.15. B4.89	Condition Health Monitoring and predictive maintenance of HVDC Converter Stations	Nadine Chapalain
NEW	**1.16.** B4.90	Operation and maintenance of HVDC and FACTS Facilities	Les Brand
NEW	**1.17.** B4.91	Power-electronics-based transformer technology, design, grid integration and services provision to the distribution grid	Marco Liserre

NEW	**1.18.** B4.92	STATCOMs at Distribution Voltages	John Wright-Smith

6. Specific Activities of the Australian Panel

Key activities of the AU B4 panel during 2021 include:

- Significant contribution by Australian and New Zealand members to the Green Book on FACTS:
  - Babak Badrzadeh
  - Peeter Muttik
  - Rizah Memisevic
  - Andrew Van Eyk
- Contributing author to Green Book on Electricity Supply of the Future, HVDC chapter - Les Brand.
- Member, SC B4 AG-01 “Advisory Group” - Les Brand.
- VSC HVDC Common Terms Document – Outgoing AU B4 convenor (Les Brand) assigned the task to develop a “Common Terms and Description” document for VSC HVDC technologies, that can be referenced as background material for all future VSC working group Technical Brochures.
- Participation on International Working Groups and Task Forces:
  - Task Force TF B4.77 – “AC Fault response options for VSC HVDC Converters” - Simon Bartlett.
  - JWG C6/B4.37 – “Medium Voltage DC distribution systems” - Les Brand and Georgios Konstantinou.
  - B4 .82 – “Guidelines for Use of Real-Code in EMT Models for HVDC, FACTS and Inverter based generators in Power Systems Analysis” - Nathan Crook.
  - B4.78 – “Cyber Asset Management for HVDC/FACTS Systems” - Mark Shilliday.
- Les Brand assigned the Special Reporter role for the Paris 2021 technical session.

7. Meeting Report: Australian Panel

The Cigre AP B4 - HVDC and Power Electronics 2021 Annual Meeting eSession was held Wednesday 3rd November 2021.

Members attended the meeting.

Cigre AP B4 - HVDC and Power Electronics
2021 Annual Meeting

eSession

Wednesday 3rd November 2021

AGENDA

DAY ONE – Wednesday 3rd November, 2021

Location: Microsoft Teams eSession Meeting

No	Topic	Approx. Time
1	Introduction and Welcome – John W-S Teams host	08:30
2	Minutes of the Previous APB4 Meeting	08:30 – 09:00
3	Action items from APB4 Meeting	09:00 – 09:30
4	Review of AP B4 membership • New Members • Update Membership List	09:30 – 09:45
5	Report and Update on SC B4 • SCB4 Working Group Activities • SCB4 Annual Meeting - Outcomes • New Working Groups • Green Books	09:45 – 10:30
	Coffee Break (15 mins)	**10:30 – 10:45**
6	AP B4 Activities • Australian Panel contributions to SC B4 Working Groups • NGN Update • Webinars	10:45 – 12:00
	Lunch and break (30 minutes)	**12:00 – 12:30**
7	ANC/ATC Update	12:30 – 12:45
8	Member Presentations (20 mins each) – expect 9	12:45 – 14:30
	Coffee Break (15 mins)	**14:30 – 14:45**
8	Member Presentations (20 mins each) - continued	14:45 – 16:00
9	Closing / Recap Actions	16:00 – 16:30

	• Next year's APB4 meeting - Location, Format, Site Visit, Hosting • Ideas for AP B4 activities • Any other business • Conclusions	
10	Closing Remarks	16:30 – 16:45

8. Invitations for SC or WG's to meet in Australia

In the Paris 2021 session, AU B4 submitted a proposal to the study committee for the 2023 SC B4 Study Committee meeting and technical sessions to be held in Cairns during the Symposium being lead by AU C6.

The SC B4 membership voted 2023 SC B4 meeting and colloquium in Vienna.

9. ANC Members on Working Groups

The following are all the current AU representatives on Working Groups.

WG	Title	Australian Member
AG01	SC B4 Advisory Committee	Les Brand
TF B4.77	AC Fault response options for VSC HVDC Converters	Simon Bartlett
JWG C6/B4.37	Medium Voltage DC distribution systems	Georgios Konstantinou Les Brand
B4.78	Cyber Asset Management for HVDC/FACTS Systems	Mark Shilliday
B4.82	Guidelines for Use of Real-Code in EMT Models for HVDC, FACTS and Inverter based generators in Power Systems Analysis	Nathan Crook

10. Membership of the Australian Panel

Name	Organisation	Type
Les Brand	Amplitude Consultants	Consultant
Tuan Vu	Powerlink Queensland	Transmission
Madeline Binet	TasNetworks	Transmission / Distribution
Robert Lees	GE	Vendor
Andrew van Eyk	ElectraNet	Transmission
John Wright-Smith (Convenor)	American Superconductor	Manufacturer
Richard Xu	TransGrid	Transmission
Greg Mather	Basslink Pty Ltd	Transmission
Colin Wood	ABB	Vendor
Nalin Pahalawaththa	Hatch	Consultant
Gerard Ledwich	Queensland University of Technology	University
Angelo Iacono	Siemens	Vendor
Michael Dalzell	Transpower, New Zealand	Transmission
Stuart Dodds	APA Group	Transmission
Ranjith Perera	Entura	Consultant
Yau Chow	Western Power	Transmission / Distribution
Georgios Konstantinou	University of NSW	University
Mark Shilliday	AEMO	Market Operator
Stephen Bex	Jacobs	Consultants
Erica Twining	Ausnet Services	Transmission/ Distribution

Name	Organisation	Type
Mark Davies	TasNetworks	Transmission/ Distribution
Stephen Northwood	ABB	Vendor
Nadesan Pushparaj	AEMO	Regulator

Convener: John Wright-Smith
Email: john.t.wright-smith@bigpond.com
Phone: 0488 200 458

AU B5 Protection & Automation

1. Study Committee Scope

Study Committee B5 Protection and Automation covers the principles, design, applications, coordination, performance and asset management of end to end:

- Power System Protection;
- Substation Control and Automation;
- Substation Monitoring and Recording;
- Remote Control Systems and Equipment;
- Metering Systems and Equipment;

Study Committee B5 also covers all associated internal and external communications including schemes relating to IEC61850 'Communication networks and systems for power utility automation'.

All technical, organisational and economical aspects are considered including staff education and training. Emphasis is placed on design and application of digital technology and modern integrated system approach including hardware and software for the acquisition of system state information, local and remote data communication, and execution of control commands.

2. Specific Activities of the Study Committee

Study Committee B5 has three thematic advisory groups, focussing on particular issues as follows:

- TM51 Substation Automation and Remote Control
- TM52 Protection and Monitoring
- TM53 New Network Requirements

The following preferential subjects were the basis of the 2021 Paris centennial virtual session B5 special reporter question response discussion sessions.

1. Human aspects in Protection, Automation and Control (PACS)
2. Communication network in Protection, Automation and Control (PACS): Experience and challenges

23 B5 Working Groups and 1 Green Book are presently active.

3. Preferential Subjects

Preferential Subjects for 2023

1. Interoperability for IEDs of different manufacturers integrated in one PAC
2. IEC 61850 engineering & test tools & settings
3. Improvement in fault detection

4. Proposed New Working Groups

During the 2021 SC B5 meeting four new working group topics were agreed:

1. PACS design for reliability
2. Requirements for IT and OT managed PACS
3. Protection Roadmap for Low Inertia and Low Fault Current Networks
4. New requirements of network protection & control for renewable energy integration

During 2021 the following CIGRE Australia corresponding members were accepted for the following recently created working groups:

B5.74	Busbar Protection Considerations When Using IEC 61850 Process Bus	Gurinder SALUJA (C) Filip IVANOVSKI (C)
B5.76	Architecture, Standards and Specification for metering system in a Digital Substation and Protection, Automation and Control (PACS) Environment	Satendra BHOLA (C)

5. Specific Activities of the Australian Panel

Despite the ongoing 2021 Covid global and national situation, the panel has progressed with activities in 2021 - albeit in a different way or in a different format. Over the year panel membership has grown from 36 to 40.

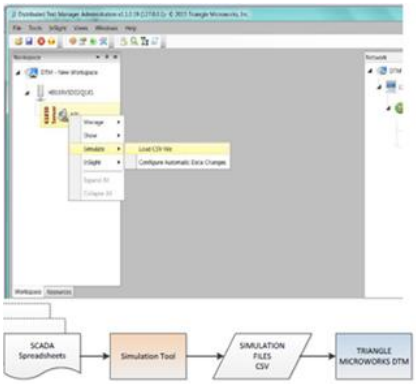
Panel Working Group and Green Book Contributions:

The panel continues to contribute to international working groups with AU B5 being represented on 16 of the 23 working groups. AU B5 member Boris Celic is the SC B5 Bushfire Liaison Person for WG B2.73 “Guide for Prevention of Vegetation Fires Caused by Overhead Line Systems”.

The AU B5 convenor is also convening the SC B5 Green Book on IEC 61850 Principles and Applications to Electric Power Systems. Six online web meetings were held in 2021. Draft chapters were completed and internal B5 study committee review comments have been received. The next step is to complete review adjustments and submit to the draft book to the publisher in early 2022.

2021 Paris Centennial Virtual Session Special Report Contribution Presentations from AU B5 Members:

Peter Bishop attended the 2021 Paris Virtual Centennial Session and presented five special reporter question response contributions on behalf of AU B5 members. These related to the preferential subjects on ‘Human aspects in Protection, Automation and Control’ and 'Communication Networks in Protection, Automation and Control (PACS): Experience and Challenges'. The contributions covered a range of practice and thinking by different Australian and New Zealand utilities.



In the Loop Article Contribution relating to IEC 61850 based Substation Automation Systems – User Expectations and Stakeholder Interactions:

Three technical brochures associated with SC B5 were published over the last year. These included a brochure on ‘IEC 61850 based Substation Automation Systems – User Expectations and Stakeholder Interactions’. This topic is very relevant for Protection & Automation Engineers in Australia and New Zealand. AU B5 panel member and associated working group representative, Ian Young, authored an article for the June edition of the CIGRE Australia ‘In the Loop’ newsletter.

SEAPAC Conference Planning:

Every second year the panel organises the South East Asia Protection, Automation and Control (SEAPAC) Conference. The next conference was due in 2021. Due to the on-going Covid-19 virus situation and the desire to hold a complete face to face event, the AU B5 panel and CIGRE Australia decided that the next physical event will be in 2023. However, the organising committee is planning an interim online presence to keep industry awareness of the conference and promote discussion on a topic of relevance.

Support for newly formed CIGRE NZ B5 panel:

During 2021 the AU B5 panel convenor helped support the CIGRE NZ national committee in forming a complementary NZ B5 panel. Many NZ distribution and generator utilities have participated in sharing local issues during initial workshop and presentation meetings. The NZ B5 panel convenor is now a representative on the AU B5 panel.

Online AU B5 KMS Space Sharing:

The panel has continued to use the CIGRE Knowledge Management System (KMS) on the AU B5 panel space to share knowledge and experience on different protection, automation and control topics.

6. Australian Panel Meeting Report

A 2021 Australian B5 panel meeting was held over two days via web meeting in July. 33 members attended. During the meeting four new members were welcomed, working group activity was reviewed, 2021 special reporter questions and Australia/New Zealand experience was discussed. Local presentations were shared on topics including TasNetwork's experience with synchrophasors, Western Power WAMPAC application, Western Power new under frequency load shedding design philosophy and a summary of recent interesting Powerlink power system events. After the meeting special reporter question response contributions were developed and submitted based on the discussion at the meeting.

An end of year panel update video conference presentation and question & answer session was held on 9 December. This presented highlights from the 2021 Paris virtual centennial session, explained outcomes from the August online SC B5 meeting and updated the panel on several other activities.

7. Invitations for SC or WG's to meet in Australia

The B5 study committee has decided to participate in the 2023 Cairns Symposium. This is a grand opportunity for local protection and automation engineers to attend, present and interact with international experts.

8. ANC Members on Working Groups

The following are all the current AU representatives on Working Groups.

WG	Title	Australian Member
B5.48	Protection for developing network with limited fault current capability of generation	Rajnish Sood

WG	Title	Australian Member
B5.51	Methods & Application of Remotely Accessed Information for SAS Maintenance and Operation	Taren Hobson
B5.52	Analysis and comparison of fault location systems in Substation Automation Systems	Darren Spoor (Full M)
B5.56	Optimization of Protection Automation and Control Systems	Tuan Vu
B5.57	New challenges for frequency protection	Mitchell Eadie Chris Wembridge
B5.58	Faster protection and network automation systems: implications and requirements	Gavin de Hosson
B5.59	Requirements for Near-Process Intelligent Electronic Devices	Kevin Hinkley
B5.63	Protection, Automation and Control System Asset Management	Mark Mundell
B5.65	Enhancing Protection System Performance by Optimising the Response of Inverter-Based Sources	Leonardo Torelli
B5.67 JWG D2	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods	Benjamin Haines
B5.69	Experience feedback and Recommendation for implementation of process bus in PACS	Frankie Lu (C) Kevin Hinkley
B5.70	Methods of Evaluating and Comparing Reliability of PACS Architectures/ Guide for reliability calculation and specification for PACS functions and architecture	Stewart Collins (C)
B5.71	Protection, Automation and Control Systems Communication Requirements for Inter-Substation and Wide Area Applications	Ritesh Bharat (C)
B5.72	Modelling, Assessment, and Mitigation of Protection Performance Issues caused by power plants during Dynamic Grid Events	Gurinder Saluja (C) Paul Blanchfield (C)
B5.74	Busbar Protection Considerations When Using IEC 61850 Process Bus	Gurinder Saluja (C)
B5.76	Architecture, Standards and Specification for metering system in a Digital Substation and Protection, Automation and Control (PACS) Environment	Satendra Bhola (C)
B2.73	Guide for Prevention of Vegetation Fires Caused by Overhead Line Systems	Boris Celic (C)
Green Book	IEC 61850 Principles and Applications to Electric Power Systems	Peter Bishop (Convenor)

9. Membership of the Australian Panel

Name	Organisation	Type
D Harper	AECOM NZ	Consultant
J Brown	BECA NZ	Consultant
R Hughes	Rod Hughes Consulting	Consultant
P Blanchfield	Independent Consultant	Consultant
M Ufferhardt	Tesla Consultants NZ	Consultant
H De Wet	Future Grid Connect Consulting Pty	Consultant
G.Munting	Entura	Consultant
H Mzungu	PSC	Consultant
M Doherty	GHD	Consultant
T Foxcroft	Power Test Services	Consultant
L Kruk	Jacobs	Consultant
R Susanto-Lee	APD Engineering	Consultant
P Tree	Essential Energy	Distribution
M Stanbury	Ausgrid	Distribution
R Coggan	Energy Queensland	Distribution
B Celic	SA Power Networks	Distribution
M Browne	Endeavour Energy	Distribution
R Anegondy	Evoenergy	Distribution
R Simpkin	United Energy	Distribution
D Yadav	Jemena	Distribution
N Kamenyitzky	Snowy Hydro	Generation
M Pallotta	ElectraNet	Transmission
B Capstaff	Powerlink Queensland	Transmission
M Sokolowski	AusNet Services	Transmission
S Bhola	TasNetworks	Transmission
G Saluja	TransGrid	Transmission
P Bishop	Transpower NZ	Transmission
K Dhang	Western Power Corporation	Transmission
S Gharti Chhetri	Power & Water Co	Transmission
A Kalem	Victoria University	University
Madhusudan S	Hitachi	Vendor
I Young	Schneider Electric	Vendor
L Torelli	CSE-Uniserve	Vendor
B Hampson	SEL NZ	Vendor
F Lu	Siemens	Vendor
F Pambrun	Grid Solutions	Vendor

Name	Organisation	Type
D Blake	Dynamic Ratings	Vendor
T Congo	Omicron	Vendor
S Kumar	BHP	Manufacturer
Alan Luc	Ausgrid	NGN Rep
S Chiu	PowerCo	CIGRE NZ B5

Convener: **Peter Bishop**
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Phone: **+6421408503**

AU C1 – Power System Development and Economics

1. Study Committee Scope

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

2. Specific Activities of the Study Committee

The main areas of attention are:

- Methods and tools for power system static and dynamic analysis.
- Planning predicaments and methods in competitive and regulatory structures. Progress and new approaches in application of power system planning criteria and reliability (security and adequacy) assessment.
- Capacity enhancement by use of risk-based security assessment and advanced information, communication and power-electronics technology for improving system stability and dynamic performance.
- Future dependence, requirements and economy of ancillary services for frequency and voltage control and other system needs.
- The impact of pricing and tariff methods for transmission services on system development.
- Asset management strategies in the definition of optimal policies.
- Planning issues related to long distance transmission and international interconnections.
- System planning issues in newly industrialised and developing countries.
- Impact on system development of new solutions and technologies in fields such as generation and demand side management (DSM).

3. Preferential Subjects

The C1 preferential subjects agreed at the 2021 Paris summit focus on solving technical challenges that the power system of the future will have to overcome. These are continuation of the same subjects of 2020:

- PS1 - Power System Resilience Planning
- PS2 - Energy Sector Synergies for efficient decarbonization
- PS3 - Distributed Energy Resources in Transmission Planning

4. Proposed New Working Groups

Committee C1 has proposed four new working groups to commence in 2022, conveners and ToR are being sought, with developments to be discussed at the next SC1 meeting in Q1 of 2022.:

- Proposal by Jeff Palermo: System strength (experience from Australia as a starting point)
- Proposal by Antonio: Benchmark of Natural resources footprint of power systems' components; issue is sustainability, and differs from environmental footprint concept for being oriented to early avoidance of natural resources depletion issue when developing a new technology/device/process
- Follow-up of C1.44 (global interconnections): impact of sector coupling (EV, industrial and buildings electrification, hydrogen) on global electricity interconnections modelling.

- Follow-up of C1.48 Hydrogen): flexibility from electrolysers, capabilities, performances, constraints, enablers and barriers

5. Specific Activities of the Australian Panel

The Australian Panel will have its own activities that might include:

- Local initiatives such as site visits, or dedicated workshops.
- General work to support the activities of the Study Committee
- Preparation of possible seminars or workshops held in 2022
- Proposed Seminars or workshops for 2022.

All of the above will be member participation and interest pending.

6. Meeting Report: Australian Panel

Committee AP C1 met three times during 2021, all meetings were held via video conferencing.

Our first meeting in January focused on reviewing the SC1 activities, AU ATC activities, and work planning for the year ahead. Inspired by several C1 interest related presentations by members, such as:

- AEMO's Engineering Framework
- CIGRE Centennial event planning (August 2021)
- AEMO 2022 Integrated System Plan

Looking ahead, AP C1 agreed to focus group discussions and debate on matters related to holistic and coordinated energy system planning, and a review of national and international planning standards.

We reflected on the limited engagement and often poor attendance at regular AP C1 meeting and discussed how to increase engagement and participation. Members were encouraged and agreed to consider how to recruit new members and individual contributions from existing ones.

The AP C1 group farewelled several members, including Graeme Ancell whose term as convener had ended and he wished to focus on managing the SC1 asset management technical stream, and Jacquie Bride, who joined Powerlink and stepped down to avoid organisational duplication and focus on another technical committee. We also saw Tom Bakker replaced Mark Hibbert as technical member on Mark's departure from Aurecon.

Several new members from GHD, EPEC, Jacobs, AEMO, and Western Power. With a present on-paper membership of 15, AP C1 has strong representation from across the Australian energy sector. However, members with a strong generation background are still being sought to complement the expertise on transmission, distribution and renewables already present in the group. Given the accelerated grid expansion activities in Australia, AP C1 has also reached out to some of the regional planning authorities charged with development and planning of Renewable Energy Zones, such as Vic Grid and Energy Corp of NSW. Follow up discussions are proposed for early 2022.

A follow-up meeting held in May 2021 was used to discuss member activities in the year gone with presentations from AEMO on the 2022 ISP preparation followed by a group discussion on the topic. We further focused on preparation of the Paris summit and proposals for new working groups. One topic of interest to the members continues to be power system resilience planning. The activities of JWG 4.46 were broadly discussed.

The last meeting of 2021 was held in November 2021 and used to discuss:

- The AU AGM of September 2021.
- The Centennial Paris event, the new WGs proposed (see section 4) at the steering committee and Australian participation in these.
- Focus areas and subjects of interest to C1 (see section 3).
- New members for the AP C1.

7. Invitations for SC or WG's to meet in Australia

While maintaining casual and frequent contact with other overseas based members of Committee C1, there have been no international or national CIGRE C1 meeting invitations issued.

Participation of the SC1 committee members in upcoming symposiums and conferences was discussed. SC1 intends to be present at the Kyoto symposium in 2022, and the Cairns conference in 2023, travel restrictions allowing. If possible, AP C1 intends to engage in both with larger meetings and a work shop.

8. ANC Members on Working Groups

The following are all the current AU representatives on Working Groups:

WG	Title	Australian Member
C1.45	Harmonised metrics and consistent methodology for benefits assessment in Cost-Benefit Analysis (CBA) of electric interconnection projects.	Prateek Beri Henry T. Nguyen
C1/C4.46	Optimising power system resilience in future grid design.	Christian Schaefer Samantha Christie
C1.47	Energy Sectors Integration and impact on power grids.	Christian Schaefer
C1.48	Role of green hydrogen in energy transition: opportunities and challenges from technical and economic perspectives.	Herath Samarakoon Cameron Potter

9. Membership of the Australian Panel

Name	Organisation	Type
Christian Schaefer	GHD (Convener)	Consultant
Brad Parker	ElectraNet	Transmission
Enrique Montiel	Powerlink Queensland	Transmission
YiSiang Ooi	AEMO (NGN Representative)	System Operator
Eli Pack	AEMO	System Operator
Julian Swartz	GSMT Consulting	Consulting
Christine Hill	TransPower	Transmission
Mark Parker	EPEC	Consulting
Herath Samarakoon	TasNetworks	Transmission
Athmi Jayawardena	Hatch	Consulting
Donald Vaugh	Entura	Generation/Consulting
Tom Bakker	Aurecon	Consultant
Glenn Carruthers	Western Power	Transmission
Stephen Hodgkinson	ETSE Consulting	Consulting
Matthew Webb	AusGrid	Distribution

Convener: Christian Schaefer

Email: christian.schaefer@ghd.com

Phone: 0428 867 171

AU C2 System Operations and Control

1. Study Committee Scope

The scope of Study Committee C2 covers the technical, human resource and institutional aspects and conditions for a secure and economic operation of power systems in a way that is in compliance with requirements for network security, against system disintegration, equipment damages and human injuries and security of electricity supply.

2. Specific Activities of the Study Committee

Study Committee C2 had defined three Technical Directions (TD) to address important factors that will influence and define new requirements on the System Operation performance.

TD1 – Real-time System Operation and Control

TD2 – System Operational Planning and Performance Analysis

TD3 – Control Centre Infrastructure and Human Resources for System Operation

Three Technical Brochures (TBs) were published, reflecting the findings and recommendations from Working Groups:

- 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); and
- TB 851 Impact of High Penetration of Inverter-based Generation on System Inertia of Networks (JWG C2/C4.41).

A number of papers were published in the CIGRE Science and Engineering Journal, including three with an Australian lead author:

- Tools and Techniques for System Restoration;
- System Strength Challenges and Solutions Developed for a Remote Area of Australian Power System with High Penetration of Inverter - Based Resources;
- Capabilities of Power Electronic Devices in Enabling the Energy Transition and Mitigating System Operational Challenges; and
- Sustained islanding operation of a normally interconnected power system with a high share of inverter-based resources – South Australian experience.

3. Preferential Subjects

Preferential subjects selected by the Study Committee for the 2020 Paris Session are:

1. System control room preparedness: today and in the future; and
2. Operational planning strategies, methodologies and supporting tools.

The Convenor of Australian Panel C2 will be Special Report for Preferential Subject 2.

4. Proposed New Working Groups

Two new Working Groups have been established:

- JWG C2/C5.06 – The Impact of Market Interventions by System Operators during Emergency Situations; and
- WG C2.42 – The impact of the growing use of machine learning / Artificial Intelligence in the operation and control of Power Network from an Operational perspective.

The Australian Panel C2 is considering the potential to propose a new Working Group to examine operational strategies for managing the new minimums (demand / inertia / system strength / etc).

5. Specific Activities of the Australian Panel

The Australian Panel C2 has contributed to the ongoing work of CIGRE as follows

- Ongoing contribution to working groups as set out in section 8 of this report;
- Presentation at the Major Disturbance Workshop at the 2021 Paris Session on the Torrens Island busbar trips that occurred in March 2021.;
- Three paper were presented at the 2021 Paris Session;
- Franco Crisci (Convenor WG C2.24) presented to the SC C2 Group Discussion Meeting on the balancing risk and customer impacts from power shutdowns linked to bushfires; and
- Sharing of local learnings through completion of surveys to support the work of working groups.

In addition, Australian Panel C2 is keen to reinvigorate work on understanding and preparing operational responses to geomagnetically induced currents (GIC) caused by solar flare activity. This has been prompted by a recent solar events which triggered some alert systems in Australia and the lead-up to the next solar maximum, expected around 2025. We are looking to organise a workshop in early 2022 involving power system operations (C2), power system analysis (C4) and transformer (A2) experts, as well as space weather experts.

6. Meeting Report: Australian Panel

The AU C2 panel met in a virtual format across two sessions on 11 November 2021. The Convenor provided an update on the activities of SC C2 and CIGRE internationally. The key insights gained from the 2021 Paris Session were shared and discussed with the panel. It was noted that the Large Disturbance Workshop provided insights into a wide variety of challenging operational situations. Potential Australian contributions for the Large Disturbance Workshop at the 2022 Paris Session were identified.

Other topics of interest that were discussed included:

- The future of Under Frequency Load Shedding arrangements in the presence of widespread Distributed Energy Resources on distribution networks; and
- The impact that changing operational practices may have on power system equipment.

Panel members shared their recent experiences of power system disturbances within their own networks and the learnings resulting from these. Panel members also contributed ideas for future AU C2 activities and thoughts for future working groups.

7. Invitations for SC or WG's to meet in Australia

Study Committee C2 plans to meet in Cairns in 2023 in conjunction with the planned Symposium. SC C2 will be one of the lead SCs for this Symposium.

8. ANC Members on Working Groups

The following are all the current AU representatives on Working Groups.

WG	Title	Australian Member
C2.18	Wide area monitoring protection and control systems – decision support for system operators	James Guest
C2.24	Mitigating the risk of fire starts and the consequences of fires near overhead lines for System Operations'	Frank Crisci (Convenor)
C2.25	Operating Strategies and Preparedness for system Operational Resilience	Mark Miller Dean Sharifi Greg Hesse
C2.26	Power system restoration accounting for a rapidly changing power system and generation mix	Babak Badrzadeh (Convenor)
C2.39	Operator Training in Electricity grids at Different Control Levels and for Different Participants / Actors in the New Environment	Danial Lavis Russell Gordon
C2.40	TSO-DSO Co-operation – Control Centre Tools Requirements	Matthew Rigano

9. Membership of the Australian Panel

Name	**Organisation**	**Type**
Alastair Andrews	Powerlink	Transmission
Stuart Donaldson	Ausgrid	Distribution
Shane Duryea	Western Power	Transmission
Duncan Griffin	Power and Water Corporation	Operator / Transmission / Distribution
Greg Hesse	Powerlink	Transmission
Keqian Hua	TasNetworks	NGN
Chong Ong	TasNetworks	Transmission / Distribution
Andrew Power	TransGrid	Transmission
Matthew Rigano	Energy Queensland	Distribution
Matthew Robinson	PSC Consulting	Consultant
Richard Sherry	Transpower	Operator / Transmission
Colin Taylor	ElectraNet	Transmission
Tjaart Van Der Walt	AEMO	Operator

Convener: **Greg Hesse**

Email: **ghesse@powerlink.com.au**

Phone: **0418 783 840**

AP C3 System Environmental Performance

1. Study Committee Scope

The scope of SC 3 includes responsibilities for the identification and assessment of the various impacts on the natural environment arising in electric power systems, and the recommendation of appropriate monitoring, management and control measures.

Impacts addressed will include greenhouse gases, air and water pollution, electromagnetic fields, noise, visual, land use and flora and fauna impacts.

Major considerations will include: sustainable development vs. economic development; risk assessment and the economics of impact containment; effective communication with the public and regulatory authorities.

Tools and measures for quantifying, controlling and mitigating the environmental impact such as life-cycle assessment (LCA), environmental product declarations (EPD), global benchmarking, etc. are included in the scope.

The Study Committee works closely together with relevant equipment and systems committees within its field of responsibility.

2. Specific Activities of the Study Committee

SC C3 currently has 1 reference group and 12 active working groups.

AG C3.01 EMF and Human Health	Michel Plante (CA)
WG C3.09A Corridor management	Aleš Kregar (SL)
WG C3.12 Methodologies for Greenhouse gas inventory and reporting for T&D utilities (Renewed TOR)	Mercedes Vázquez (ES)
WG C3.14 Impact of environmental liability on transmission and distribution activities	Vincent Du Four (BE)
WG C3.15 Best environmental and socioeconomic practices for improving public acceptance of high voltage substations	Marijke Wassens (NL)
WG C3.16 Interactions between electrical infrastructure and wildlife	Cécile Saint-Simon (FR)
WG C3.17 Interaction between wildlife and emerging renewable energy sources and submarine cables	Katherine Palmquist (USA)
WG C3.18 Eco-friendly approaches in transmission and distribution	Anne-Sophie Desaleux (FR)
WG C3-20 Sustainable Development Goals in the Power Sector	Lou Ceceres (USA) New
WG C3.21 Including stakeholders in the investment planning process (Renewed TOR of former JWGC1/C3.31)	Susana Batel (PT)
WG C3.22 Vegetation management in substations	Vincent Du Four (BE)
WG C3.23 Eco-design methods for TSO/DSO under environmental transition	Guillaume Busato (FR)
JWG B1/C3 85 Environmental impact of decommissioning of underground and submarine cables	Kieron Leeburn (ZA)

Recently completed working groups include:

JWG C3/B1/B2.13 Environmental issues of high voltage transmission lines for rural and urban areas (JWG with SC B1 and B2). –Closed this year-	Hector Pearson (UK)
WG C3.19 Responsible management of the Electric and magnetic Fields Issue	James Hart (AU)

3. Preferential Subjects

The current preferrential subjects include:

PS 1 : Sustainable development goals (SDG's) of the UN

- How do companies integrate the SDG's in their business strategy to contribute to their achievement
- What are the main challenges to do so
- In what way do companies benefit of integrating SDG's in their business strategies

PS 2: Environmental impact of energy transition

- Effects of raw materials becoming scarce
- Which methods are used for measuring these impacts, regarding whole chain
- How to deal with the negative impacts of energy transition, e.g. effects of solar fields on biodiversity

PS 3: Relation of wildlife and electric infrastructure

- Equipment of generation, transmission and distribution often suffer from wildlife like birds, rodents, exotic species. How to prevent damages or outages.
- Which methods are used and which data are needed to determine mortality
- Which methods for mitigation are used.

4. Paris session 2021

The Paris session in 2021 was conducted online. A number of interesting papers were discussed. Some examples are shown below:

Brazil – proposed strategic approach to including sustainable development goals in the criteria for evaluating R&D projects. In Brazil, electricity companies are required to invest 1% of net operating revenues in R&D.

Germany – proposed approach to quantifying benefits of additional measures used to facilitate public acceptance and avoid project delays.

Japan – results from a survey of electric power companies about sustainable development goals and their business strategies. The results showed that few companies adopted strategies in line with the sustainable development goals (apart from those dealing with reneable energy and batteries).

Italy – the experiences of implementing the Envision protocol which evaluates the overall impact of electrical infrastructure over its life cycle with the aim of improving sustainability.

Norway – methods for limiting land degradation around new transmission lines. The preferred methos is to loosely replace original, stored top soils around the disturbed areas. While seeding had the highest initial vegetation cover it was suggested that seeded plant may compete with local vegetation.

Netherlands – discussed a sustainable substation using 50% less concrete, less steel, insulation, solar panels and passive climate control. A eco-cost calculation demonstrated a saving of 66% over the standard substation design.

Germany – discussed a risk assessment of equipment containing non-SF6 gases. Recommendations are given for protective measures associated with lead components in different gas mixtures.

India – discussed mitigation measures for a number of scenarios involving electric field induced shocks under a 765kV transmission line. Measures included earthing fences and installing shielding wires over distribution lines.

Italy – discussed the development of an avian action plan to reduce risk associated with the interaction of birds and powerlines. The plan includes monitoring, modelling, design measures, training, guidelines for the selection and installation of nest boxes and webcams.

Germany – use of video monitoring to study the behaviour of birds. Over 100,000 birds were videoed crossing powerlines. The results showed a collison rate of 0.1%. Approximately half flew over the lines with 25% flying between the conductors and the earth wires. The larger the swarm size the more likely it was that they would fly over the line. All wiring components were collided with while larger birds were more susceptible to collision. This is likely due to their poor manoeuvrability and limited filed of vision for some species.

Portugal – discussed methods for monitoring bird mortality rates near powerlines. A number of recommendations were provided to improve monitoring programs and remove bias.

Australia – discussed a threatened bird strategy including aspects of knowledge, awareness, mitigation and offsetting. Threatened species mortality rates have fallen since the strategy was implemented. New design standards will include fibreglass cross-arms network wide, use of delta three-wire configurations in rural areas, retrofitting the network in high risk areas and use of bird diverters.

5. Proposed New Working Groups

Working groups which commenced in 2020 include:

JWG B1/C3 85 Environmental impact of decommissioning of underground and submarine cables	Kieron Leeburn (ZA)

Potential working groups where the Terms of Reference are being considered include:

- EMF impacts on wildlife
- Reducing electrocution of birds from low voltage lines.

C3 will conduct a survey to assist in identifying preferred working groups. One option will be to focus on completing some of the existing ones.

6. Specific Activities of the Australian Panel

During 2020 AP C3 convenor delivered a CIGRE tutorial based on the work of C3.19 Responsible management of the EMF issue.

AP C3 had a virtual meeting on 21 October 2021. Key topics discussed during the meeting included legal requirements in the EPBC Act and potential opportunities for improvement. Other topics of discussion centred around climate change, the impact of renewable energy, emission reduction targets and SF6.

7. Invitations for SC or WG's to meet in Australia

CIGRE Australia is proposing to host a CIGRE Symposium, led by SCC6 in Cairns Australia 4th–7th September 2023.

A decision has yet to be made by SC C3 on 2023. Japan has also offered to host the SC3 meeting, considering that there will be a Colloquium in Sendai, with other committees involved.

8. ANC Members on Working Groups

The following are all the current AP representatives on Working Groups.

WG	Title	Australian Member
WG C3.18	Eco-friendly approaches in Transmission and Distribution	Andrew Johnson
WG C3.19	Responsible management of the Electric and Magnetic Field Issue (NOW COMPLETE)	James Hart (convenor)

WG	Title	Australian Member
WG C3.17	Interaction between wildlife and emerging RES and submarine cables	Michael Roberts
WG C3.20	Sustainable development goals in the electric power sector	Michael Roberts

9. Membership of the Australian Panel

Name	Organisation	Type
James Hart	Ausgrid	Distribution/Transmission
Gina Pavlovic	Endeavour Energy	Distribution
Brett Haywood	Essential Energy	Distribution
TBA	ElectraNet	Transmission
Ed Parker	TasNetworks	Distribution/Transmission
David Donehue	TransGrid	Transmission
Linda Dawson	Powerlink	Transmission
Sonya Bryce	Energy Queensland	Distribution/Transmission
Andy Shaw	Western Power	Distribution/Transmission

Convener: **James Hart**
Email: **jhart@ausgrid.com.au**
Phone: **02 93946659**

AU-C4 System Technical Performance

1. Study Committee Scope

SC C4 deals with methods and tools for the analysis of power systems, with particular reference to dynamic and transient conditions and the interactions between the power system and its apparatus/subsystems (including external causes of stress). Specific issues related to the design and manufacturing of components are not in the scope 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 network. However, as many design studies depend on the tools used and developed within the scope of SC C4, it is important to note that C4 encourages and regularly supports joint activities with other study committees.

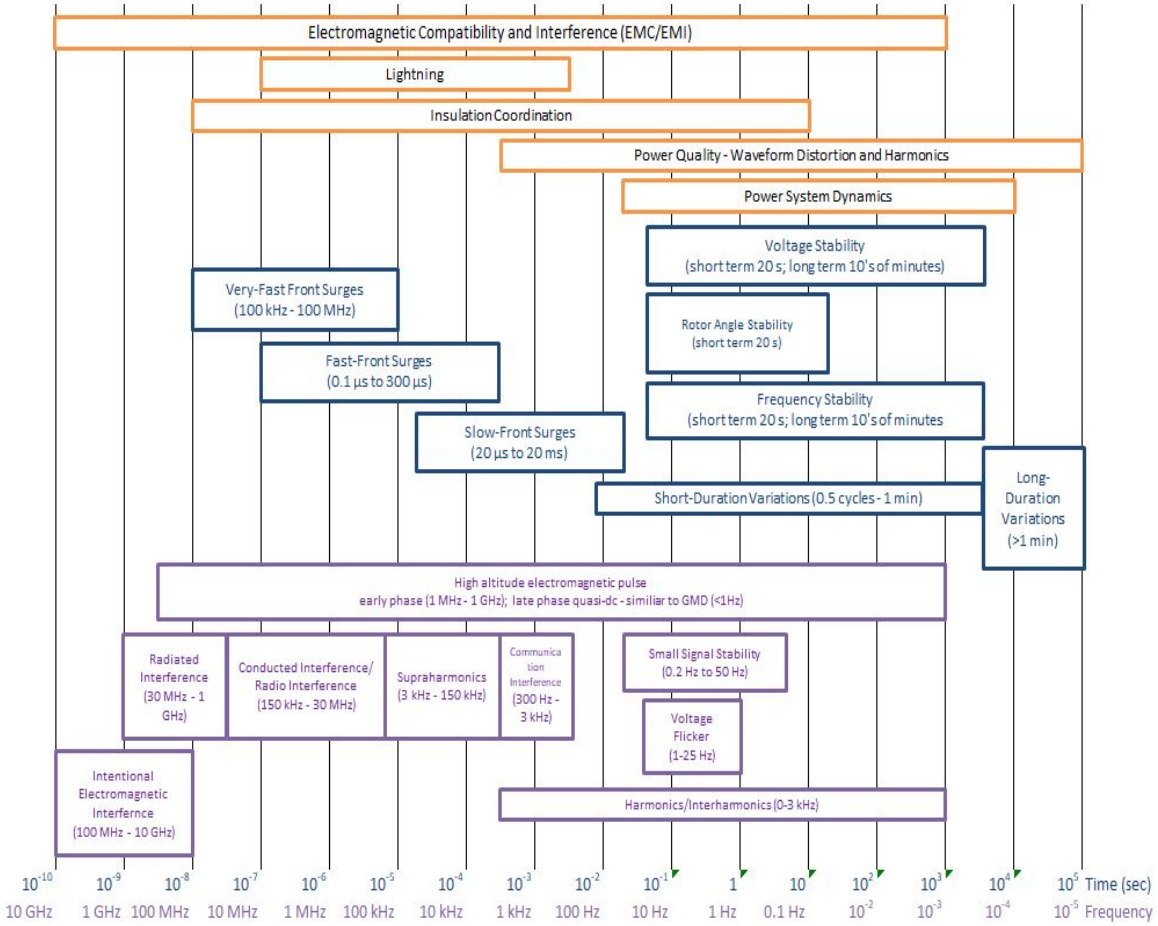


Figure 1: Time frame of various phenomena of interest in power system studies.

To better describe the continuum of phenomena, the following broad topics of interest are defined:

- Power quality
- Electromagnetic compatibility and interference (EMC/EMI)
- Insulation co-ordination
- Lightning
- Power systems dynamics and numerical analysis

The common theme among the topics is the investigation and development of new tools, models, analysis methods and techniques for the assessment of critical power system dynamics. The need for

models ranges from individual pieces of equipment up to the system level, with the focus being on simulations to analyse system and equipment interactions. Measurement systems and techniques, and their use in validating complex simulation tools, forms part of the overall modelling effort. The broad listing provided above also relates to emerging smart grids, micro grids, distributed and renewable energy resource technologies (such as wind and solar), with emphasis on power quality, advanced tools for the analysis of electromagnetic and electromechanical transients, and the dynamic performance of power electronic interfaced equipment.

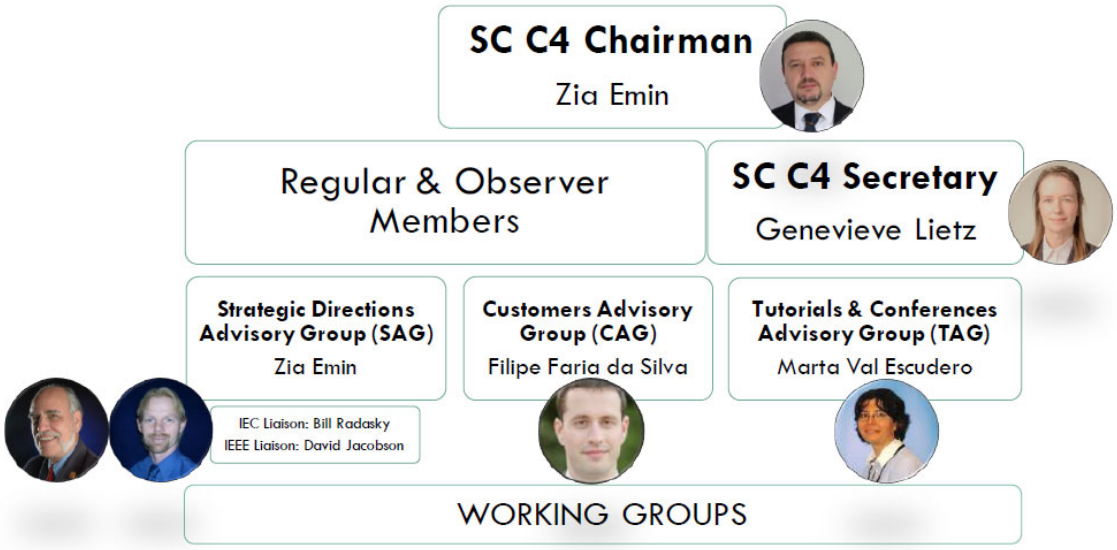
2. Study Committee Structure

The organisational structure of SC C4 is as shown in Figure 2. At the 2021 SC meeting held during the Paris Session, the composition of the SC was confirmed as follows:

- Chair and Secretary
- 27 Regular Members
- 18 Observer Members

The membership of SC C4 presently encompasses 42 countries.

Figure 2: SC C4 structure



From AU C4, Andrew Halley and Sarath Perera are currently both members of SAG. Andrew will remain a Regular Member of the SC until August 2022, being one of twenty seven (27) national representatives.

Next year will see a number of changes, with a new SC Chairman and eleven new regular members to rotate into the group. This will include a new representative from Australia.

3. Specific Activities of the Study Committee

3.1 Active Working Groups

SC C4 currently has thirty nine (39) active Working Groups (WG). The breakdown by sub-topic is:

- Power quality, 6
- Electromagnetic compatibility and interference (EMC/EMI), 4
- Insulation co-ordination, 6
- Lightning, 9
- Power systems dynamics and numerical analysis, 14

WG #	Title	Convener	Schedule
WG C4.36	Winter lightning – Parameters and engineering consequences for wind turbines.	M. Ishii (Japan)	2014 - 2017
WG C4.39	Effectiveness of line surge arresters for lightning protection of overhead transmission lines.	K. Tsuge (Japan)	2015 - 2017
WG C4.43	Lightning problems and lightning risk management for nuclear power plants.	T. Shindo (Japan)	2017 - 2020
WG C4.44	EMC for large photovoltaic systems.	E. Salinas (Sweden)	2017 - 2019
WG C4.46	Evaluation of temporary over voltages in power systems due to low order harmonic resonances.	F. F. da Silva (Denmark)	2017 - 2019
WG C4.47	Power system resilience.	M. van Harte (South Africa)	2017 - 2020
WG C4.48	Overvoltage withstand characteristics of power system equipment 35-1200 kV.	I. Dudurych (Ireland)	2017 - 2020
WG C4.49	Multi-frequency stability of converter-based modern power systems.	Ł. Kocewiak (Denmark)	2018 - 2021
WG C4.50	Evaluation of transient performance of grounding systems in substations and its impact on primary and secondary systems.	B. Zhang (China)	2018 - 2021
WG C4.51	Connection of railway traction systems to power networks.	D. Vujatovic (UK)	2018 -2021
WG C4.54	Protection of high voltage power network control electronics from the High-altitude Electromagnetic Pulse (HEMP).	W.A. Radasky (USA)	2019 - 2022
WG C4.55	EMC related very-fast transients in gas-insulated substations - EMC interferences, measured characteristics, modelling and simulations.	A. Ametani (Japan)	2019 - 2022
WG C4.56	Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter connected generation.	B. Badrzadeh (Australia)	2019 - 2022
WG C4.57	Guidelines for the estimation of overhead distribution line lightning performance and its application to lightning protection design scope.	K. Michishita (Japan)	2019 - 2022
WG C4.59	Real-time lightning protection of the electricity supply systems of the future.	C. Tong (China)	2019 - 2022
WG C4.60	Generic EMT-Type Modelling of Inverter-Based Resources for Long Term Planning Studies.	A. Haddadi (USA)	2020 - 2023
WG C4.61	Lightning transient sensing, monitoring and application in electric power systems.	J. He (China)	2021 - 2023
WG C4.63	Harmonic power quality standards and compliance verification – a comparative assessment and practical guide.	N. Shore (UK)	2021 - 2024
WG C4.64	Application of Real-Time Digital Simulation in Power Systems.	C. Fang (Canada)	2021 - 2023

WG #	Title	Convener	Schedule
WG C4.65	Specification, Validation and Application of Harmonic Models of Inverter Based Resources.	J. David (Australia)	2021 - 2024
WG C4.66	New concept for analysis of multiphase back-flashover phenomena of overhead transmission lines due to lightning.	M. Miki (Japan)	2021 - 2024
WG C4.67	Lightning Protection of Hybrid Overhead Lines.	A. Piantini (Brazil)	2022 - 2025
WG C4.68	Electromagnetic Compatibility (EMC) issues in modern and future power systems	P. Munhoz-Rojas (Brazil)	2021 - 2024
JWG C4.40/CIRED	Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14.	M. Halpin (USA)	2015 - 2018
JWG C4.42/CIRED	Continuous assessment of low-order harmonic emissions from customer installations.	I. Papič (Slovenia)	2015 - 2018
JWG C4/B4.52	Guidelines for sub-synchronous oscillation studies in power electronics dominated power systems.	C. Karawita (Canada)	2019 - 2021
JWG C4/A3.53	Application effects of low-residual voltage surge arresters in suppressing over voltages in UHV AC systems.	J.He (China)	2019-2021
JWG C4/C2.58/IEEE	Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems.	U. Annakkage (Canada)	2019 - 2021
JWG C4/C2.62/IEEE	Review of advancements in synchrophasor measurement applications.	A. Rajapakse (Canada)	2021 - 2023
JWG A1/C4.52	Wind generators and frequency-active power control of power systems.	N. Miller (USA)	2015 - 2018
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.	D. K. Chaturvedi (India)	2019 - 2021
JWG A2/C4.52	High-frequency transformer and reactor models for non-standard waveforms.	B. Gustavsen (Norway)	2014 - 2018
JWG B1/C4.69	Recommendations for the insulation coordination on AC cable systems.	T. du Plessis (South Africa)	2018 - 2021
JWG B2/C4.76	Lightning & grounding considerations for overhead line rebuilding and refurbishing projects, AC and DC.	William A. Chisholm (Canada)	2019 - 2022
JWG B4/B1/C4.73	Surge and extended overvoltage testing of HVDC Cable Systems.	M. Saltzer (Sweden)	2016 - 2017
JWG B5/C4.61	Impact of low inertia network on protection and control.	R. Zhang (UK)	2017 - 2020

WG #	Title	Convener	Schedule
JWG C1/C4.36	Review of Large City & Metropolitan Area power system development trends taking into account new generation, grid and information technologies.	V. Jesus (Brazil) S. Utts (Russia)	2017 - 2019
JWG C1/C4.46	Optimising power system resilience in future grid design.	Christian Schaefer (Australia)	2021 - 2022
JWG C2/C4.41	Impact of high penetration of inverter-based generation on system inertia of networks.	M. Rampokanyo (South Africa)	2018 - 2020

Nine working groups are expected to complete and publish their Technical Brochures (TB) in the near future. As of November 2021, the working groups which are approaching the end of their activities are as follows:

- WG C4.39 and JWG C2/C4.41 have submitted their TB's for review by the SC, with publication to follow after final approvals.
- Submissions to the SC for review are pending for WGs C4.36, JWG C4.42/CIRED, C4.43, JWG B4/B1/C4.73, JWG A2/C4.52, JWG A1/C4.52, and JWG C1/C4.36.

  These WG are likely to be completed in the near future.

3.2 Proposed Working Groups

There is currently only one proposal for a new WG which is under review by the SC.

- WG C4.xxx "Small signal stability analysis in IBR dominated power system" – Sachin Goyal (Australia)

A decision on this WG is likely to be made early in 2022.

To assist with the identification of future WG topics and help address the needs of industry, SC C4 is continuing with its Gap Analysis Task Force. The objective is to identify new areas of investigation and/or specific topics which require review given the significant changes occurring across the industry.

To date, the Task Force has been assisting with the development of draft Terms of Reference (ToR) for future WG, as well as providing review and support to individuals wanting to present their own WG initiatives.

The composition of the Task Force is shown below, with Australian contributors highlighted in yellow.

TF Streams	Power Quality	EMC	Insulation Coordination	Lightning	Dynamics
Contributors	**Marta Val Escudero** Sarath Perera Theo Laughner Brandon Peterson Igor Papic	**WH Siew** Bill Radasky John van Coller Ener Salinas Dave Thomas Qingmin Li Patricio Munoz Rojas Kazuo Yamamoto	**Claus Leth Bak** Alain Xemard Angelica Rocha Manuel Martinez Duro Filipe Faria da Silva Stephan Pack Igor Papic	**Alberto Borghetti** Hideki Motoyama Stephan Pack Jinliang He Bill Chisholm Fridolin Heidler Marina Bernardi Vlad Rakov Maria Teresa Correia de Barros Joan Montanya Pantelis Mikropoulos Yoshihiro Baba Alexandre Piantini Silvério Visacro Udaya Kumar	**David Jacobson** Liisa Haarla Andrew Halley Emil Hillberg Babak Badrzadeh
WG Approved	C4.63, C4.65	C4.68		C4.61, C4.66, C4.67	C4/C2.62, C4.64

3.3 Green Books

SC C4 has recently commenced the development of a new Green Book (GB) titled "*Power system dynamic modelling and analysis in evolving networks*". The Chief Editors are Babak Badrzadeh (AU) and Zia Emin (UK). The document is expected to be published in 2023.

The scope of the GB will be as follows:

- 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.
- Provide a comparison of changes occurring between 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 in terms of dynamic phenomena experienced, analysis methods and simulation tools required, and enablers to achieve this.
- Describe different types of power system studies and associated analysis tools as the system evolves.
- Present modelling requirements for different power system components, both existing and emerging technologies, such that power systems can be planned and operated securely and reliably.

- Present practical examples obtained from real world power systems as a step-by-step study guide such that they can be applied by practicing engineers in their day to day tasks.
- Demonstrate the importance of power system model acceptance testing and validation by practical examples describing applications and various methods.

In addition to Babak, Australian contributors will be Andrew Halley (TasNetworks), Sachin Goyal (PowerLink) and Nilesh Modi (AEMO).

3.4 CIGRE Science and Engineering Journal and Electra Articles

A number of excellent C4 articles have been published in Volumes 20 and 21 of the Science and Engineering (CSE) Journal, including several with an Australian focus. The following are highlighted for Australian readers:

- CSE Article: ""***Developing Dynamic Load Models for the Australian National Electricity Market with a Focus on Distributed Energy Resources***", P. Pourbeik et al.
- CSE Article: ***"Practical experience with mitigation of sub-synchronous control interaction in power systems with low system strength",*** Contributions from PowerLink (QLD)

In addition, an Electra Reference Paper titled ***"System Strength"*** (RP-315-1) was published following an article presented in CSE Vol 20. The paper was prepared by Babak Badrzadeh (AU) and followed the successful C4 technical workshop on the same topic that was presented as part of the 2020 Paris E-Session.

All documentation is available via the e-CIGRE website.

3.5 Published Technical Brochures

The following TB have been published by SC C4 since November 2020.

TB 829: Challenges with series compensation application in power systems when over compensating lines, JWG C4/B5.41.

TB 836: Measuring techniques and characteristics of fast and very fast transient over voltages in substations and converter stations, WG C4.45.

TB 839: Guide to procedures for estimating the lightning performance of transmission lines, WG C4.23

As outlined above, two other TBs are currently under review by the SC and a number of WG are due to be completed in the near future.

3.6 Webinars

Since the last report, SC C4 has offered two webinars to CIGRE members:

- **"Impact of high penetration of inverter based generation on system inertia of networks",** by JWG C2/C4.41, December 10, 2020. AU-C4 representative: Nilesh Modi (AEMO).
- **"New aspects and guides to procedures for estimating lightning performance of transmission lines"**, by C4.23, July 22, 2021.

The webinar format is continuing to prove very successful for SC C4, with 329 attendees participating in the C2/C4.41 event (with 580 registrations in total). More webinars are being planned for 2022. Details will be made available via the SC C4 website: https://c4.cigre.org/GB/events/events-calendar.

3.7 International Events

The impacts of COVID-19 have been widely felt and continue to significantly impact international travel. As a result, a number of planned events involving SC C4 were cancelled, most notably the International Colloquium planned to be held in Suzhou (China) during March 2021.

The current listing of future events which SC C4 is involved is as follows:

- **CIGRE Symposium 2022,** "*Power system transformation including active distribution*", Kyoto (Japan), 3-8th April 2022.
- **CIGRE Session #50**, Paris (France), August 2022.
- **CIGRE Symposium 2023, "***Renewables and challenges of integration and the impact of renewable generation on the grid*", Cairns (Australia), 4-7 September 2023.

SC C4 has recently indicated that it will hold its Annual Meeting as part of the Cairns symposium. This is likely to attract a number of additional C4 representatives from around the world, adding to the expected quality of the event.

The participation of Australian C4 members will continue to be influenced by travel limitations relevant at the time of each event.

3.8 SC C4 Awards

The following SC awards were announced during the Paris 2021 Session. Congratulations in particular go to Babak Badrzadeh given his significant efforts to lead two working groups as well as contribute to a number of major publications over the last twelve months.

- David Jacobson……..TC Award
- Liisa Haarla……WiE award
- Marta Val Escudero….WiE award
- David Jacobson……..CIGRE Pioneer e-session achievement award
- Filipe Faria de Silva…CIGRE Pioneer e-session achievement award
- Marta Val Escudero….CIGRE Pioneer e-session achievement award
- Genevieve Lietz……..CIGRE Pioneer e-session achievement award
- Babak Badrzadeh……CIGRE Pioneer e-session achievement award
- Andrew Halley…….CIGRE Pioneer e-session achievement award

4. Paris Sessions

4.1 Preferential subjects 2022

Preferential subjects for the **2022 Paris Session** are as follows:

PS1: Challenges and advances in power quality (PQ) and electromagnetic compatibility (EMC)

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

PS2: Challenges and advances in insulation coordination and lightning research

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

PS3: Challenges and advances in Power System Dynamics

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

The Special Reporters for the Paris Session are:

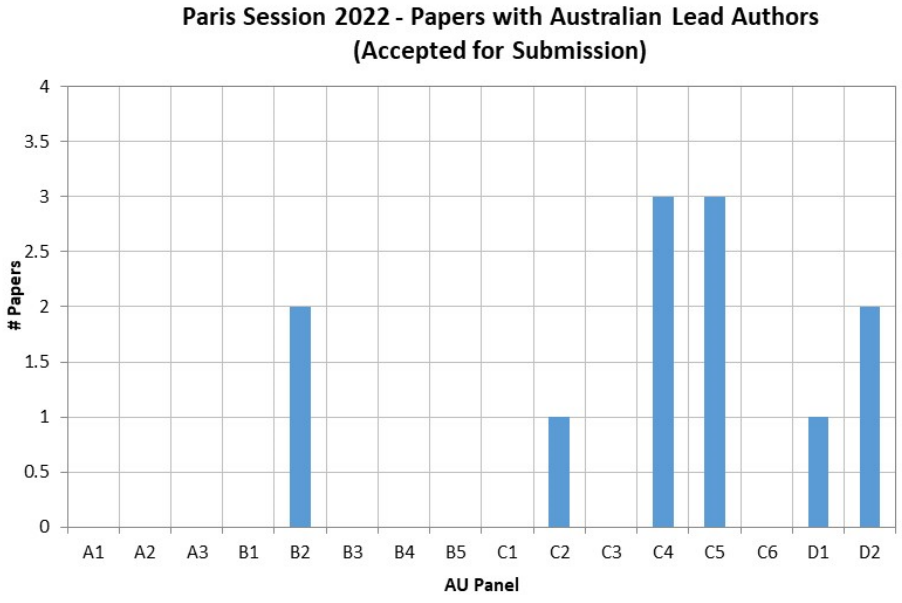
- PS1 – Sarath Perera (AU)
- PS2 – Kostas Velitsikakis
- PS3 – Babak Badrzadeh (AU)

Congratulations to both Sarath and Babak for being selected for the Special Reporter roles. To have two Australians on the panel is a fantastic outcome and will make the next SC General Meeting all that more enjoyable to participate in.

4.2 Accepted Papers from AU C4 for 2022

Three papers have been accepted from AU C4 for the 2022 Paris Session. A total of twelve papers have been accepted from CIGRE Australia, which is down on previous years. A summary of the papers accepted from Australia is provided below in Figure 3.

Figure 3: Australian papers accepted for Paris E-Session 2022



The three papers to be presented from AU C4 are as follows:

Lead author	PS, Paper #	Title
Tim Browne	PS1, 428	Critical review of harmonic assessment procedures for transmission customers.
Pierluigi Mancarella	PS3, 583	Rethinking the system non-synchronous penetration (SNSP) metric.
Stephen Sproul	PS3, 585	System strength support using grid forming energy storage enabling high penetrations of inverter-based resources to operate on weak networks.

4.3 Technical Workshop – E-session 2021

On Monday 23 August, the SC C4 workshop was held via webinar. The workshop was presented by WG C4.56 and was titled:

"**Electromagnetic transient analysis for large-scale system impact studies in power systems having a high penetration of inverter connected generation**".

The workshop was coordinated by the Convenor of WG C4.56, Babak Badrzadeh from AU C4.

The workshop focused on the following:

- Systematic development of wide-area EMT models from load flow models.
- Model acceptance testing and validation of EMT models.
- Approaches for increasing the simulation speed and reducing the wide-area model development time.
- Country specific practical case studies on the use of wide-area models and added benefits compared to conventional phasor-domain modelling.

As a summary of the workshop outcomes:

- Eight presenters from four different countries delivered fourteen presentations.
- The total workshop ran for four hours including two Q&A sessions.
- 205 people attended the webinar.
- Most presentations were made live, except for a couple which were pre-recorded.
- The entire workshop, including Q&A sessions, can be downloaded by registered attendees.

Feedback received was positive, with an overall survey rating of 4.5 out of 5.

5. Other Specific Activities of the Australian Panel

The Australian Panel has continued to be active in 2021 despite the issues associated with COVID-19. There has been ongoing involvement in a number of WG, contributions to the Paris Session and to various other local initiatives.

The following summary highlights the major achievements of the panel over the last 12 months.

5.1 Contributions to WG

The following CIGRE Australia members are recognised by AU-C4 as contributing to active WGs. It is notable that AU C4 now has two WG Convenors following the appointment of Jason David to lead the activities of C4.65. Well done and best wishes to Jason in the new role.

WG Ref	Title	AU.C4 Reps	Involvement	Status	TB Ref
C4.65	Specification, Validation and Application of Harmonic Models of Inverter Based Resources	Jason David Sarath PERERA	Convenor Member	In progress.	Pending.
C4.60	Generic EMT-Type Modelling of Inverter-Based Resources for Long Term Planning Studies.	Sasan Zabihi (Hitachi ABB Power Grids)	Member	In progress.	Pending.
C4/C2.58/ IEEE	Evaluation of voltage stability assessment methodologies in transmission systems.	Ehsan Farahani	Corresponding member	In progress.	Pending.
C4.56	Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter connected generation	Babak Badrzadeh Sachin Goyal Mark Davies Sorrell Grogan Jingwei Lu Neville Watson	Convenor Member Corresponding members	In progress.	Pending.
C4/B4.52	Guidelines for sub-synchronous oscillation studies in power electronics dominated power systems	Babak Badrzadeh David Vowles Sachin Goyal	Member Corresponding members	In progress.	Pending.
C4.51	Connection of railway traction systems to power networks	Igor Perin Phil Coughlan	Members	In progress.	Pending
C2/C4.41	Impact of high penetration of inverter based generation on system inertia of networks.	Nilesh Modi Michael Negnevitsky Gregor Verbic	Members	Complete 2021	TB 851
		Cheryl Noronha Craig Blizard	Corresponding members		

WG Ref	Title	AU.C4 Reps	Involvement	Status	TB Ref
C4.47	Power system resilience	Julian Eggleston Terry Lampard Pierluigi Mancarella	Members	In progress.	Pending
C4.42/CIRED	Continuous assessment of low-order harmonic emissions from customer installations.	Tim Browne Sarath Perera Vic Gosbell	Corresponding Members	In progress.	Pending.
C4.40/ CIRED	Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14.	Alex BAITCH Sarath PERERA Vic Gosbell	Members	In progress.	Pending.

5.2 Contributions to other significant industry activities

CIGRE Australia members aligned with AU C4 are also contributing to a variety of other industry activities well as technical committees associated with Standards Australia and the International Electrotechnical Commission (IEC).

Reference	AU representatives	Contribution
Standards Australia / IEC EL-034 Power Quality Technical Committee	Sarath Perera	Chairman
Standards Australia / IEC EL-043 High voltage installations	Alex Baitch	Chairman Mirror committee to IEC TC-99.
Standards Australia / IEC EL-064 Decentralised electrical energy and grid integration of renewable energy systems	Alex Baitch	Chairman Established in 2019 to mirror the activities of IEC TC8 and its subcommittees IEC SC8A and IEC SC8B. This year an additional subcommittee has been established (IEC SC8C).
Standards Australia / IEC EL-062 Smart Grids	Alex Baitch	Member Has recently been re-constituted with a view to acting a mirror committee to the IEC Systems Committee IEC SyC Smart Energy.

5.4 AU C4 Panel Meeting and Technical Seminar

Given ongoing COVID related travel restrictions, the Australian Panel of C4 held its annual meeting this year as an online event. Twenty nine members and invited guests participated in the

administrative meeting held on Monday 27 September. The meeting agenda included a discussion on the imminent CIGRE Australia Annual General Meeting (AGM) being held later in the same week, feedback from the most recent International Study Committee Meeting and a review of AU C4 activities over the last 12 months. Panel membership was also reviewed with a notable increase in numbers over the last two years. With two new membership applications in the process of being finalised, the industry diversity across the panel is likely to be as follows at the start of 2022:

- **Network Service Providers (11)**
- **Consulting (10)**
- **Academia (6)**
- **Equipment suppliers (3)**
- **System operator (1)**
- **Generators (1)**
- **Regulator (0)**

The ongoing lack of gender diversity across the panel was also discussed. This remains an area of focus as collective member representatives rotate over time and new members seek to join the panel.

The day concluded with members providing a short summary of key activities being undertaken in their organisations related to the scope of C4.

On Tuesday 28 September, a technical seminar was conducted online. Seven presentations were delivered to an audience of thirty two.

- Huuson Nguyen; *STATCOM solution for Eastern Goldfields saturated reactors replacement: controllers design, tunings and commissioning.*
- Neil Browne; *Time of day analysis of PQ voltage measurements.*
- Neville Watson; *Project Update: Architecture of the future low-carbon, resilient, electrical power system.*
- Garry Melik; *Installation of a harmonic filter at a solar farm and associated magnetic field design considerations.*
- Wei Jian Chan (NGN liaison); *Broken neutral detection using voltage and current observations.*
- Robert Barr; *Measurement of harmonics in transformer excitation currents.*
- Don Geddey; *Identifying solar-farm inverter harmonic models from connection-point measurements.*

Thank you to all presenters who took the time to prepare and deliver an excellent array of material.

At this point in time, the 2022 Panel Meeting will be held in either South Australia or Western Australia. The decision is pending based on further discussions with panel members as to whether going to WA in 2023 is too onerous (in terms of travel budgets etc) given that the CIGRE Symposium is being held in Cairns during the September.

6. Invitations for SC or WG's to meet in Australia

Other than ongoing discussions within the SC related to the 2023 Australian Symposium in Cairns, no formal invitations have been offered or received for WG or SC meetings in the near term.

7. Thank you and incoming Panel Convenor

As this is my last annual report as Convenor, I would like to thank all existing and immediate past panel members for their contributions, support and encouragement over the last six years. The time has gone quickly. It has been an enjoyable and rewarding experience due in great part to the

exceptional people that I have been fortunate enough to interact with on a regular basis, both domestically and internationally.

I would also like to acknowledge the support of the CIGRE Australia Brisbane office, especially the contributions from Terry Killen who has eagerly assisted with various panel activities that have been organised over the last couple of years. Thanks also to the CIGRE Australia Board who continue to provide funding which allows people to participate in activities which ultimately return significant benefits to our industry.

The new incoming Panel Convenor is Babak Badrzadeh who is well known to many in CIGRE as well as the Australian power sector. Babak is currently the Technical Director for Power Systems at Aurecon Group, having previously spent significant time at the Australian Energy Market Operator (AEMO) as well as Vestas. He is passionate about power engineering and is already leading a number of working streams focused on the energy transition. I have no doubts that the AU C4 panel will continue to prosper under Babak's guidance.

Thanks to everyone who has made my time as Convenor so memorable.

8. Membership of the Australian Panel

The AU C4 Panel consists of thirty (30) members as of November 2021, with two additional applications for new panel membership still pending.

Name	Organisation	Type
Shabir Ahmadyar	Jacobs	Consulting
Salim Anwari	Hatch	Consulting
Alex Baitch	BES (Aust) Pty Ltd	Consulting
Babak Badrzadeh	Aurecon Group	Consulting
Errol Bebbington	PSC Australia	Consulting
Jason David	Australian Power Quality and Reliability Centre	Academia
Julian Eggleston	DigSilent Pacific	Consulting
Don Geddey	TransGrid	Network Service Provider
Vic Gosbell	University of Wollongong	Academia
Andrew Halley	Tasmanian Networks Pty Ltd	Network Service Provider
Miron Janjic	BECA	Consulting
Yugal Kishore	Siemens Australia	Consulting
Viji Krishnaratnam	Energex Ltd	Network Service Provider
Ben Li	Ausnet Services	Network Service Provider
Hadi Lomei	Essential Energy	Network Service Provider
Garry Melik	Magshield Products International	Consulting
Rizah Memisevic	Powerlink Queensland	Network Service Provider
Nilesh Modi	Australian Energy Market Operator	System Operator
Michael Negnevitsky	University of Tasmania School of Engineering	Academia

Name	Organisation	Type
Huuson Nguyen	Western Power	Network Service Provider
Hitesh Parekh	Hitachi ABB Power Grids	Equipment Supplier
Devinda Perera	ElectraNet	Network Service Provider
Sarath Perera	University of Wollongong	Academia
Albert Pors	Endeavour Energy	Network Service Provider
Brett Roberts	AUSGRID	Network Service Provider
Aditya Upadhye	Grid Wise Energy	Consulting
David Vowles	University of Adelaide	Academia
Ping Wang	GE Energy Connections (was Alstom Grid Aust)	Equipment Supplier
Neville Watson	University Of Canterbury	Academia
Wei Jian Chan	Energy Queensland	NSP / NGN Representative

9. Panel contact details

For further information or questions, please contact:

Incoming Convener: Babak Badrzadeh
Email: Babak.Badrzadeh@aurecongroup.com

Outgoing Convener: Andrew Halley
Email: andrew.halley@tasnetworks.com.au
Phone: 0419 120 115

Secretary: Jason David
Email: jasond@uow.edu.au
Phone: 0401 495 741

AU C4 KMS Home Page:

https://cigregroups.org/display/AUC4/AU+C4+System+Technical+Performance+Home

AP C5 Markets and Regulation

1. Study Committee Scope

The scope of Study Committee C5 is: Analysis of the impacts on the planning and operation of electric power systems of different market approaches and solutions; and of new structures, institutions, actors and stakeholders. The role of competition and regulation in improving end-to-end efficiency of the electric power system. Areas of attention include:

- **Market structures** and products such as physical and financial markets and the interaction between them, contracts, internationally integrated markets.
- **Techniques and tools** to support market actors such as demand and price forecasting profit estimation, financial risk management etc.
- **Regulation and legislation** such as regulation objectives, extension and limits, price regulation of transmission, and ancillary services, transmission/distribution coordination and interactions, international harmonization, environmental and regulatory objectives etc.
- **Evolution** of markets and regulation from wholesale transmission focus to include retail and distribution. The increasing interaction between regulation and markets throughout the electric power system value chain and the ability of markets and regulation to cater for rapid evolution in dynamic / variable generation, demand and storage technologies and behaviours.
- **Coordination** of regulation, funding and trading arrangements for new assets and technologies expansion in new market structures, including the trend of decentralization of operations with distributed applications; the remaining assets coexisting with the retirement of other in utilities; the consideration of legacy trading arrangements in the new market arena

The study committee conducts the Market Disturbance portion of the Large Disturbance Workshop held as part of the Paris Session. The C5 contribution:

- shared experiences from Australia;
- provided an opportunity to learn from real life experiences of unusual or extreme market circumstances and how markets responded during system disturbances; and
- examines the performance of various market designs and regulations.

The 2021 large disturbance workshop was held as part of the virtual 2021 Paris Session. Initial work has commenced to prepare the 2022 workshop in conjunction with C2.

2. Specific Activities of the Study Committee and AU panel participation

The Study Committee is continuing its focus on market developments, both at the macro and the micro level. A focus on distribution networks and the edge of the grid has again been included in the preferential subjects for 2022.

The AU panel represented SC C5 in the preparation and running of the Large Disturbance workshop in cooperation with SC C2. Between 150 and 200 members were on-line for at least part of the workshop. Feedback from participants was favourable with interest being expressed for the 2022 workshop. Members of the panel prepared 3 interventions for the Paris 2021 session.

3. Preferential Subjects

The preferential subjects for 2021 were:

PS1: The changing nature of markets and ancillary requirements

- Market adaptations to handle the value shift between energy and services
- Markets and services to address inertia and resilience
- Role of markets with respect to aggregation and the provision of network services
- Pricing approaches for emerging technologies and impacts of those approaches

PS2: Changing role of regulators and standards

- Role of regulators in the changing markets
- Evolving policy, standards, and guidelines to address issues affecting markets
- Regulatory policies on transmission and distribution; too little or too much?

PS3: Market designs for coordination of generation and network investments

- Markets and regulations to promote coordinated investments
- Customer-driven market changes – the transition from centralized to distributed planning
- Impacts of the changing nature of customers on investments and markets
- The impact of peer-to-peer trading on the provision of market services.

4. Activities of the Australian Panel

The Australian Panel held its annual meeting via Go To Meeting on Monday 28th June 2021. Thirteen panel members participated. The main topics for the meeting were 'dry runs' of presentations for the Large Disturbance Workshop and the papers for the Technical Session from Australian members

The chair and secretary of C5 and convenor of AU C5 held a number of web meetings with the chair and secretary of C2 to finalise the logistics for the Large Disturbance Workshop.

Four papers from AU C5 were accepted and presented to the virtual Paris Session. The papers covered:

- Value of battery behaviour to customers
- Impact of price signals on Demand Management and Distributed Energy Resources
- System strength, inertia and network loss factors
- Emerging Ancillary Service changes in the NEM

5. Invitations for international participation

C5 will be meeting in conjunction with a Symposium in Kyoto in April 2022. Participation is expected to be virtual and possibly in person subject to Covid. Arrangements are progressing for SC C5 to meet in conjunction with the Cairns Symposium in 2023.

6. Australian Members on Working Groups

The current and recently reported SC C5 working groups and their AP members are shown below.

Working Group	Title	AU/NZ Leader*/ Representative
JWG C2.06/C5	Interventions in electricity markets – System and Market Operator impacts	Greg Thorpe Stephen Hinchliffe
WG C5-28	Energy Market Price Formation	Greg Thorpe
WG C5-31	Cost impacts of flexible Demand Response	Lance Hoch Alex Cruickshank
WG C5-32	Carbon Pricing in Electricity Market	Brian Joseph
WG C5-33	Block chain applications in power markets	David Bowker*

7. Membership of the Australian Panel during 2021

Name	Organisation	Type
Greg Thorpe	Convener/Oakley Greenwood	Consultant
Victor Francisco	Secretary/PSC Consulting	Consultant
Ramu Naidoo	Transpower	TNSP
Chantal Hopwood	TasNetworks	TNSP
Julian Eggleston	DigSilent	Consultant
Stephen Hinchliffe	Mott McDonald	Consultant
Lizzy O'Brien	GHD	Consultant
John Cooper	Hydro Tasmania	Generator/Retailer
Pippa Williams	Hydro Tasmania	Generator/Retailer
Jenni Harris	Powerlink	TNSP
Rainer Korte	ElectraNet	TNSP
Brian Joseph	NGN/EY	Consultant
Rohan Zauner	Jacobs	Consultant
Ian Rose/Ben Vanderwaal	EY	Consultant
David Swift	David Swift Consulting	Consultant
Jacinda Papps	Alinta	Generator/Retailer
Sean Egan[2]	Power&Water (NT)	System Control

Convener: **Greg Thorpe**
Email: **gthorpe@oakleygreenwood.com.au**
Phone: **0419 347 955**

AU C6 Active Distribution Systems and Distributed Energy Resources

1. Study Committee Scope

The scope of the C6 Study Committee (SC) is principally concerned with the assessment of the technical impacts and requirements which a more widespread adoption of distributed generation could impose on the structure and operation of electricity distributions systems.

In parallel, the SC assesses the degree to which such solutions are likely to be adopted in the short, medium and long term. The practical importance and timing of the related technical impacts and requirements are also assessed. Rural electrification, demand side management methodologies and application of storage are within the scope of this SC.

Through its work the SC strives to objectively analyse the implications of distributed generation and to become an internationally recognised forum on this evolving subject.

2. Specific Activities of the Study Committee

Working groups develop technical recommendations and best practices for topics within the Study Committee's scope.

The main areas of attention are:

- Enabling technologies for renewable and distributed energy resource integration and application:
  active network management, microgrids, virtual power plants, distribution management systems, DER monitoring and control, aggregation systems and platforms.
- Innovative solutions for DER and distribution technology deployment:
  smart inverters and power electronic interfaces and interconnection device applications, MV/LV DC supply systems, distribution system modernization.
- Storage technologies:
  deployment of various storage technologies such as electrochemical battery energy storage systems, flywheels, flow batteries, hydropower, hydrogen, multi-energy solutions (with thermal storage), power2X applications (power to heat, power to gas, etc), electric vehicles.
- New approaches to configure distribution systems for enhanced reliability and resilience:
  islandable grid-connected microgrids, power exchange between microgrids.
- 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.

3. Preferential Subjects

The preferential subjects for the 2022 Paris Session are:

PS 1 - DER Solutions and Experiences for Energy Transition and Decarbonisation

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

PS 2 - Innovative Planning and Operation of Active Distribution Systems

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

PS 3 - Aggregated DER for Enhancing Resilience, Reliability and Energy Security of Distribution Systems

- Configuration of local energy storage systems for managing uncertainties,
- Coordination of multi-energy systems supported by state-of-the-art technologies including intelligent inverter controls,
- Individual AC and DC micro-grids, multiple microgrids, virtual power plant and local energy communities' control and network integration.

4. Proposed New Working Groups

In 2021 two new C6 working groups were approved. These were:

- C6.43 Aggregation of Battery Energy Storage and Distributed Energy Resources (DER), including Solar PV
- C6.44 Nodal Value of Distributed Renewable Energy Generation

5. Specific Activities of the Australian Panel

In addition to the contribution to SC C6 working groups as listed in Section 9 below, Australia has assisted the international SC C6 with reviews of draft technical brochures and other documents, through Advisory Group AG C6.02 "Quality Review".

Shervin Fani, Jacqui Mills and Sam Steinberg all presented as part of the SC C6 tutorial on Rural Electrification during this year's CIGRE Virtual Session.

6. CIDER 2022

Australian Panel C6 will host the Conference on Integration of Distributed Energy Resources (CIDER) in Adelaide on 10-11 May 2022, at the Stamford Grand Hotel in Glenelg. This was due to be held on 2-3 November 2021 but was postponed due to uncertainty caused by the corona virus pandemic.

This will be the fourth CIDER run by AU C6, the previous three conferences being in Brisbane in 2015, Sydney in 2017 and Melbourne 2019.

Further details and the call for presentations are available on the CIGRE Australia website.

7. Meeting Report: Australian Panel

Due to the corona virus pandemic, the face-to-face meeting of Australian Panel C6 was cancelled in 2021. Instead, teleconferences were held on 6 July and 1 November 2021.

8. Invitations for SC or WGs to meet in Australia

Study Committee C6 has accepted the Australian National Committee's invitation to hold their meeting in 2023 in Cairns, in conjunction with the CIGRE Symposium.

9. ANC Members on Working Groups

The following are current AU representatives on Working Groups.

WG	Title	Australian Member
C6/C2.34	Flexibility Provision from Distributed Energy Resources	Pierluigi Mancarella (convenor)
C6/C2.34	Flexibility Provision from Distributed Energy Resources	Michael Negnevitsky
C6/C2.34	Flexibility Provision from Distributed Energy Resources	Gloria Zhang
C6.35	DER Aggregation Platforms for the Provision of Flexibility Services	Jenny Gannon
C6.35	DER Aggregation Platforms for the Provision of Flexibility Services	Archie Chapman
C6.36	Distributed Energy Resource Models for Impact Assessment	Filip Brnadic
C6.36	Distributed Energy Resource Models for Impact Assessment	Shariq Riaz
C1/C6.37/ CIRED	Optimal Transmission and Distribution Investment Decisions under Increasing Energy Scenario Uncertainty	Alex Baitch
C6/B4.37	Medium Voltage DC Distribution Systems	Georgios Konstantinou
C6.38	Rural Electrification	Jacqui Mills (secretary)
C6.38	Rural Electrification	Glen Summers
C6.38	Rural Electrification	Shervin Fani
C6.38	Rural Electrification	Sam Steinberg
C6.39	Distribution Customer Empowerment	Neha Moturi (secretary)
C6.39	Distribution Customer Empowerment	Sanika Willard
C6.39	Distribution Customer Empowerment	Matthew Zillmann
C6.40	Electric Vehicles as Distributed Energy Resource (DER) Systems	Laura Jones
C6.40	Electric Vehicles as Distributed Energy Resource (DER) Systems	David Stephens
C6.41	Technologies for Electrical Railway Distribution Supply Systems	Phil Coughlan
C1/C6.42	Planning Tools and Methods for Systems Facing High Levels of Distributed Energy Resources	Rama Ganguli
C6.43	Aggregation of Battery Energy Storage and Distributed Energy Resources (DER), including Solar PV	Han Wang
C6.43	Aggregation of Battery Energy Storage and Distributed Energy Resources (DER), including Solar PV	Julius Susanto
AG C6.02	Quality Review	Ray Brown (convenor)

10. Membership of the Australian Panel

Name	Organisation	Type
Greg Abramowitz	AGL	Retailer
Graeme Ancell	Ancell Consulting	Consultant
Ken Ash	Energ-G Management Group	Consultant
Ian Askell	Essential Energy	Distribution
Alex Baitch	BES	Consultant
Ray Brown	RBPE	Consultant
David Butler	TasNetworks	Distribution
Hedy Dalvand	United Energy	Distribution
Sean Elphick	University of Wollongong	University
John Fletcher	University of NSW	University
Jenny Gannon	Energy Queensland	Distribution
Victor Ho	SA Power Networks	Distribution
Nathan Kirby	Western Power	Distribution
Adrian Lloyd	Energy Queensland	NGN Rep.
Janica Lukas	Western Power	Distribution
Jackson Lung	Wellington Electricity	Distribution
Pierluigi Mancarella	University of Melbourne	University
Yateendra Mishra	Queensland University of Technology	University
Michael Negnevitsky	University of Tasmania	University
Albert Pors	Endeavour Energy	Distribution
Jenny Riesz	AEMO	Operator
Thomas Smolka	Reinhausen	Manufacturer
Stephen Sproul	Hitachi Energy	Manufacturer
David Stephens	Horizon Power	Distribution
Pradip Verma	Pacific Power Association	Distribution
Sanika Willard	CutlerMerz	Consultant
Mike Wishart	EcoJoule Energy	Manufacturer
Wai-Kin Wong	AGL	Retailer
Richard Yan	University of Queensland	University

Convener: **Ray Brown**

Email: **ray@rbpe.com.au**

AP D1 Materials and Emerging Test Techniques

1. Study Committee Scope

The scope of Study Committee D1 covers new and existing materials for electrotechnology, diagnostic techniques and related knowledge rules, as well as emerging test techniques with expected impact on power systems in the medium to long term.

2. Specific Activities of the Study Committee

- Insulating gases and gaseous insulation systems.
- Liquid and liquid impregnated insulation systems.
- Solid materials.
- High voltage and high current testing and diagnosis.

The SC has 22 working groups active: 16 D1 WGs, 3 JWG D1/X and 3 JWG X/D1. These are detailed in the figure below.

The SC also has very close relationships with IEC technical committees,

TC 2 “Rotating Machines”,
TC 10 “Fluids for Electrotechnical Applications”,
TC 14 “Power Transformers”
TC 28 “Insulation co-ordination” has merged with TC 9 “Insulation co-ordination and system engineering”
TC 36 “Insulators”,
TC 42 “High-Voltage and High-Current Test Techniques”, there is a need for a liaison
TC 90 “Superconductivity”,
TC 112 “Evaluation and Qualification of Electrical Insulating Materials and Systems“

Study Committee D1 – Organisation

Status August 2021

SC Chair
R. Pietsch(DE)

- AG D1.01: Liquid and liquid impregnated insulation systems [L. Lundgaard (NO)]
- AG D1.02: High voltage and current testing and diagnosis [U. Riechert (CH)]
- AG D1.03: Solid materials [S. Sutton (GB)]
- AG D1.04: Gases [K. Juhre (DE)]

- SC Secretary [J. Seiler (DE)];
- Strategic and Customer AG [R. Pietsch (DE)]
- Tutorial AG [I. Atanasova-Hoehlein (DE)]

Liquid & impregnated systems

- WG D1.65 [Schmidt (DE)/2015-12] Mechanical properties of insulating materials and insulated conductors for oil insulated power transformers
- JWG A2/D1.51 [Coenen (DE)/14-02] Improvement to PD Measurements for Factory and Site Acceptance Tests of Power Transformers
- WG D1.68 [M. Pompili (IT)/2017-01] Natural and synthetic esters - Evaluation of the performance under fire and the impact on environment
- WG D1.70 [I. Hoehlein (DE)/2016-11] Functional properties of modern insulating liquids for transformers and similar electrical equipment
- JWG D1/A2.77 [F. Scatiggio (IT)/2020-03] Liquid Tests for Electrical Equipment
- JWG B1/D1.75 [A. Gustafsson (SE)/2019-11] Interaction between cable and accessory materials in HVAC and HVDC applications
- WG D1.76 [J. Lukic (RS)/2021-04] Tests for verification of quality and ageing performance of cellulose insulation for power transformers

Testing & Diagnosis

- WG D1.50 [J. Rickmann (US)/2012-04] Atmospheric and altitude correction factors for air gaps and clean insulators
- WG D1.54 [B. Dardel (CH)/2013-01] Principles and methods to measure the AC and DC resistance of conductors of cables and overhead lines
- WG D1.60 [Y. Li (AU)/2014-09] Traceable measurement techniques for very fast transients
- WG D1.61 [N. Mahatho (ZA)/2014-09] Optical corona detection and measurement
- WG D1.63 [R. Plath (DE)/2015-04] Partial discharge detection under DC stress
- WG D1.69 [R. Taylor (AU)/2017-02] Guidelines for test techniques of High Temperature Superconducting (HTS) systems
- JWG B1/B3/D1.79 [C. Plet (NL)/2019-11] Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends

Testing & Diagnosis

- WG D1.72 [Lambrecht (DE)/2018-04] Test of material resistance against surface arcing under DC
- WG D1.74 [A. Cavallini (IT)/2019-01] PD measurement on insulation systems stressed from HV power electronics

Gases

- WG D1.66 [W. Koltunowicz (AT)/2016-08] Requirements for PDM systems for gas insulated system

Solids

- JWG D1/B1.49 [M. Jarvid (SE)/2012-04] Harmonized test for the measurement of residual inflammable gases in insulating materials by gas chromat.
- WG D1.58 [Kornhuber (DE)/2014-01] Evaluation of dynamic hydrophobicity of polymeric insulating materials under AC and DC voltage stress
- WG D1.62 [B. Komanschek (DE)/2014-10] Surface degradation of polymeric insulating materials for outdoor applications

Solids

- WG D1.64 [Hayakawa (JP)/2015-12] Electrical insulation systems at cryogenic temperatures
- WG D1.73 [J. Castellon (FR)/2017-12] Nanostructured dielectrics: Multi-functionality at the service of the electric power industry
- JWG D1/B1.75 [J. Tusek (AU)/2019-11] Strategies and tools for corrosion prevention for cable systems

WG under D1 resp. | JWG under D1 resp | JWG not under D1

CIGRE Study Committee D1 – Organisation

The following Technical Brochures have been published in the last 12 months (dot point summaries are from author of the report)

TB 822 – December 2020

Methods for dielectric characterisation of polymeric insulating materials for outdoor applications – WG D1.59

- Extensive documents covering :
  - Diagnostic methods in time domain and in frequency domain
  - Contact methods and contactless methods
  - Round Robin Tests – comparing different test methods and with different commercial instruments
- Practical conclusions from round robin tests are obtained, e.g.,
  - Test results can be qualitatively compared
  - Frequency domain method are recommended, with good applicability in the 0.1 mHz to 10 kHz range
  - The effect of humidity on test results is clearly detectable, especially for volume properties
  - Defining drying processes is important

TB 842 – September 2021

Dielectric testing of gas insulated HVDC systems – JWG D1/B3.57

- Covering Gas-insulated DC Transmission Lines (DC GIL) and Gas-insulated DC Substations (DC GIS)
- Test procedures for difference performances, at various test voltage levels
- Tests are now all non-standard, i.e, no IEC or other international standards yet to follow

TB 846 – October 2021

Electrical insulation systems at cryogenic temperatures – WG D1.64

- Dielectric properties of insulation materials at cryogenic temperatures - gaseous, liquid, solid and composites
- Discharge characteristics and mechanisms – effects of electric field distributions, temperature, magnetic field, radiation,...
- Mechanical properties and fatigue under thermal stress – thermal conductivity and expansion, heat capacity…practical examples
- Experience in design of insulation systems and devices – superconducting wire, cables, transformers, rotating machines and magnets
- Dielectric testing of cryogenic insulation systems – cables, fault current limiters, transformers and fusion magnets, and their failures

TB 849 – October 2021

Electric performance of new non-SF6 gases and gas mixtures for gas-insulated systems – WG D1.67

- Need to consider technical, environmental, health and safety requirements
- Models for predicting dielectric strength potential gases from a range of correlated parameters
- Methods of characterising new gases and performance tests for practical insulation systems
- Round robin tests on SF6, C4-FN, C5-FK, HFO-1234ze(E) and CF3I, with various analysis methods used: GC, GC-MS, GC-TC, FTIR…

TB 850 – October 2021

Harmonised test for the measurement of residual methane in insulating materials – JWG D1/B1.49

- Methane generated during peroxide cross-linking process in production of power cables
- Recommended a harmonised test regime using GC for determining concentration in XLPE cables
- Round robin tests by 7 labs using similar procedures and different instruments and calibration methods
- Recommendations made for sampling equipment, sample storage and calibration of GC instruments

3. Preferential Subjects

Preferential subjects for 49th Paris Session – 2022

D1 - MATERIALS AND EMERGING TEST TECHNIQUES

PS1 : 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

PS2 : Materials for electrotechnical 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

PS3 : Simulation tools partnered with measurement techniques

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

4. Proposed New Working Groups

These are the new WGs proposed for D1, with respective ToR either in preparation or completed.

1. Surface charge measurement techniques and experiences of insulators inside HVDC gas-insulated system
2. Partial discharges in alternative insulating gases

5. Specific Activities of the Australian Panel

In 2020-21 there were active activities of recruiting new AU D1 members, with one organisation joining D1 and potentially two others joining soon. AU D1 members were also active in four international working groups. AU D1 also participated the Transformer Seminar organised by AU A2 Panel and delivered a lecture at the Seminar on Impulse Voltage Testing of Power Transformers.

6. Meeting Report: Australian Panel

The Australian Panel D1 held a virtual meeting on 11 November 2021. This was a full day meeting with attendance of 15 members and guests.

Below is a record of the meeting:

Chairperson: Yi Li
Secretary: Sam Murali
Attendees:
Yi Li, Dharmendra Shah, Sam Murali, Andrew Wilkinson, Brett Roberts, David Allen, Florian Perdl, Hui Ma, James Baker, Joe Tusek, Karl Haubner, Trevor Blackburn, Toan Phung, Wenyu Guo and Winston Yan
Apologies:
Prasanna Wickramasuriya, Mark Cotton, Mukesh Sharma,
Session 1:

Welcome

- Yi Li has given a welcome to the AU D1 group

Cigre Antitrust guidelines:

- Yi Li has provided Cigre antitrust guidelines for the group and explained the importance of these guidelines and confidentiality during meetings.

Self-introduction of members:

- All members and guests have introduced themselves and outlined their roles in their respective organisations.
  - Dr Yi Li - National Measurement Institute
  - Dharmendra Shah – Powerlink Queensland
  - Sam Murali – Transgrid
  - Andrew Wilkinson – Electranet
  - Brett Roberts – Specialist (AusGrid)
  - David Allen – Powerlink Queensland (Retried)
  - Florian Perdl – Omicron Australia
  - Hui Ma – University of Queensland

- James Baker – Essential Energy
- Joe Tusek – Verico High Voltage Testing
- Karl Haubner – Doble
- Trevor Blackburn – University of NSW (Retried)
- Toan Phung – University of NSW
- Wenyu Guo – Omicron Australia
- Winston Yan – Guest (National Measurement Institute)

Confirmation of minutes of 2020 meeting:

- The meeting minutes have been accepted all and if there are no comments or changes

Matters arising from minutes:

- No issues or matters from the previous minutes were discussed

Session 2:

- SC D1 – update on WGs, JWGs and Tutorials
  - Yi Li has shared technical brochures:
    - Field grading in electrical insulation systems (794)
    - Methods for dielectric characterisation of polymeric insulating materials (822)
    - Dielectric testing of gas-insulated DC systems (842)
    - Electrical Insulation Systems at Cryogenic Temperatures (846)
    - Electric performance of new non- SF6 gases and gas mixtures for gas-insulated systems (849)
    - Harmonised test for the measurement of residual methane in insulating materials (850)
    - Yi has shared the Study Committee Org chart
- CIGRE Australia update – ACT annual report,
  - Yi has shared the ATC report for 2020, which summaries what is currently happening across Cigre Australia
- AU D1 2020 Report
  - Yi has shared the 2020 Annual report summarising AU D1 Panel for 2020.
- NGN updates
  - Sam Murali has shared a summary of NGN activities in 2021.
  - Encourage young engineers in their respective organisations to join NGN and become part of the committee.
  - NGN have a Women in Engineering subcommittee.

Session 3A:

Research activities at University of Queensland – Dr Hui Ma - Research on Power System Asset Management

- Challenges in combining asset data across data sources.
- Focus on data science in power engineering
- Sensing, modelling, signal processing and data mining
- Example on load tap changer condition monitoring
- Example on using diagnostic information on transformers
- Understanding and mitigating silver sulphide corrosion in OLTC
- Modal Analysis for Transformers Windings
- Summary of other research works

Update on research activities at University of NSW, Professor Toan Phung - A report on research activities at UNSW

- Flame retardant electrical insulating materials (Silicone rubber)
- Overhead power line monitoring system, develop a real time FPGA-based fault simulator. Optical sensors to measure voltage and current.

- Diagnostics using AI/ Machine learning
- Transformer Frequency Response Analysis using Statistical Indicators to interpret FRA results.
- DDF measurement under distorted excitation voltage.

Case Study- Online PD measurement in the UHF range via integrated sensors in the presence of external discharge activity or no travel restrictions for UHF signals. Karl Haubner, Doble - Case Study, 330kV GIS

- GIS is known to be very reliable, defects tend to occur and can be catastrophic,
- Floating particle is a common defect.
- Commissioning tests are vital to ensure the system is in satisfactory condition.
- Siemens utilise Power VT secondary injection to undertake HV GIS tests.
- On-line UHF PD tests are common in Asia.
- IEC60270 is not applicable for on-line PD testing
- Significant difference in PD pattern between offline & online PD measurement.

Session 3B:

Pole tip fires, bushfires, surge arrestors and lightning protection, Professor Trevor Blackburn, University of NSW - Discussion Topic

- Trevor has been involved with updating various standards post the 2019 bushfires in NSW.
- Lightning protection AS1768
- Gapless arresters for AC systems - AS60099-5, additions to the standards specifications and testing of “spark” production.
- AU B2 Overhead lines generated WG B2.73 Bushfire mitigation. (Peter Dulhunty Convener)

Development of voltage and current calibration systems at frequencies up to 10 kHz. Dr Winston Yan, National Measurement Institute

- Harmonic pollution from renewable energy sources
- Overview of on-site systems in NMI’s laboratory
- Current limitations in the current and voltage calibration system, NMI are developing the system to higher frequencies.
- NMI has several partners for this project.

Vibro-Acoustic Measurement on Transformer On-Load Tap Changers, Florian Predl, OMICRON

- Florian is sharing his experience on acoustic measurements on-load tap changers.
- Similar concept to SFRA.
- Acoustic reference is required in the factory or during commissioning
- Records vibrations on all mechanical operations
- Can be performed online and offline.
- VAM data is analysed using wavelet transformation
- Sensors are temporarily mounted to the transformer tank.
- Screw adapters have the best SNR
- VAM and DRM can be combined for evaluation.
- Oil temperatures have a large impact on timing curves.
- Better repeatability on Vaccum rather than oil tap changers.

A measurement system for insulator puncture test with short front impulse voltage, Dr Yi Li, National Measurement Institute

- Paper presented in the Paris e-conference
- Traceable measurement of both peak voltage and front time of short front impulses
- Dr Yi shared arrangement for measuring the short front impulse.
- Measurement results of the various parameters experiments are shown in the paper.

Session 4:

General Business (All)

- Sam Murali:
    - Discussed transformer and oil filled reactor health index for their upcoming revenue reset program. As well as the risk assessment methodology for public and worker’s safety

- Challenges with transformer refurbishment and high costs
- Offline and Online DDF testing has found several out of tolerance bushings.

- Brett Roberts:
  - Has shared Cigre C4 Item 1 (over voltage), 2 (tap changer operation) and 3 (polymer long rods)
  - Acidic film over the polymer surface
  - DER consequences due to weak feeds.
  - Issues from contamination on polymer insulators due to biological growth.
  - Suggested to have a reference material section on AU D1 website, similar to that on AU C4 site.

Review of

- Paris 2022 Session and papers
  - Yi has shared the papers and sessions that will presented at Paris 2022
- AU D1 web space access
  - Yi demonstrated the CIGRE KMS and AU D1 web access and members that have access. Yi will send another round invitation to members yet not on KMS after the meeting.
  - Joe has mentioned that AU D1 is fairly quiet until the annual D1 meeting.
- Joe Tusek - GIS Cleanliness
  - Discharges on blanking plugs from using cable tie for suction relief on a blanking plate. This occurred after inserting the blank for a few times.
- Joe Tusek - Sludging on 11kV bushing due to an internal flash inside of a transformer.
- Working Group: IEC TC 42: High-voltage and high-current test techniques.
- Yi has expressed inviting colleagues from Western Australia, Tasmania, New Zealand and Victoria utilities. Brett Roberts offered to contact utilities in Tasmania and New Zealand.
- Next meeting
  - Dr Hui Ma will investigate possibility of UQ hosting the 2022 meeting, possibly in June/July. Attendees to email Yi Li about other possible locations for the next meeting.

7. Invitations for SC or WG's to meet in Australia

There are no current invitations for WGs or SCs to meet in Australia.

8. ANC Members on Working Groups

The following are all the current AU representatives on Working Groups.

WG	Title	Australian Member
D1.60	Traceable measurement techniques for very fast transients	Dr Yi Li (Member)
D1.50	Atmospheric and altitude correction factors for air gaps and clean insulators	Dr Yi Li (Convenor)
D1.69	Guidelines for test techniques of High Temperature Superconducting (HTS) systems	Richard Taylor (Convenor)
D1/B1.75	Strategies and tools for corrosion prevention for cable systems	Joe Tusek (Convenor)

9. Membership of the Australian Panel

Name	Organisation	Type
Joe Tusek	Verico	Consultant
Prasanna Wickramasuriya	Energy Queensland	Distribution
Wenyu Guo	Omicron	Manufacturer
Mark Cotton	AusNet Services	Transmission
James Baker	Essential Energy	Distribution
Karl Haubner	Doble	Manufacturer
Mukesh Sharma	Hitachi ABB Power Grids Australia	Manufacturer
Andrew Wilkinson	ElectraNet	Transmission
Sam Murali	TransGrid	Transmission
Dharmendra Shah	Powerlink	Transmission
Dr Hui Ma	University of Queensland	University
Dr Yi Li	National Measurement Institute	Other
A. Prof Toan Phung	University of NSW	University
Prof Trevor Blackburn	University of NSW	University

Convenor: **Yi Li**

Email: **yi.li@measurement.gov.au**

Phone: **0420 961 120**

AP D2 Information Systems and Telecommunication

1. Study Committee Scope

SC D2's 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 telecommunication for power systems.

2. Activities of the Study Committee

In the area of information systems and cybersecurity, the trends observed within the SC D2 panel members are as follows:

a) Cybersecurity challenges to the power utility
b) Opportunities from new applications, including Big Data, AI, Virtualisation and Blockchain
c) Network transformation and migration from legacy telecommunication networks to packet-based networks, and new technologies (5G)

The SC D2 Strategic Plan is as follows:

a) Develop joint work with other Study Committees
b) Fulfil the needs of its Target Groups (SC members, Grid market participants, Cigre Internal)
c) Balanced coverage between the topics of Information Systems and Telecommunication
d) Draw the interest of its Target Groups for the work done in the SC D2
e) Develop reciprocal exchange with other international bodies with similar scope (e.g. IEC) to strengthen links and avoid duplication of work.

The Virtual Centennial Session 2021 was held between 18 and 27 August 2021, and saw 58 papers from 27 countries with 4 papers from D2 Australia.

The D2 Panel meeting was held online via web conferencing this year on 29 and 30 July 2020 with 25 attendees.

3. Virtual Centennial Session 2021, Online (18 – 27 August 2021)

Preferential subjects (PS) were as follows:

a) THE IMPACT OF EMERGING INFORMATION AND COMMUNICATION TECHNOLOGIES ON ELECTRIC POWER UTILITIES
   i. The potential of Machine Learning and Artificial Intelligence in improving operations.
   ii. Enhancing asset and lifecycle management using the Internet of Things, Big Data, and Analytics.
   iii. The role of Blockchain in facilitating efficiency of market operations.
b) NEW CYBERSECURITY CHALLENGES IN THE CHANGING ELECTRICITY INDUSTRY
   i. Cybersecurity challenges in the use of the Internet of Things, Big Data, and Cloud-based platforms.
   ii. Cybersecurity challenges related to Distributed Energy Resources and interconnection of new flexibility providers.
   iii. Identification of cybersecurity threats using Big Data analysis and Machine Learning.
c) INCREASING OPERATIONAL EFFICIENCY USING PACKET SWITCHED COMMUNICATION TECHNOLOGIES
   i. Challenges in the migration to packet switched networks.
   ii. Supporting the changing electricity industry with the use of existing and new communication technologies.
   iii. Supporting time critical operational services with time distribution and synchronisation.

During the two Days of the D2 Group Discussion Meeting, the highlights were as follows:

a) 31 contributions presented for PS1-PS3
b) 3 NGN Showcases presentations
c) 5 Working Group Technical presenters
d) 4 Keynote speeches by Mr K.V.S. Baba, CMD, POSOCO; Mr Yuri G. Rassega, CISO, Enel Group; Mr Iony Patriota de Siqueira, DSc., CIGRE Honorary Member and Former Chair of SC B5; Mr Kenneth C. Budka, Sr. Partner, Nokia Bell Labs

4. Publications

The following were the publications by SC D2 in 2021:

1. Publications of articles in Future Connection Newsletter:
   a. “Augmented & Virtual reality & XR, Future of Electric power utilities O&M” by Siamak Khalaj WG D2.49 Convener
   b. “Technology and applications of industrial internet of things in power industry” by Zhengyun Sun (WG D2.53 Convener), Kunlun Gao (WG D2.52 Convener), Haiwang Zhong and Qiaoyin Yang (Leader for SC D2 in JWG B5/D2.67)
2. 1 TB published: TB 840 “Electric Power Utilities' Cybersecurity for Contingency Operations”

5. New Working Groups

Two new working groups were launched in 2021:

1. D2.54 “Regulatory approaches to enhance EPU’s cybersecurity frameworks”
2. D2.55 “Application of 5G Technology to Smart Grids”

6. Working Group Status

The summary of working group status is shown in Figure 1.

WG	Title	Convenor	Supervising AG	SC D2 TD	2020		2021		2022		2023	
					S1	S2	S1	S2	S1	S2	S1	S2
WG D2.43	Enabling Software Defined Networking for EPU telecom applications	V. TAN (AU)	AGD2.03	TD1								
WG D2.44	Usage of public or private wireless communication infrastructures for monitoring and maintenance of grid assets and facilities	P. MULVEY (IE)	AGD2.03	TD2								
WG D2.45	Impact of governance regulations and constraints on EPU sensitive data distribution and location of data storage	H. KLIMA (AT)	AGD2.01	TD3								
JWG B5/D2.67	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods	QIAOYIN YANG (CN)	AGD2.03	TD1								
JWG D2/C6.47	Advanced consumer side energy resource management systems	A.A. NEBERA (RU)	AGD2.01	TD2								
JWG D2/C2.48	Enhanced information and data exchange to enable future transmission and distribution interoperability	G. TAYLOR (GB)	AGD2.01	TD2								
JWG B2/D2.72	Condition Monitoring and Remote Sensing of Overhead Lines	Y. CHEN (CN) A. KULKARNI (GB)	AGD2.01	TD3								
WG D2.49	Augmented reality to support EPUs operation and maintenance	S.H. KHALAJ (IR)	AGD2.01	TD3								
WG D2.50	Electric power utilities' cybersecurity for contingency operations	D.K. HOLSTEIN (US)	AGD2.02	TD4								
WG D2.51	Implementation of Security Operations Centers (SOC) in Electric Power Industry as Part of Situational Awareness System	V. KARANTAEV (RU)	AGD2.02	TD4								
WG D2.52	AI Application and Technology on Power Industry	KUN LUN GAO (CN)	AGD2.01	TD2								
WG D2.53	Technology and Applications of Internet of Things in Power Systems	ZHENGYUN SUN (CN)	AGD2.01	TD2								

Figure 1 - SC D2 working group status

7. Activities of the Australian Panel

In 2021, the Roundtable Update format was introduced. The purpose of such a meeting outside of our annual regular panel meeting is to provide an opportunity for all panel members to have a focused coverage on a particular topic, through a short 1-2 hour online meeting format.

The following were the Roundtable Update sessions held in 2021:

1. 30 March: Roundtable Update on Teleprotection over Packet Networks
    a. 31 participants
    b. Presentations:
        i. Teleprotection over IP/MPLS in a 132 kV, 3-terminal configuration (15 minutes) – James Cole, Evoenergy
        ii. Challenges in Deploying Teleprotection over IP/MPLS in a Bandwidth-Constrained Network (sub-10Mbps DSL) (15 minutes) – Aruna Yahampath, Endeavour Energy.
        iii. Experiences in Production Deployment of Teleprotection over IP/MPLS in a Distribution Network (15 minutes) – Peter Faccin, SA Power Networks
    c. Panel discussions

2. 15 June: Roundtable Update on Utility Cybersecurity
    a. 26 participants
    b. Presentations:
        i. An Approach in Adopting Cybersecurity Frameworks and Standards for an OT Environment and a Recent Experience in Implementing an Industrial Cybersecurity Control - Ahmad Taufiq, Origin Energy (20 minutes)
        ii. Application of Cybersecurity Framework and Standards in the OT Environment and the Development of an In-House SOC for a Distribution Power Utility - Lindbergh Caldeira & Louise Watts, SA Power Networks (20 minutes)
    c. Panel discussions

The Australia D2 Panel meeting was held online via web conferencing this year on 28 and 29 July 2021 due to COVID-19 travel restrictions. We had 37 participants and 20 presentations.

8. Membership of the Australian Panel

Name	Organisation	**Type** **V**endor **T**x Utility **D**x Utility **G**x Utility **C**onsultant **A**cademic
Aaron Gates	Western Power	T
Adam Hoare	Transgrid	T
Ahmad Taufiq	Origin Energy	G
Andy Hemming	Transpower	T
Aruna Yahampath	Endeavour Energy	D
Chris Yuen	Horizon Power	D
David Conway	Powercor	D
David Paramandan	CommTel	V
David Taddeo	GHD Pty Ltd	V
James Cole	ActewAGL	T, D
John Grace	Genesis Energy	D
Josh Cunningham	TasNetworks	T
Mark Mullins	Tesla Consultants	C
Mark Remmer	Powerlink	T
Paul McKeen	Energex	D
Rohan Fernandez	ElectraNet	T
Ross Gaspard	PSC New Zealand	C
Sumith Withanage	Power and Water Corporation	T, D
Thoai Ton	Ausnet	T
Tony Myatt	SA Power Networks	D
Victor Tan	VTan Consulting	C
Warwick Glendenning	Wellington Electricity	D

Convener: **Victor Tan**

Email: victor@vtanconsulting.com

Phone: **08 7079 0301**

Working Group A2.58 - Installation, Pre-commissioning and Trial Operation

1. Working Group Scope

The Working Group will prepare a guide that covers the full scope of activities in the installation, testing, functional checking and pre-commissioning of transformers and reactors (ready for handing over to others for final switchyard commissioning – an important distinction). The guide provides a methodology for all stakeholders - asset managers, specification writers, installation practitioners, project managers and technical experts. That methodology must define adequately, yet comprehensively, the important stages, tasks, deliverables, risks and competencies for these site activities. Ultimately, the goal is to assist all stakeholders realize consensus on required expectations.

The guide will also cover activities and practices for the period of trial operation – which effectively coincides with the warranty period.

Link to Terms of Reference
https://www.cigre.org/userfiles/files/News/2018/TOR_WG_A2_58_Installation_and_Pre_Commissioning_of_Transformers_and_Shunt_Reactors.pdf

2. Working Group Activities

2017

1st Meeting 6-7 April Sydney hosted by GE

2nd Meeting 30-31 August Nuremberg, Germany hosted by Siemens

2018

3rd Meeting 26-27 February Klaus, Austria hosted by Omicron

4th Meeting 25-26 August before the Paris Session

2019

5th Meeting 12-13 April Boston, USA hosted by Doble

6th Meeting 17-18 September Hamilton, Scotland hosted by Polaris Diagnostics

7th Meeting 20 November Delhi during the A2/B2/D1 Colloquium

2020

8th Meeting 4-5 February Prague, Czech Republic hosted by CEPS (transmission utility)

A series of 2h teleconferences then commenced due to COVID and having to cancel the 9th face to face meeting.

5 May, 27 May, 9 June, 24 June, 8 July, 22 July, 9 September, 7 October, 4 November, 9 December

2021

A series of teleconferences continued through 2021 due to COVID.

13 January, 14 January, 10 February, 11 February, 7 July, 28 July, 21 October, 3 November, 17 November, 1 December

The TB is developing very well as a much-needed guideline to inform all stakeholders when procuring new transformers or reactors. This work is also being incorporated into a SC A2 Green Book on Transformer Procurement.

3. Working Group Program

It is planned at this stage that a draft Technical Brochure document, ready for comment, will be completed in Q1 or Q2 2022 for the SC Chair to review. The TB document can then be finalized, along with a tutorial and Electra article for the 2022 Study Committee meeting in August 2022.

No.	Milestone	Planned	Status	Completed Date	Deliverables
1	Scope finalized and submitted	08 2016	√	08 2016	TOR
2	TOR Accepted and call for members	02 2017	√	02 2017	List of members
3	TB structure defined, TF leaders identified	08 2017	√	08 2017	Table of content
4	Literature review	06 2020	95%		Bibliography
5	Preparation of the TB chapters	06 2020	100%	07 2021	1st draft
6	Review of the draft by WG	12 2020	30%		Final draft
7	Preparation of the tutorial	12 2020	0%		Tutorial ppt
8	Preparation of the Electra article	12 2020	0%		Article
9	Review of the final draft by SC A2	08 2020	0%		Publication of TB

Progress summary of the draft TB

Chapter	Title	Progress Complete (%)
1	Site Preparations	95
2	Site Assembly	95
3	Pre-commissioning	95
4	Trial Operation	90
Appendix A	Definitions and Abbreviations	0
Appendix B	References and Links	0
Appendix C	WG A2.58 Survey Results	95
Appendix D	IEEMA Flow Chart for Erection of Power Transformer	100
Appendix F	Example Documentation of Transformer Installations	0
Appendix G	Alternative insulation liquids	95

Date and place of the next meeting(s)

Meetings	Date	Location / Virtual meeting	Access provided for online (y/n)	Attendance (% WG)
Meeting 1	14 Dec 2021	Virtual (teleconferencing only)	y	100 % WG but unpredictable!
Meeting 2	16 Dec 2021	Virtual	y	100
Meeting 3	Q1 2022	Several Virtual and final F2F	y	100

Convener: **Ross Willoughby**
Email: **willoughby.ross@icloud.com**
Phone: **0417 712 879**

Working Group B4.92 – STATCOMs at Distribution Voltages

1. Working Group Scope

The new Working Group has the following deliverables:

- Technical Brochure and Executive Summary in Electra
- Electra Report
- Future Connections
- Tutorial
- Webinar

The Working Group commenced in October 2020 and the aim is to produce the final report by December 2024.

2. Current Progress

The draft Technical Brochure is now 70 pages and going through final edit.

This WG B4.92 focuses on providing guidelines for the D-STATCOM grid integration and grid services capabilities based on and with reference to existing service experience.

The Technical Brochure will provide recommendations to the following:

- Topologies and architectures of STATCOM in distribution grids.
- Definition and control of STATCOM stages.
- Type and factory tests for acceptance of STATCOM in distribution grids.
- Guidance of application of connecting and operating STATCOM in AC at medium voltage level, and in radial and meshed configurations.
- Service provision for distribution grids.
- Economical assessment and business cases including a comparison with:
- Tapping at the substation
- Voltage Regulators
- Switched cap banks
- Voltage regulation distribution transformers.
- Summary of impact on distribution networks.
- Maintenance requirements.

The Working Group has 19 members.

3. Meetings

A kick-off meeting was held on 19th February, 2021. A 2nd meeting occurred on Friday 29th October, 2021. The 3rd meeting is planned for March, 2022.

Convener: John Wright-Smith

Email: john.t.wright-smith@bigpond.com

Phone: 0488 200 458

Study Committee D1

WG D1.60 2021 SUMMARY REPORT – November 2021

WG Nr: D1.60	**Year:** 2021	**Convener:**	Yi Li (AU)
Approved: 26/9/2014		**Secretary:**	Jari Hallstrom (FI)

Title of the Group: Traceable measurement techniques for very fast transients

Number of Members: 20	**Number of meetings:** 6
Number of countries represented: 10	**Date of last meeting:** 29 Oct 2021

Scope :

1. Identify parameters for performance evaluations (calibrations) that are relevant to requirements of present IEC standards and other industrial applications and identify common uncertainty components and their magnitudes.
2. Literature survey of fast transient measurement techniques, not limited to, but relevant to high-voltage field, including hardware (dividers, probes) and digital algorithms.
3. Coordinate development of suitable hardware and software for traceable measurement.
4. Round-robin test of reference measurement systems (e.g., 100 kV, rise time 10 ns)

Deliverables: Report of a round robin test, and a Technical Brochure with summary in Electra

CIGRE WG D1.60 Membership

NAME	GIVEN NAME	STATUS	Gender	Country name
Li	Yi	Convenor	M	Australia
Hällström	Jari	Secretary	M	Finland
Diaz	Richardo	Full Member	M	Argentina
Márcio	Thelio	Full Member	M	Brazil
Orsino	Filho	Full Member	M	Bazil
Patrícia	Oliveira	Corresponding member	F	Brazil
Shao	Haiming	Full Member	M	China
Li	Zhibing	Full Member	M	China
Ma	Guoming	Young Member	M	China
Klüss	Joni	Full Member	M	United States
Johann	Meisner	Full Member	M	Germany
Wakimoto	Takayuki	Full Member	M	Japan
Okabe	Shigemitsu	Full Member	M	Japan
Sato	Masayuki	Full Member	M	Japan
Lee	Kang Won	Full Member	M	Korea
Valero	Alvaro	Full Member	M	Spain
Fernando	Garnacho	Full Member	M	Spain
Elg	Alf-Peter	Full Member	M	Sweden
Larzelere	Bill	Full Member	M	United States

Recent Activities

1. Members have completed more allocated writing tasks for the D1.60 technical brochure “Traceable measurement techniques for very fast transients” over the last year.
2. Further progress has been made in drafting the technical brochure, with versions 7 issued in Feb 2021, version 8 in September 2021 and a new version being prepared incorporating member contributions since then.
3. A working group meeting was held on 29 Oct 2021, discussing the recent work carried out by members and revision of the draft technical brochure. The meeting decided to restructure the chapters to make the document more reader friendly. Further allocation of editing tasks were made. The next draft version will be sent to members by the convenor in December 2021. Another WG meeting was planned for the 1st quarter of 2022.

Working Group Report 2021
Working Group D2.43
Enabling Software-Defined Networking (SDN) for EPUs

1. Working Group Scope

The purpose of this Technical Brochure which is an output of the CIGRE Working Group D2.43 – Enabling Software-Defined Networking (SDN) for EPUs is as follows:

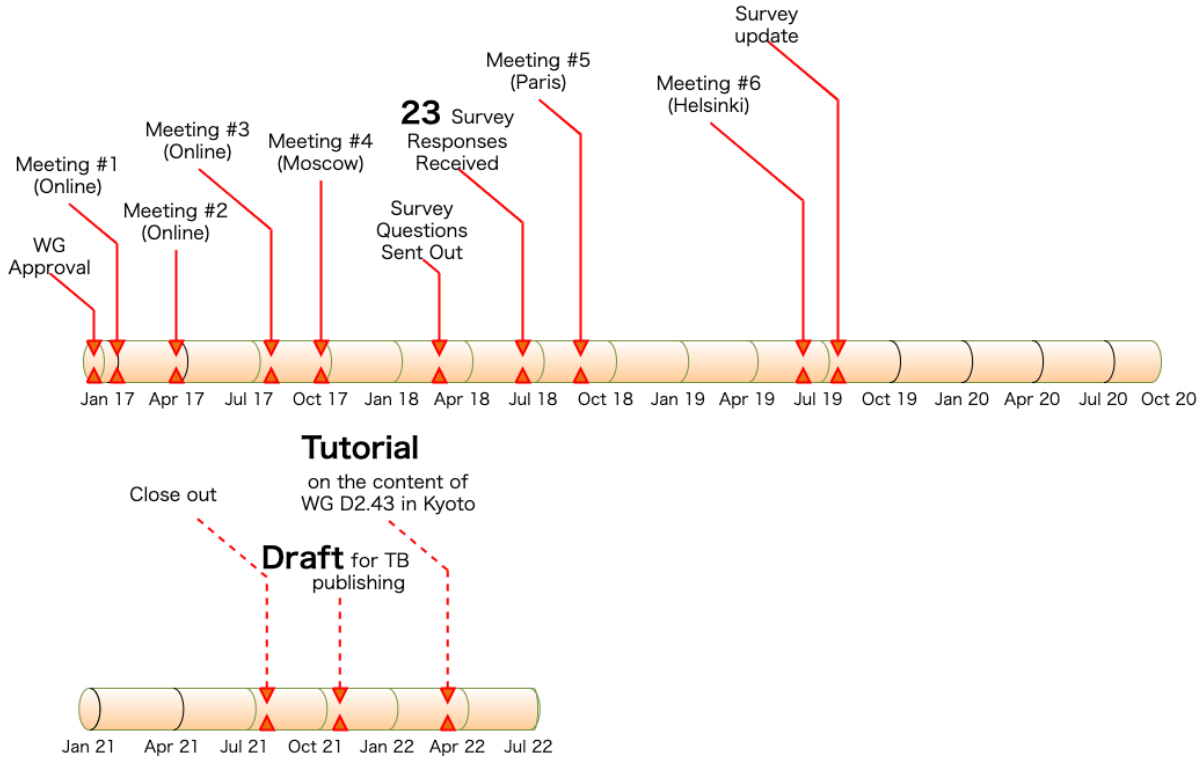
a) Provide a technology background on SDN and Network Function Virtualisation (NFV) with emphasis on EPU applications
b) Provide an analysis of the current strategy, plans and production or trial implementations adopted by EPUs based on the analysis of a survey carried out on EPUs worldwide
c) Develop SDN and NFV use cases and architectures suitable for EPUs
d) Provide recommendations on strategic considerations when considering SDN and NFV in EPUs
e) Provide a case study on the use of SDN and NFV in an EPU

2. Commentary on Progress

There is difficulty in low participation rate among members in recent Helsinki meeting and in KMS.

Current plan is to seek contribution from a few targeted core members.

A new survey has been issued which we hope to get good responses.



3. Requests for SC Input / Assistance

None.

4. Progress Summary

The working group's original completion in 2020 will be delayed to 2021.

The following tables show the current progress:

Chapter	Title	Progress
1	Introduction (Subchapters: Technology evolution, Overview, SDN/NDV Bulding Blocks, Current Market Landscape, Standards and Related work)	
2	Survey Results and Analysis	
3	EPU Use Cases and Architectures (Subchapters: Substation Virtualisation, Multi-service Network, Microgrid and DER, Security with Micro-segmentation, Resiliency and DR, Cloud Services integration, IEC61850 SDN Controller and Switch Applications)	
4	Recommendations on Strategic Issues in Implementing SDN/NFV (Subchapters: Critical Success and Risk Factors, Interoperability and Integration, Impact on EPUs Operational Model)	
5	Case studies	
Appendix A	Definitions and Abbreviations	
Appendix B	References and Links	

5. Working Group Program

Milestone	Planned	Actual Date
Initial Approval from Technical Committee		2016-12-13
Draft TB for SC review	AUG 2020	
Electra Article	Feb 2021	
Final draft	Mar 2021	
Technical Brochure published	Apr 2021	
Tutorial Presentation	TBD	

Meetings	Location	Date	Attendees
1	Teleconferencing	2017-01-12	14
2	Teleconferencing	2017-03-28	11
3	Teleconferencing	2017-07-28	7
4	Teleconferencing	2017-09-18	3
5	Paris	2018-08-25	6
6	Helsinki	2019-16-10	1

6. Members

The member list will need to be tidied up upon confirmation of membership.

Names	Country Code	Type **V**endor **T**x Utility **D**x Utility **C**onsultant **A**cademic	Role	Activity **H**igh **M**edium **L**ow **N**on
Ashley Jacobs	ZA	V	Corresponding	N
Carlos Di Palma	AR	D	Corresponding	N
Carolina Villasanti	PY	D	Corresponding	L
Dennis K. Holstein	US	C	Regular	M
Gary Stuebing	US	V	Corresponding	L
Greg Helps	AU	T	Corresponding	M
Hiroki Doi	JP	A	Regular	H
Jaume Darne	ES	C	Corresponding	L
Joel Mataboge	ZA	T	Corresponding	L
Keng LI	CN	V	Corresponding	L
Kgomotso Setlhapelo	ZA	T	Corresponding	M
Kun LIU	CN	V	Corresponding	N
Louise Watts	AU	D	Corresponding	M
Maik Seewald	DE	V	Corresponding	M
Marcelo Costa De Araujo	BR	T	Regular	M
Ouali Aggar	FR	T	Corresponding	L
Peng ZHANG	US	A	Corresponding	L
Qiaoyin Yang	US	V	Regular	M
Santiago Grijalva	US	A	Corresponding	N
Stanko Kacar	CA	V	Regular	L
Tim Godfrey	US	A	Corresponding	M
Tom Pederson	NO	T	Corresponding	N
Victor Tan	AU	C	Convenor	H
Vladimir Karantaev	RU	C	Corresponding	L
Xu Han	ZA	V	Corresponding	N
Yuquan ZOU	CN	V	Corresponding	N
Zhu JIANG	CN	A	Corresponding	L

Zwelandile Mbebe	ZA	T	Regular	H

Convener: **Victor Tan**
Email: **victor@vtanconsulting.com**