

Australian Technical Committee of CIGRE 2023 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 2023.



Australian National Committee ATC Report 2023

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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 Chairperson. The Chairperson 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. Currently there are two panels with panel membership exceeding 40 members and the smallest panel has 10 members. It is pleasing to note that the number of panel membership has continued to increase across 2023.

The ATC structure, including the linkage to the Australian Panels is illustrated in the organisation chart shown below. Key features of this organisational alignment are as follows:

- The ATC structure mirrors the international structure of CIGRE.
- The convener of each Australian Panel is also the ANC representative on the international Study Committee.
- Each Australian Panel is made up of individual members and representatives of collective members of CIGRÉ.
- Each Australian Panel convener is also represented on the Australian Technical Committee to coordinate the technical activities in Australia and NZ.
- This structure directly informs the ANC members of the work of CIGRÉ and provides a structure that
 effectively influences the international work of CIGRÉ to address issues of most concern to our
 region.





Throughout the 2023 year, the majority of ATC panel meetings were being run as a face-to-face event with eleven of the sixteen panels meeting at the Cairns Symposium.

To ensure regular communication across the ATC convenor members, quarterly meetings were being held to maintain contact and share knowledge regarding the planning for the 2023 Cairns Symposium and preplanning for the Paris 2024 session and the ATC Annual Presentation Day.

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 2023, six new Panel Conveners were appointed and will be taking over as the new 2023 incoming Convenors as follows:

Panel Number	2023 ATC Current Convenor	NEW 2023 ATC Incoming Convenor
A1	Tri Tran	Len Gunn
B1	Russell Wheatland	Rob Bradley
B3	Crina Costan	Andreas Laubi
B5	Peter Bishop	Rob Coggan
C2	Greg Hesse	Tjaart Van Der Walt
C6	Ray Brown	Jennifer Gannon



It is acknowledged that 'outgoing' convenors have all completed an outstanding 6-year term and have provided outstanding leadership in ensuring the work of CIGRE continues to grow and bring relevance to the Australian local industry.

CIGRE Australia enjoys excellent access to the international technical activities of CIGRE through both Alex Cruickshank's role as the SC C5 Chairman and Victor Tan in the role of SC D2 as members of the CIGRE Technical Council. CIGRE Australia is currently enjoying an extended period of influence over the technical direction of CIGRE.

Australian Panels

Throughout the 2023 year, the ATC panel meetings were held on a regular basis with the annual meeting in the majority of cases being run as a face-to-face event. These meetings form an important communication forum for Panel members. The 2023 annual panel meetings were held as follows:

2023 Annual Meeting Date

Panel			
No.	DATE	Location	F2F or online
		Bayswater Power	
A1	18th October 2023	Station, NSW	F2F
A2	Sep-23	Online	Online
A3	4-7th Sept 2023	Cairns	F2F
B1	4-7th Sept 2023	Cairns	F2F
B2	Sep-23	Cairns - Ergon	F2F
B3	4-7th Sept 2023	Cairns	F2F
B4	Sep-23	QLD - Powerlink	F2F
B5	4-7th Sept 2023	Cairns	F2F
C1	4-7th Sept 2023	Cairns	F2F
C2	4-7th Sept 2023	Cairns	F2F
C3	1-2nd November 2023	Brisbane	F2F
C4	4-7th Sept 2023	Cairns	F2F
C5	4-7th Sept 2023	Cairns	F2F
C6	4-7th Sept 2023	Cairns	F2F
D1	4-7th Sept 2023	Cairns	F2F
D2	4-7th Sept 2023	Cairns	F2F

In addition, a number of Australian Panels have provided a number of seminars, tutorials and webinars across 2023. This year has seen a large number of tutorials been delivered as a result and success of the Cairns Symposium. Tutorials and webinars held are as follows:

WEBINAR TUTORIALS 2023

	Title Of Tutorial Presentation	No.	Held at
A2	Digital Twin	1	
A3	Measurement of Harmonics and Impact of High Frequency Transients on Instrument Transformers	1	Cairns Symposium
B1	Fault Location on land and submarine links (AC and DC)	1	Cairns Symposium
B3	Knowledge Transfer of Substation Engineering and Experiences Air Insulated Substation Design for Severe Climate	2	Cairns Symposium



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B5	Applying synchrophasor technology for protection of the power system'	1	Cairns Symposium
C1	The Role of Green Hydrogen in Energy Transition	1	Cairns Symposium
C2	 Presentation of results from survey on the impact of the growing use of ML/AI in the operation and control of power networks (WG C2.42) – Webinar – June 2023 Mitigating the Risk of Fire Starts and Consequences of Fires Near Overhead Lines for System Operations (WG C2.24) – Power System Restoration Accounting for a Rapidly Changing Power System and Generation Mix (WG C2.26) 	3	Cairns Symposium
C4	 Guidelines for sub-synchronous oscillation studies – A summary of TB 909 Modelling and analysis of power networks with high percentage of inverter resources 	2	
C5	Hydrogen certification	1	Cairns Symposium
D1	UHF Partial Discharge Detection System for GIS: Application Guide for Sensitivity Verification	1	Cairns Symposium
D2	 Time in Communications Networks, Protection and Control Applications Enabling Tele-protection over Packet Based Switched Networks 	2	Cairns Symposium
	TOTAL	16	

Furthermore, membership of Australian Panels across 2023 has shown steady growth. Sector representation is shown in the following figure. The distribution of panel members across different industry segments has not varied significantly between 2021, 2022 and 2023.

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.

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 2023 ATC report.

Each Panel Convener also delivered a presentation at the ATC Technical presentation day held 27th November 2023. The face-to-face meeting was hosted by CIGRE Australia and Ausgrid at the AusGrid Offices located at Level 15, 24-28 Campbell St Haymarket. The recorded presentations are available via the CIGRE Australia YouTube Channel.



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Above chart: Membership chart of Australian Panels across 2023 showing sector representation



Above chart : Number of members (Individual and Collectove) per panel 2023



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 2023 a total of 28 technical brochures were published. All of those brochures are available for CIGRE Australia members via the e-cigre (https://e-cigre.org/).

Australian Panel convenors and members historically are active members on working groups and on average Australian members have participated in over 50% of active working groups on an annual basis. Further details are provided in the annual reports prepared by each Australian Panel Convener regarding the involvement of panel members in international working groups.

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.

Some of the conveners listed in the following table have prepared a report on the key outcomes from their working group during 2023. 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.

A list of the 2023 Technical Brochures published and the Australian member participation on these working groups is provided in table as follows:

	No. of WG where ANC member participated in 2023	Technical Brochure Name published in 2023	WG
A1	4	Survey on industry practices and effects associated with the cutting out of stator coils in hydro generators	A1
A2	12	 High-Frequency Transformer and Reactor Models for Network Studies - Part A - E 	A2/C4
A3	7	Guidelines for SF6 end-of-life treatment of T&D equipment (>1 kV) in substations	A3/B3
B1	24	 Condition evaluation and lifetime strategy of HV cable systems Losses in Armoured Three Core Power Cables Recommendations for the use and testing of Fibre Optic Cables used in Land Cable Systems 	B1 B1 B1
B2	5	 Correct handling of fittings and conductors for overhead lines Sustainability of overhead line conductors and fittings – Conductor condition assessment and life extension Volume 1: State of the art 	B2 B2



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В3	8	 Guidelines for SF6 end-of-life treatment of T&D equipment (>1 kV) in substations Mobile Substations Incorporating HV GIS Knowledge transfer of substation engineering and experiences Impact on Engineering and Lifetime Management of Outdoor HV GIS 	A3/B3 B3 B3 B3
В4	28	Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems	B4/C4
В5	19	 Protection for developing network with limited fault current capability of generation Protection, Automation and Control Architectures with Functionality Independent of Hardware 	B5 B5
C1	7	Business requirements for asset performance management	C1
C2	6	 Wide Area Monitoring Protection and Control Systems – Decision Support for System Operators Power system restoration accounting for a rapidly changing power system and generation mix 	C2 C2
C3	1		
C4	16	 Evaluation of Temporary Over-voltages in Power Systems due to Low Order Harmonic Resonances Guidelines for sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems High-Frequency Transformer and Reactor Models for Network Studies - Part A - E 	C4 B4/C4 A2/C4
C5	7	-Carbon Pricing in Wholesale Electricity Markets - Trading Electricity with Blockchain Systems	C5 C5
C6	24	Distributed Energy Resource Benchmark Models for Quasi-Static Time-Series Power Flow Simulations	C6
D1	3	 Basic principles and practical methods to measure the AC and DC resistance of conductors of power cables Atmospheric and altitude correction factors for air gaps and clean insulators 	D1 D1
D2	3	Impact of governance regulations and constraints on EPU sensitive data distribution and location of data storage	D2
Total Australian WG participation	174	Total Number of technical Brochures Published for 2023 (Note: JWG TB are counted as 1)	28



Study Committee Meetings in Australia

Cairns International Symposium 2023

In 2023 CIGRE Australia hosted the Cairns International Symposium at 2023 Cairns Convention Centre Cairns Australia - 4-7th September 2023. Key overview of event:

- Hosted by the C2 and C5 Study Committees
- Key Theme: The end-to-end electricity system: transition, development, operation and integration
- Eleven of the Sixteen global Study Committees supported and attended the Symposium
 - o A3 Transmission & Distribution Equipment
 - o B1 Insulated cables
 - o B3 Substations and electrical installations
 - o B5 Protection and automation
 - o C1 Power system development and economics
 - C2 Power system operation and control
 - o C4 Power system technical performance
 - C5 Electricity markets and regulation
 - o C6 Active distribution systems and distributed energy resources
 - D1 Materials and emerging test techniques
 - D2 Information systems and telecommunication

In addition, it was decided that both the SEAPAC (South East Asia Protection Automation Conference) and CIDER (Conference on the Integration of Distributed Energy Resources) were to be held at the same venue and during the same time.

The event was a major national and international success. The planning for this event commenced in circa 2017 where a case was put forward to the Australian board seeking support to host a Symposium Board. Approval was granted and planning activities commenced. It was originally anticipated we the two hosting study committees C2 and C5 that we target an audience of circa 300 and only hire out the part of the convention centre. As news of the proposed event was circulated the Symposium event grew rapidly with over 1300 registrations and the entire convention centre needed to be booked.

The Symposium opening ceremony was delivered by:

• Dr Sean McGoldrick – CIGRE Australia Chairperson

- with opening ceremony keynote speakers:
 - Mr David Shankey, Deputy Director-General of the Energy Division in the Department of Energy and Public Works, Queensland.
 - Topic: "Renewable Energy Transformation in Queensland"
 - Mr Adam Middleton, Vice President Western Europe, Siemens Energy
 - Topic: "Industrialisation of the Energy Transition" How do we make it happen?

In addition, CIGRE Australia also had an opportunity to host a successful Women in Energy Breakfast with keynote speaker:

 Ms Merryn York - Executive General Manager, System Design AEMO Topic:" Women in Energy – Supporting the transition".







Below are some statistics of the Cairns Symposium event:

- Over 1,300 attendees the conference was over-subscribed with about 1240 registrants for the whole 4 days and daily tickets between 40 and 100 per day.
 - 40% were international delegates
 - 30 countries were represented by the papers
- 11 Study Committees
 - o 240 paper presentations 986 authors, 243 published papers from 339 synopses.
 - 10 tutorials and two workshops
 - 51 meetings the TC, Study Committees, Strategic Advisory Groups and Working groups (across seven days from the Saturday before to the Friday after the Symposium)
- ConfTool proved a success again gathering synopses, papers and the presentations
 - o 184 reviewers
 - o 1,561 reviews entered into ConfTool
 - Papers and presentations were downloaded from ConfTool to the website.
- Proceedings to be published in November, including all papers and presentations
- Top papers from each SC to be published in CIGRE Science and Engineering Journal (CSE)
- The below graph shows papers by country of submitting author. As can be see Australia had 115 papers submitted and presented throughout the event.





The below table shows the numbers and percentage split of delegates by country with representation from 35 countries.

DELEGATES			
Country	Percentage Split	Numbers	
Aust/NZ	73%	1004	
USA /Canada/South America	6%	87	
UK & Europe	9%	100	
Asia	9%	129	
Other	2%	27	
TOTAL		1377	
% non-AUST/NZ	27%		

A special thank you to the Cairns Symposium Organising Committee as follows:

- Local Organising Committee Chair Phil Southwell
- Technical Committee Chair Alex Cruickshank
- Technical Tour Coordinator Andrew Halley
- Administrative and Business Support Terry Killen
- Sponsorship contact and Event Co-Ordinator Debbie Haddock
- AV and technical Brendan Watterson
- Graphic and Design Linda Gleeson
- Symposium Oversight and Audit subcommittee Chair David Bones with members: Jennifer Crisp, Les Brand, Angela Klepac
- Sponsor liaison and Project Management Terry Killen
- Women In Energy Breakfast Nicola Falcon, Natasha D'Silva, Jennifer Crisp, Tara-Lee Macarthur

CIGRE Paris Sessions

The Australian panel have also been active in preparing for the PARIS 2024 session. Thirty-six (36) synopses were submitted and reviewed with twenty-nine (29) synopses being accepted.

Paper authors have all been notified and are currently working to complete their papers which will be reviewed by the relevant panel convener before submission to the Paris Central office. Papers are due at the central office by 6th February 2024.



Seminars, Conferences and Training

In 2023, the following Seminars and Conferences were held.

CIDER 2023

Conference on the Integration of Distributed Energy Resources was held in Cairns as part of the 2023 Cairns International Symposium. See attachment 2 for the CIDER 2023 annual report.

SEAPAC 2023

South East Asia Protection Automation Conference was be held on 5th September 2023 as part of the 2023 Cairns International Symposium. See attachment 2 for the SEAPAC 2023 annual report.

Cairns International Symposium 2023

Details as above under Study Committee meetings held in Australia.

Thank You

On behalf of the ATC and CIGRE Australia, I thank those member organisations in Australia and New Zealand who have supported the CIGRE technical activities during 2023.

I thank the members of the ATC for their efforts and contributions. In particular I would like to make mention of the dedication and effort of each member in volunteering of their own time to make important contributions to the future of CIGRE Australia. As a result of your commitment the CIGRE Cairns Symposium was an extraordinary success which has also been recognised internationally in particularly by CIGRE PARIS office.

I would also extend my appreciation to the CIGRE Australia office for their support of the work of the ATC and Australian Panels.

Angela Klepac

CIGRE Australia Chair of the Australian Technical Committee

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November 2023



Attachment 1 – 2023 Members of the ATC

ATC Chair Person	Angela Klepac
ATC Secretary	Natasha D'Silva
A1 Rotating electrical machines	Tri Tran
A2 Power transformers and reactors	Matthew Gibson
A3 Transmission and distribution equipment	David Pita
B1 Insulated cables	Russell Wheatland
B2 Overhead lines	Asif Bhangor
B3 Substations and electrical installations	Crina-Miana 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	Brett Hayward
C4 Power system technical performance	Babak Badrzadeh
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	Louise Watts
SC C5 Chair Person	Alex Cruickshank
SC D2 Chair Person	Victor Tan
CIGRE Australia CEO	Peter McIntyre



Attachment 2 – Annual Reports by the ATC

Australian Panel Annual Report

CIGRE_Annual_Report_AU_A1_2023.pdf CIGRE_Annual_Report_AU_A2_2023.pdf CIGRE_Annual_Report_AU_A3_2023.pdf CIGRE_Annual_Report_AU_B1_2023.pdf CIGRE Annual Report AU B2 2023.pdf CIGRE_Annual_Report_AU_B3_2023.pdf CIGRE_Annual_Report_AU_B4_2023.pdf CIGRE Annual Report AU B5 2023.pdf CIGRE_Annual_Report_AU_C1_2023.pdf CIGRE_Annual_Report_AU_C2_2023.pdf CIGRE_Annual_Report_AU_C3_2023.pdf CIGRE Annual Report AU C4 2023.pdf CIGRE_Annual_Report_AU_C5_2023.pdf CIGRE_Annual_Report_AU_C6_2023.pdf CIGRE_Annual_Report_AU_D1_2023.pdf CIGRE_Annual_Report_AU_D2_2023.pdf

Reports on Events supported by ANC of CIGRE CIGRE_Event_Report_CIDER 2023 CIGRE_SEAPAC_Report_AU_B5_2023 Cairns Symposium covered in ATC Annual Report 2023

Reports on Working Groups supported by ANC of CIGRE CIGRE_Working_Group_Report_WG_B2.77_2023 CIGRE_Working_Group_Report_WG_B2_85_2023 CIGRE_Working_Group_Report_WG_B4_92_2023 CIGRE_Working_Group_Report_WG_C4-65_2023 CIGRE_Working_Group_Report_WG_D1.60_2023



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.

Major activity:

A1 Study Committee held a Colloquium and Tutorials from 11th to 15th September 2023. The colloquium was held at the Doshisha university, Kyoto Japan. It was hosted by the Cigre Japanese National committee. The Colloquium incorporated both face to face and on-line facilities. During the Colloquium, technical presentations and status reports were given by all working group convenors. Comprehensive update reports were presented by each of the active advisory group convenor. Three tutorials were also presented.

3. **Preferential Subjects**

Preferential subjects for the Colloquium in Kyoto – Japan on 11th to 15th September 2023 were:

PS 1: Changing Role of Electrical Machines in Power Generation

- Impact and effect of increasing renewable power mix on new and existing generators, generator auxiliaries and motors.
- Variable speed/pump storage and synchronous compensator design and performance for supporting power generation networks.
- Increasing focus on alternative power generation sources (wind, tidal, solar, small thermal/nuclear, geothermal, small hydro).

PS 2: Optimisation of Installed Assets

- Adaptation of maintenance regimes due to new operating regimes.
- Experience with refurbishment, replacement, conversions, power up-rating and efficiency improvement of generators.



• Developments in condition monitoring, diagnosis, prognosis to improve reliability and extend operational life of conventional plant, including data handling and digital modelling.

PS 3: New Developments and Operational Experience

- Evolution and trends in designs of rotating machines, materials, manufacture, maintenance, and performance improvements.
- Operational experience: Failures, root cause analysis, recovery options, cost, and time reduction initiatives.
- Developments in the use of variable or high-speed motors in power generation.

4. **Proposed New Working Groups**

New working groups were formed / approved in 2023 as following:

Working Group	Title	Convenor
A1.75 (AG 01)	Large air-cooled turbo-generator – state of the art, limits and perspectives for Small Modular Reactors	Vincent Fernagut
A1.76 (AG 01)	Study on Eco-Design, Circular economy and impacts on Generator production process	Raul Morales Garcia
A1.72 (AG 02)	Survey on Generator and Motor multi-turn coils with dedicated turn insulation versus coils without dedicated turn insulation.	Yoon Duk Seol
A1.73 (AG 02)	Customer Requirements for Qualification of Form Wound Stator Insulation Systems for Hydro Generators	Dr. Marcelo Jacob da Silva
TBA (AG 05)	Grid stability events driven by wind generation	ТВА
A1.74 (AG 06)	Evaluating quality of large electric motors used in power generation plant	ТВА
A1.77 (AG 06)	Survey on stator insulation reliability of motors	ТВА
AG 06 proposed New WG topics	 State of the art in new advanced motor technologies Guide on specification And selection of motors for various industry applications Guide on methods for detection of broken bars in Squirrel cage induction motors Guide on rotor faults detection in squirrel-cage induction motors Guide on specification And design of large synchronous compensators Guide on experience of implementation Of ie4 efficiency class Guide for specification/operation of motors in explosive environments Guide for special application motors: marine motors, water cooled motors, brake motors, motors for high ambient temperatures, traction motors. Motor performance under abnormal conditions 	TBA



	 11. Effect of different types of windings on efficiency, torque and harmonics of Induction motor 12. Guide on use of expert systems for determining the risk of failure in motors 	
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5. Specific Activities of the Australian Panel

- The AU A1 panel currently has 14 members and 3 expert guests. One member is the A1 study committee secretary.
- The panel has representatives from Utilities, Consultants, Service Providers and Testers from all states of Australia,
- Members participate four SC A1 working groups,
- Members share experience in the form of technical presentations at panel meetings and direct contacts in a wide range of relevant topics such as generator & motor failures, abnormal operations, major overhaul experience, new industry practice and technologies, condition monitoring, management of aged generators.
- Excellent technical networking and knowledge sharing of experience from their work through informal meeting and technical discussions.
- One technical paper was submitted for Paris 2024.

6. Meeting Report: Australian Panel

AU A1 organized a face-to-face meeting at Bayswater power station on 17th and 18th October 2023. The meeting was hosted by AGL Energy.

The following technical presentations were presented and discussed during the panel meeting:

- Mortlake G12 generator failure 2019 Incorporating Fibre Optic Arc Flash Detection into a Conventional Generator Protection Scheme.
- Poatina Power Station Hydro Generator Asset Management.
- Guide on Synchronous Condensers for System Inertia.
- Vales point power station Unit 6 Toshiba 660MW rotor refurbishment strategy.
- Generator uprating and inclusion of specialised condition monitoring equipment.
- Bayswater generator stator rewind (technical discussion).

A technical tour was conducted at Bayswater power station to view a 660MW generator stator complete rewind by the OEM, generator rotor refurbishment and two generator step up transformer high voltage bushing replacement.

The meeting had participation from members face to face and on-line.

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

There is no current invitation for future SC A1 meeting or working group meeting 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	Peter Wiehe
	Value of Hydro-generators	Aaron Vogel
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



WG	Title	Australian Member
A1-70	Dielectric Dissipation Factor Measurements on	Peter Wiehe
	Stator Windings.	Tri Tran

9. Membership of the Australian Panel

Name	Organisation	Туре
Tri Tran (Convenor)	AGL	Utility
Peter Wiehe (Guest)	Acutel Consulting	Consultant
Marc Ransome	Hydro Tasmania	Utility
Hossein Rahimpour	Ampcontrol ETM	Consultant
Damien VERMEER	Веса	NGN
Aaron Volgel	Snowy Hydro	Utility
Len Gunn	Origin Energy	Utility
Franco Rabines	CS Energy	Utility
Simon Nawrot	Sunset Power International	Utility
Viet Trinh	ElectraNet	Utility Transmission
Nicholas Buckley	Stanwell Corporation	Utility
Fabian Spescha	Total Energy	Consultant
Johan Strydom	Synergy	Utility
Ashok Ojha	Alinta	Utility
Ron Scollay	MachineMonitor	Consultant
Jeff Russell	Aurecon	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:

- Power **transformers**, including, industrial, DC converter, phase-shifting and distributed energy resource (DER) transformers
- Reactors, including shunt, series, saturated and smoothing;
- All transformer **components**, including **bushings**, **tap-changers**, and 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.



Goals of the Transformers Study Committee

- To monitor current trends in transformer technology;
- To facilitate the integration of transformers in power networks and in the environment;
- To maintain its leading position in the field of transformers by providing unbiased and neutral information on all essential transformer aspects;
- To be recognized by the industry as a leading and reliable partner with competence in all engineering issues related to power transformers
- To encourage more young experts to participate in the work of Study Committee A2
- To encourage the participation of experts from emerging market and developing countries in the activities of Study Committee A2

Major meetings:

A2 Study Committee held an online committee meeting / workshop day on 28th June 2023. During the meeting, technical presentations were given by the convenors of three working groups (A2.58, A2.60 & A2.62) which are nearing completion of their work. An update on the progress of Green Books was also given.

The workshop component was aimed at exploring new working group ideas and future topics for discussion and focus for SC A2.



The main in-person annual meeting for SC A2 will be held over two days in conjunction with a joint Colloquium in Split, Croatia from 28th Nov to 1st Dec.

3. **Preferential Subjects**

The preferential subjects for the 2023 joint Colloquium are:

PS 1: Digital twins

- Definition, reliability of models (physics-based, machine learning and hybrid models)
- Development of twin modules (e.g. thermal, dielectric, mechanical, etc.), case studies
- How to make twins of existing vs. new transformers
- Benefits and use cases from using digital twin
- Input data and data management, digitalization examples

PS 2: Trends in Transformer Maintenance

- Innovative work methods (tools, robots, drones, cameras and 3D-printing)
- New development in monitoring and diagnostics (online/offline)
- Case studies of condition-based, risk-based and predictive maintenance approaches
- Total Lifecycle Cost strategies, Mid-life refurbishment, Life extension alternatives, comparative financial analysis of different strategies

PS 3: Design performance in service

- Sound levels of transformers in service
- Influence of environmental aspects and loading on thermal aspects, loss and noise
- Experience with actual in-service short circuit and overvoltage stresses,
- Resilience to earthquakes, floods, extreme heat etc.
- Experience with different breathing systems
- Transformer design verification for very fast transients
- Model verification for harmonics and GIC

The preferential subjects for the 2024 Paris Session are:

PS 1: Design of Resilient Transformers

- Stresses from the environment: Impact of global warming, high temperatures heavy rain, high winds, offshore installations, etc.
- Stresses from the system: Switching impulses, reverse flow, emergency overloading, harmonics, GIC, short-circuits and internal arcing etc.
- Specifications: Design criteria, materials and testing requirements for new transformers. Suitable maintenance standard and refurbishment strategies.

PS 2: Advances in Transformer Analytics

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

PS 3: Reliability of Transformers for Renewable Energy

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



4. Proposed New Working Group and Green Books

There were 3 new Working Groups created in 2023, as shown below.

Working Group/Task Force	Title	Convenor
JWG A2/C3.70	Life Cycle Assessment (LCA) of Transformers	Myles Margot (DE)
JWG A2/D1.71	Modern Insulating Liquids Qualification for OLTC, Bushings and other accessories	Lars Liden (SE)
JWG A2/D1.71	Retro-fill of Mineral Oil in Transformers – Motivations, Considerations and Guidance	Roberto Asano (BR)

Work on a new Green Book on Transformer and Reactor Life Management has commenced. The primary aim is to consolidate A2 work on transformer life management over many years into a single handbook for engineers. It is planned for completion during 2025.

5. Specific Activities of the Australian Panel

Joint AU/NZ A2 Webtutes

The Australian and New Zealand A2 panels continued with a series of jointly held webtutes during the year.

18th August – Risk-based approaches to distribution transformer replacement

Many utilities run distribution transformers to failure as this is seen a lower lifecycle cost than early replacement. However, in the wake of the storms in NZ and significant damage across the country, some networks are asking if they can be more proactive and focus on minimising disruption. This was a difficult question because many transformers fail in storms due to impact, lightning surges or clashing conductors. The speakers, **Russell Watson, David Shephard and Dan Martin**, gave their expert perspectives on this matter. There were fifty-eight attendees showing a high level of interest.

6. Meeting Report: Australian Panel

The AU A2 panel held an online meeting and a technical discussion day during 2023.

The online meeting was held on 18th August and covered an update of international SC & WG activities, discussion on future webtute topics, 2024 transformer workshop and preferential subjects for the 2023 A2 Colloquium and 2024 Paris Session.

The technical discussion day was a joint meeting with NZ A2 and held in conjunction with the Cairns International Symposium on 8th September. The presentations and discussion focussed on the following areas:

- Geomagnetically Induced Currents and transformers Prof. Andrew Lapthorn
- Esters and semi-hybrid transformers Dr Bhaba Das
- High frequency switching transients & harmonic impacts on data centre transformers Jimmy Kuang
- Aust/NZ framework for quantifying risk/cost-benefit & NPV for mid-life refurbishment Matt Ridgley



• ESG, environmental footprint & life-cycle analysis in relation to the proposed WG A2/C3.70

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 table lists all the current AU CIGRE members on Working Groups.

WG/JWG	Working Group	Expected Finish	AU/NZ Members
A2.54	Audible Sound Requirements	Q2 2023	
A2.56	Transformer Efficiency	Q2 2023	
A2.57	Effects of DC Bias on Power Transformers	Q3 2023	
A2.58	Site Installation and Pre-commissioning of Power Transformers and Shunt Reactors	Q3 2023	Ross Willoughby
			Gibson
A2.60	Dynamic Thermal Behaviour of Power Transformers	Q1 2024	Seamus Allan
A2.62	Analysis of Transformer Reliability	Q4 2023	Dan Martin
A2.63	Transformer Impulse Testing	Q4 2023	Arun Mathur
A2.64	Condition of Cellulose Insulation in Oil Immersed Transformers after Factory Acceptance Test	Q2 2023	Alan Vietch
A3/A2/A1/B1.44	Limitations in Operation of High Voltage Equipment Resulting of Frequent Temporary Overvoltages	Q2 2023	NEW
A2/D2.65	Transformer Digital Twin – Concept and Future Perspective	Q1 2025	NEW
A2/D1.66	Breathing Systems of Liquid Filled Transformers And Reactors	Q1 2025	Robert Li
A2/D1.67	Guidelines for DGA Monitoring	Q1 2025	Tara-lee MacArthur
A2.68	Failure Survey of Lower Voltage Generator Step Up Transformers Installed in Wind Farms and PV Parks	Q1 2025	Dan Martin
A2.69	Guide for Transformer Maintenance – Update	Q1 2025	Ross Willoughby
D1/A2.79	Understanding of Dynamic Behaviour of Winding Insulating Materials in Liquid Insulated Transformers	Q1 2026	NEW



9. Membership of the Australian Panel

Name	Organisation	Туре
Arne Petersen	AP Consulting	Consultant
Caolan Griffin	Powerlink Queensland (NGN)	NGN
Chandima Ekanayake	Transformer Innovation Centre	University
Dan Martin	Cigre NZ	Cigre
Deepak Maini	WIIson Transformer Co P/L	Manufacturer
Gianni Reginato	Stanwell	Generation
Jimmy Kuang	Jemena	Distribution
Kerry Williams	Kerry Williams (K-Bik Power)	Consultant
Kris Bryla	Origin Energy	Generation
Lagath Ganepola	Powerlink Queensland	Transmission
Mark Cotton	AusNet Services Group	Transmission
Matt Ridgley	Energy Queensland	Distribution
Matthew Gibson	Ausgrid	Distribution
Michael Jordanoff	Transpower New Zealand Ltd	Transmission
Neeraj Kant	ETEL	Manufacturer
Peter New	Snowy Hydro Limited	Generation
Peter Scoles	SA Power Networks	Distribution
Philippe Reboul	Molekulis	Supplier
Robert Li	TransGrid	Transmission
Ross Willoughby	Ross Willoughby	Consultant
Sam Mulquiney	Essential Energy	Distribution
Santosh Dhakal	Tasmanian Networks Pty Ltd	Transmission
Scott Corbett	Ampcontrol Group P/L	Manufacturer
Seamus Allan	Dynamic Ratings	Manufacturer
Shawn Nielsen	QUT (Gardens Point Campus)	University
Stjepan Perin	Hitachi-ABB Australia Pty Ltd	Manufacturer
Tapan Saha	University of Queensland	University
Tara-lee MacArthur	Energy Queensland	Distribution
Tim Farrell	Reinhausen Australia	Manufacturer
Tri Tran	AGL	Generation
Waleed Khan	ElectraNet Pty Ltd	Transmission
Walter Wasinger	Walter Wasinger (Wasinger Transformers P/L)	Consultant
Wenyu Guo	Omicron	Manufacturer
Vacant	Western Power	Transmission
Vacant	Endeavour Energy	Distribution



Membership changes:

Company	Previous member	New Member
Jemena		Jimmy Kuang
Molekulis		Philippe Reboul
Reinhausen Australia	Thomas Smolka	Tim Farrell
ElectraNet Pty Ltd	Marko Prokic	Waleed Khan
ETEL	Dan Martin	Neeraj Kant
Western Power	Carlos Gamez	

Convener: Matthew Gibson

Email: matthewg@ausgrid.com.au



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 that 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
- Focus on the environment and sustainability
- Network, 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:

2.1 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.
- WG A3.47 Lifetime Management of Medium Voltage Switchgear
- WG A3.48 4th CIGRE Reliability Survey on T& D Equipment
- JWG A3/A2/A1/B1.44 Consequences of HV equipment exceeding highest system voltages
- JWG B4/A3.86 Fault Current Limiting Technologies for DC Grids

2.2 Answer the environment concerns

- WG A3.41 Interrupting and switching performance with SF6 free switching equipment. The TB-871 published in October 2022.
- JWG B3/A3.59 Guidelines for SF6 end-of life treatment of T&D equipment (above 1kV) in Susbtations TB 914 published in October 2023.
- JWG B3/A3.60 User guide for non-SF6 gases and gas mixtures in Substations

2.3 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. It 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 prepared to add more chapters to the existing green book and update some of the existing chapters for example Lifetime Management, based of work by WG's A3.43 and A3.48.

The new chapters will include non-SF6 alternative options, surge arresters and DC equipment. The first draft is due December 2024.

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

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 2023.



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 2023.

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 respect 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 statistics 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.

WG A3.47 Lifetime Management of Medium Voltage Indoor Switchgear

The working group will deliver a technical brochure on lifetime management of indoor medium voltage switchgear. The brochure will take into consideration the environmental, safety, equipment reliability, equipment changes of use and logistical factors and recommend options for increasing in-service life of the switchgear. Options will include various factors such as retrofitting of components, replacement, and other measures such as work practices.

The final report is due in 2024.

WG A3.48 4th CIGRE Reliability Survey on Transmission and Distribution Equipment

The previous third CIGRE reliability survey on equipment such as circuit breakers, disconnecting switches, earthing switches, instrument transformers and gas insulated switchgear (GIS) was carried out in 2004-2007, and the results on these equipment were presented in CIGRE Technical Brochures 510, 511, 512, 513 and 514, respectively.

The scope of the fourth CIGRE reliability survey is expanded to cover generator circuit breakers, vacuum circuit breakers and MO surge arresters to provide field experience to related WGs. Due to a couple of new participations in the survey, the TF1 has already collected sufficient large number of the reliability data on the equipment and analysed them classified into different design categories. They show very interesting results including ageing assets serviced more than 40 years with considerable different tendency among the countries.

WG A3.49 Aging effects on accuracy class of Instrument Transformers

The working group will deliver a technical brochure on aging effects on the metrological performance of IT. The brochure will take into consideration the environmental conditions, degradation mechanisms of the components inside IT, electrical operation (either sinusoidal or distorted primary quantities).

The final report is due in 2025.

WG A3.50 On-site calibration and verification of the accuracy of instrument transformers

The working group would investigate and report on all aspects relevant to on-site calibration of instrument transformers, considering all the available technologies (inductive, capacitive, low-power, both passive and electronic), with particular, but not exclusive, reference to power frequency and power quality measurement applications, at frequencies at least up to the 50th harmonic.

The final report is due in 2025.



WG A3.51 Requirements for HV T&D Equipment operating under Abnormal Weather Conditions

The new WG shall investigate evolving and changing levels and frequency of non-standard environmental requirements that might affect T&D equipment performance with emphasis, but not restricted, to: earthquake above 8 in Richter scale, atmospheric discharges above normally expected values, extreme ambient temperatures, snow, and ice (beyond standard values), heavy rains, wind above standard values, including tornado, tsunami, flood, wildfires, sandstorm, etc.

The final report is due in 2026.

JWG B4/A3.86 Fault Current Limiting Technologies for DC Grids

The purpose of the proposed Joint Working Group is to start from the literature review and global survey of the available concepts and applications for fault current limiting devices. The WG will then assess and summarize the technologies and devices, identify the possible applications and technical requirements of DC FCL. Finally, the JWG will provide guidelines for users to select DC fault current limiting technologies and devices for their specific applications.

The final report is due in 2022.

JWG Consequence of High Voltage Equipment operating exceeding highest A3/A2/B1.44 system voltages

In transmission and distributions systems, the operating voltage can temporarily exceed the highest voltage for the equipment (Um).

This working group will investigate the influence of standard frequent TOV on the equipment, covered under B1, A1, A2 and A3 study committees (generators, power transformers, overhead lines, switching equipment, surge arrestors). This WG will not cover all TOVs that can arise in the power system such as harmonic resonances during transformer energization. This will be investigated under separate WG.

The final report is due in 2023.

JWG B3/A3.60 User guide for non-SF6 gases and gas mixtures in Substations

Recent developments show the growth in application of non-SF6 gases and gas-mixtures in medium voltage (MV) and high voltage (HV) switchgear for insulation and arc quenching. Recently presented alternative gases/ non-SF6 gases contain components of air (such as N2 or CO2) and can contain fluorinated compounds.

For users and manufacturers, different aspects are still uncertain. IEC 62271-4 and TB 802 (Application of non-SF6 gases or mixtures in MV and HV GIS) provides basic information, however, the practical user aspects need to be discussed in more detail. This WG will provide guidance for non-SF6 gas handling, mixing methods, tightness, and non-SF6 gas measurement and monitoring of gas leakage.

The final report is due in 2024.



JWG Guide to procedures for the creation of contamination maps required for outdoor insulation coordination

Contamination maps are essential to optimise the insulator design from the contamination point of view, thus increasing the system reliability and reducing the overall costs deriving from over or under design. The main objective of the JWG is to analyse and compare the experience in the different countries and approaches to give guidelines for the creation of contamination mapping for use in insulation co-ordination and to stress the advantages of the statistical approach for insulator design.

The final report is due in 2026.

3. Preferential Subjects

The A3 preferential subjects for 2024 Paris Session are:

- PS1 Energy Transition involving T&D Equipment
 - Innovative technologies to reduce total cost of ownership and to foster the energy transition
 - Novel applications and increased duty of equipment in DER
 - Improvement of grid resilience due to climate change: the impact of equipment requirements
- PS2 Lowering the carbon footprint of T&D Equipment
 - Performance & maturity of SF6 alternatives report on industry experience
 - Lifecycle assessment of T&D equipment
 - Life cycle management and life extension of the existing SF6 equipment.
- PS3 Maintaining and management of T&D equipment
 - Smart sensors, low power instrument transformers, monitoring and condition assessment
 - Digital Twin and equipment reliability modelling also covering new/higher load profiles
 - Big data management and data ownership

4. **Proposed New Working Groups**

The following new working groups were approved:

- WG A3.49 has been approved in December 2023 focused on Aging effects on accuracy class of Instrument Transformers. The Terms of Reference document was instigated and written by member of the IT A3 panel, Roberto Tinarelli.
- WG A3.50 has been approved in December 2023 focused to On-site calibration and verification of the accuracy of instrument transformers. The Terms of Reference document was instigated and written by member of the IT A3 panel, Paolo Mazza.
- WG A3.51 has been approved in December 2023 focused Requirements for HV T&D Equipment operating under Abnormal Weather Conditions. The Terms of Reference document was instigated and written by member of the IN A3 panel, Santosh Kumar Annadurai.
- JWG C4/A3/B2/B4.75 Guide to procedures for the creation of contamination maps required for outdoor insulation coordination The Terms of Reference document was instigated and written by member of the IT A3 panel, Massimo Marzinotto.

5. Specific Activities of the Australian Panel

Australian Panel A3 members have decided to continue focus on the following key areas in 2023-24 period:



- SF₆ gas mitigation strategy Investigate a key reasons for the SF6 leak Develop SF6 leak detection flow charts for different HV CB's, highlight HV equipment design which contributes to SF6 leaks - Develop SF6 management strategy to reduce gas leakage – Implementation action
- **Transition to SF6 free equipment technology** Investigate the SF6 alternatives market availability and evaluate processes, procedures and impediments to adoption of new technology. Share information from leading innovators and gain from learnings from early adopters of technology for mutual benefit. Trails of equipment with SF6 alternative gases.
- Asset management topics Lifecycle cost evaluations; equipment condition monitoring, condition based maintenance, risk based asset management of S/S equipment; end-of-life modelling for AER capital expenditure submissions.
- 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.
- Seminars or workshop held in July 2023 organised by A3 and B3 panel on Non SF6 Gas Switchgear Technology and Integration to Substations. The purpose of this seminar was:
 - To provide an update from the suppliers of the latest developments for 132 kV, 220 kV, 275 kV, 330 kV and 500 kV live tank and dead tank switchgear.
 - How is the European legislation approval 'finding its way' throughout the countries where the factories are located (non-European countries) (5 April 2023 - EU Parliament F Gas Discussion 8162/23 ENV357, CLIMA 189, CODEC 572)
 - What is the actual process implemented across the factories of replacing the SF6 gas with the new gas.
 - Any insights of new the legislation or guidance regarding non-SF6 gas bottles handling, identification and labelling, gas recycling, replenishing, disposal.
 - Whole of life analysis of zero carbon footprint for the manufacturing of the non SF6 gas
- Proposed Seminars or workshop in July 2024 Impact to for HV T&D Equipment operating under Abnormal Weather Conditions.

6. Meeting Report: Australian Panel

AU A3 Panel meeting was held on the 08^{th} September in Cairns (face-to-face and online) and additional 4 x hours on-line meeting was n 28^{th} September.

Panel meeting, members reported on significant activities and major challenges within their utilities. Common issues within utilities are listed below:

- Significant capital expenditure growth across all states.
- Significant amount of renewable projects including solar farms, wind turbines, hydro pump storage and batteries.
- Network system stability due to removable injection and requirement for voltage support by introducing synchronous generators, reactors, SVC, STATCOM's.
- Most of states in Australia are targeting to meet net zero by mid-2030. State of Queensland is targeting to organise the first Olympics game in 2032 with net zero.
- Major projects measured in multibillions including:
- QEJP (Queensland Electricity and Jobs Plan), currently focusing on Copperstring Project (1100 km line and network upgrade to 550kV)
 - 2 x Pumped Hydro Projects (2.5 GW and 5 GW)
- Victoria -NSW & QNI Upgrades
- Project EnergyConnect, HumeLink, Snowy Hydro 2.0, NSW
- Significant substation upgrades in transmission network in state of Victoria
- South Australia Government Hydrogen jobs planning project
- Human resource issues Significant increase in stuff and resource constraints. Many utilities going through international campaign via an international recruiter.



- Long lead equipment delivery Equipment delivery time has significantly increased due to post Covid and global increase of workload. Manufacturing capacity challenges resulting in long lead times (approx. 75 weeks or longer).
- Most of utilities are focusing on digital asset management to improve condition monitoring.
- Move towards online condition monitoring for critical primary plant –focus on transformers and CB's.
- Uptake of digital engineering incl. 3D mapping of substations to assist with project scoping/planning/etc.
- Currently looking into SF6 alternatives, however there is no regulation on "F" gases by the Australian government yet.
- Some of AU/NZ utilities (Transgrid, Ausgrid, Transpower) undergoing the trail projects with SF6 alternatives.
- Guest speakers on AU A3 panel meeting in Cairns were from the key manufacturers to provide us an update on SF6 alternative equipment development:

<u>Siemens</u>

- SF6 price increase by 300% in EU prior to COVID
- Currently >4200 orders for clean air units
- More than 2500 units delivered worldwide
- Siemens aiming to stop SF6 production by 2030
- Clean air + vacuum solution currently available up to 420kV
- 145kV 63kA DTCB available
- GIS & instrument transformers up to 420kV
- Live tank & dead tank CB's up to 145kV

GE Grid Solution

- Use of g3 gas (C4FN+CO2+CO)
- Live tank & dead tank CB's up to 145kV, 63kA available
- GIS 145kV available, up to 420kV soon to be released
- 50 sites, 500 bays currently installed with g3 products (EU, US & Korea)
- 245kV live tank with g3 planned to be completed by Q3 2024
- 245kV dead tank with g3 under development, aiming for 2025
- 362kV & 550kV options aiming for 2026

<u>Hitachi</u>

- Live tank up to 145kV available now
- Dead tank up to 420kV available now
- GIS up to 145kV available now
- 550kV availability planned for 2025
- Only retro-filled equipment currently in service, no new C4-FN equipment installed globally
- Discussion was made about SC-A3 activities including preferential subjects for next year Paris, papers submission, involvement in WGs and future event.
- Presentation were made on interesting topics including equipment failures, asset management issues, major projects development, equipment strategies etc. All presentations available on A3 KMS site.

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

WG A3.47 - Lifetime Management of Medium Voltage Indoor Switchgear, led by Australian convenor Ankur Maheshwari is planning WG meeting in 2024 and organise webinar – to be confirmed.



8. 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 Chadian
A3.47	Lifetime Management of Medium Voltage Switchgear	Ankur Maheshwari - Convenor
A3.48	4 th CIGRE Reliability Survey on T& D Equipment	Wayne Pepper
A3.49	Aging effects on accuracy class of Instrument Transformers	David Pita, Matt Burns

9. Membership of the Australian Panel

Name	Organisation	Туре
David Pita	Powerlink, QLD	Transmission
(Convenor)		
Wayne Pepper	Ausgrid, NSW	Distribution
Akila Ranatunga	AusNet Services, VIC	Transmission & Distribution
Julian Orozco Perez	Western Power	Transmission & Distribution
Ankur Maheshwari	AMCL	Consultant
Timothy Blair	Transgrid	Transmission & Distribution
Jose Lopez-Roldan	Energy Queensland, QLD	Distribution
David Roby	Hitachi-ABB, NSW	Vendor
Hitesh Parekh	Hitachi-ABB, NSW	Vendor
Melissa Taylor	TasNetworks, TAS	Transmission & Distribution
John Shann	Transpower, NZ	Transmission
Xiang Heng	GE Energy, NSW	Vendor
Songtao Gong	GE Energy, NSW	Vendor
Andrew Wilkinson	Electranet, SA	Transmission
Mark Garrett	Essential Energy, NSW	Distribution



Australian National Committee Panel Report 2023

Name	Organisation	Туре
Kerry Williams	K-Bik Power Pty Ltd, QLD	Consultant
Aaron Thompson	Essential Energy, NSW	Distribution
Brody Ward	Powerlink, QLD	NGN
John Wright-Smith	AMSC	Vendor
Vinay Krishnamurthy	EPC	Vendor
Clayton Zarb	Powerlink, QLD	NGN
Natasha D'Silva	GHD	Consultant

Convener:David PitaEmail:dpita@powerelink.com.auPhone:0438 762 190



AU B1 Insulated Cables

1. Study Committee Mission & Scope

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.

According to the 2002 CIGRE reorganisation, the scope of work of SC B1 is:

Theory, design, applications, manufacture, installation, testing, operation, maintenance and diagnostics techniques for land and submarine, AC and DC insulated cable systems.

The field of activities of SC B1 concerns the development and operation of all types of AC and DC insulated

cable systems for land and submarine power transmission and distribution applications. While the main focus of SC B1 remains on high voltage (HV) and extra high voltage (EHV) transmission applications, CIGRE's recently adopted approach to capture more of the end-to-end technologies has seen a considerable uptake in the medium voltage (MV) distribution, embedded generation and smart grid cable system applications.

Within this field, the scope of work of SC B1 covers theory, design, applications, manufacture, installation, testing, operation, maintenance, end of life and diagnostic techniques of insulated cable systems.



Accordingly, the core technologies of SC B1 can be defined as insulated components and equipment for power transmission and distribution. Supporting technologies are materials, emerging technologies as well as asset, operational and environmental management.

2. Specific Activities of the Study Committee

2.1 History

CIGRE was established in 1921. The first Study Committee dealing with Power Cables was founded in 1927 under the designation of SC 2. (SC 1 was for Insulating materials and oil)

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 and this year we celebrated 95 years.

In 2002, SC B1 celebrated 75 years of existence when the SC B1 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.

In 2027, SC B1 will celebrate 100 years with a memorial green book being published outlining the history, achievements and changes that the world has seen over the past century.


2.2 Study Committee Meetings

The Study Committee (SC) meets annually, with this year's meeting occurring during the Cairns Symposium in September.

The SC continues to focus on its two technological fields of activity while beginning to incorporate an end-toend 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 find it difficult 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,

Australia plays a significant role in the AORC, especially the AORC B1 committee which the AU B1 panel founded. Together with NZ B1, we are trying to spearhead an incentive to include some of the surrounding islands. It seems a logical step but with politics, nothing is as easy as it might seem

SC B1 currently consists of a Chairman, a Secretary, Regular Members (to a maximum number of 24 persons), Additional Regular Members and Observer Members (as appropriate).

Advisory Groups are set up to support the activity of the SC by making recommendations in various fields.

Conveners of Advisory Groups (AG), Working Groups (WG) and Task Forces (TF), take part in the SC meetings.

The organization of the Study Committee is represented in the adjacent figure.

There are 516 experts working for the SC. It is believed that the last decade of activity within the B1 committee was the most important in the Insulated Cable Committee history.

Overall SC B1 has a strong foundation for the work it undertakes:

- The SC has 43 members (24 regular, 14 observer and 5 additional}
- National Committees from the 24 represented countries have been very active during the year
- Australia is one of a handful of countries that has mirror panels of all 16 Study Committees

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. Recent examples are listed in section 2.5.

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. Most of the existing WGs being applicable to MV, HV and EHV applications.

2.3 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 January 2023, SC B1 has

- 18 active Working Groups (B1.XX) (54, 58, 64, 67, 68, 70, 72, 73, 76, 80, 82, 83, 86, 87, 88, 89, 90, 91)
- 5 active Joint Working groups JWGs (led by SC B1) (B1/C4.69, B1/B3.74, B1/D1.75, B1/B3/D1.79, B1/C3.85)
- 4 active JWGs lead by another SC (A3/A2/A1/B1.44, B4/B1/C4.73, D1/B1.75, B2/B1.90)
- 2 active Task Forces (91, 92)

2.4 Study Committee Statistics

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

2.4.1. Country Participation

In a more detailed analysis, the 516 participations are coming from the following countries

2023 - Number of B1 positions per country (SC + WG + TF + AG)



While the number of experts from Australia being involved in the SC, AGs, WGs and TFs continues to grow (up from 22 last year to 27 this year), there is always room for learned people to become involved in the committee's national and international activities.



2.4.2. Number of B1 experts : Total

	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Experts	516	472	461	437	421	402	389	329	334	310	279
Women	58	47	44	38	39	38	34	30	27	23	27
Men	458	425	417	399	382	364	355	299	307	287	252
NGN	103	88	73	52	44	40	29	15			



2.4.3. SC B1 Composition per Affiliation



2.4.4. SC B1 experts - Distribution per continent (over 10 years)







2.4.5. SC B1 experts - Distribution per affiliation – past 10 years

2.5 Publications

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

2.5.1. Publications during 2022/23

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

WG Number	Name of Publication	Technical Brochure Number
WG B1.61	Installation of HV cable systems	TB 889
WG B1.63	Recommendations for Mechanical Testing of Submarine Cables for Dynamic Applications	TB 862
WG B1.64	Evaluation of Losses in Armoured Three-core Power Cables	TB 908
WG B1.65	Installation of submarine cables	TB 883

2.5.2. Green Books

Green books are CIGRE's state of the art, flagship reference publications

"Accessories for HV and EHV Extruded Cables – Vol. 2" has been published

A proposal for a book on "Cable Rating" is underway

A proposal for a book on "Cable System Design" is still to be shaped within SC B1.





2.5.3. Publication Plan for 2023/24

WG Number	Name of Publication	Planned date for Publication
WG B1.54	Behavior of cable systems under large disturbances (earthquake, storm, flood, fire, landslide, climate change)	Q4 2023
WG B1.58	Condition Assessment and Diagnostic Methods to support Asset Management of MV Cable Networks	Q4 2023
WG B1.67	Loading Patterns on Windfarm Array and Export Cables	Q4 2023
WG B1.68	Condition evaluation and lifetime strategy of HV cable systems	Q4 2023
JWG B1/C4.69	Recommendations for the insulation coordination on AC cable systems	Q4 2023
WG B1.70	Recommendations for the use and the testing of optical fibres in submarine cable systems	Q4 2023
WG B1.72	Cable ratings verification (2nd part)	Q1 2024
WG B1.73	Recommendations for the use and testing of Fibre Optic Cables used in Land Cable Systems	Q1 2024
JWG B4.C4.B1.73	Surge and extended overvoltage evaluation of HVDC cable systems for testing	Q1 2024
JWG B1/B3.74	Recommendations for a performance standard of insulated busbars	Q1 2024
JWG B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC applications	Q2 2024
WG B1.76	Enhancing Quality Assurance/Quality Control Procedures for HV and EHV Cable Systems	Q2 2024
JWG B1/B3/D1.79	WG B1/B3/D1.79 Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends	
WG B1.80	Guidelines for Site Acceptance Test of DTS and DAS systems	Q2 2024

3. Preferential Subjects for SC B1

The three preferential subjects for 2024 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



4. Proposed New Working Groups

At the latest SC meeting in Cairns (Sept 2023) a further WG and two TFs were launched

TF/WG Number	Title
WG B1.92	Qualification of lead -free submarine cables < 170 kV
TF B1.94	Grid operations (switching etc) and Transient voltages in XLPE insulated cable systems possibly causing accelerated failure modes
TF B1.95	Mechanical performance and limits of submarine cables – modelling and testing
TF B1.93	Robotic supervision in Tunnels – Still being decided upon

4.1 **Tutorials and Webinars**

Year	Date	Туре	Title
2020	9 January	Webinar	TB 722, Additional testing of XLPE 6-60 kV
2020	28 May	Webinar	TB 770, Trenchless technologies
2020	26.aug	Webinar	B1.35 - Cable ratings
2020	15.dec	Webinar	B1.52-TB 773 Fault location
2021	04.March	Webinar	TB 680 Long HV/EHV AC cable syst.
2021	04. June	Webinar	TB 610/B1.40 - Offshore generation cables
2021	27.aug	Webinar	B1.45/61/65 - Installation of land and sub. Cables
2021	November	Webinar	TB 825 - Maintenance HV cable sysst
2022	April	Webinar	TB 797 - Sheath bonding systems AC cables
2022	June	Webinar	TB 862 - Mechanical testing dynamic cables
2022	August	Tutorial	A new era of submarine power cables
2023	September	Tutorial	Fault Location on Land and Submarine Links (AC & DC)

4.2 SC B1 Public Website

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

Explanation of the content of the website

- Structure
- Publications: technical brochures, overview can be created with Excel file to search for key words
- Tutorial request: automatic emails are sent to TAG Convener



5. Specific Activities of the Australian Panel

The AU B1 panel continues to grow, currently having 42 members, with 3 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 single transmission utility within NZ 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, CIGRE NZ B1 has been established to focus on MV and LV cable topics.

Considerable cable activity throughout both countries

- MV cable networks continue to grow as more new housing estates are established
- MV, HV and EHV connections are being deployed as networks are expanded to capture renewable generation points of supply

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:

- Distribution utilities keen on 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
- The importance and benefits of maintenance programs
- Continued connections for Solar and Wind farms at MV, HV and EHV levels.
- Lots of non-cable people becoming involved in cable related decisions
- Big Battery systems to harness renewable energy are being connected by cables (MV, HV and EHV)
- · Continued growth in use of fibre optic cables for measuring and monitoring cable performance
- Off-shore windfarms Submarine cables, DC links, long AC links
- Large conductors for HV cables : 66kV up to 2500mm², Higher voltages to 3500mm²

6. Meeting Report

Summary of Past/Future Event(s)

Event Name	Date	City	Web site link	Comments
AU B1 Face to face meeting	Nov 2022	Sydney	https://cigregroups.org/display/AUB1/2022+11+Syd ney	Meeting after Paris
AUB1 on-line meeting	May 2023	On-line	https://cigregroups.org/display/AUB1/2023+05+On- Line?src=contextnavpagetreemode	On-line panel meeting 95% attendance 2x 2.5hr sessions
AU B1 Face to face meeting	Sept 2023	Cairns	https://cigregroups.org/display/AUB1/2023+09+Cair ns?src=contextnavpagetreemode	Meeting held on the days before the Symposium to allow panel members to attend both events
AUB1 on-line meeting	May 2024	On-line		On-line panel meeting 2x 2.5hr sessions
AU B1 Face to face meeting	Oct 2024	Wellington New Zealand		Meeting was scheduled for 2019 before Civid19

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

An invitation was accepted by SC B1 to meet in Cairns - Australia in 2023 for the CIGRE Symposium. SCA3, SCB1, SCB3, SCB5, SCC1, SCC2, SCC4, SCC5, SCC6, SCD1 and SCD2 were in attendance. AU B1 held their 2023 meeting in Cairns at the same time. The AU B1 panel extended a dinner invitation to the SC B1 for a 'once in a generation' opportunity to join the two groups together. The evening was a great success.



8. 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 19 out of the 24 active TF's, WG's and JWG's.

WG/TF Number	WG/TF Title	AU B1 Rep	
TF B1.93	Robotic supervision of tunnels	Samir MD Aris	
TF B1.92	Qualification of Lead-free Submarine Cables at 72.5kV <um<170 kv<="" td=""><td>No AU B1 rep</td></um<170>	No AU B1 rep	
JWG B2/B1	Transition facilities between overhead and underground lines	Gian Moffa	
WG B1.91	Transient Thermal Modelling of Power Cables (update to IEC 60853)	Rajitha Vitharana	
WG B1.90	Cable Systems Electrical Characteristics (Update of TB 531)	Ryan Atkinson	
WG B1.89	Guidance for conducting cable systems failure analysis	Rob Bradley	
WG B1.87	from TF B1.84_1 Finite Element Analysis for Cable Rating Calculations	Chandima Ekanayake	
WG B1.86	Guidelines for safety issues associated to cable systems	Nic Moffa	
JWG B1/C3.85	Environmental impact of decommissioning of underground and submarine cables	Nimal G	
WG B1.83	Grounding aspects for long HVDC land cable connections	Kerry P	
WG B1.82	MVDC Cable system requirements/topics	Craig Harrison	
	How to have statistics every 2 years?	-	
WG B1.81	2021 Decision : extension 1 year with the TF, and then set an Advisory Group in 2022 to handle those statistics	Russell W	
WG B1.80	Guidelines for Site Acceptance Test of DTS and DAS systems	Jeff Cairns	
WG B1.76	Enhancing Quality Assurance/Quality Control Procedures for HV and EHV Cable Systems	Peter N	
JWG D1/B1.75	Strategies and tools for corrosion prevention for cable systems (2019 – 2022)	Graeme B	
WG B1.72	Cable ratings verification (2nd part) (2018 - 2020)	David S	
JWG B1/C4.69	Recommendations for the insulation coordination on AC cable systems (2018 - 2021)	Tony Auditore	
WG B1.68	Condition evaluation and lifetime strategy (2018 - 2021)	Rob B	
WG B1.67	Loading pattern on cables connected to windfarms (2018 - 2021)	Kerry P	
WG B1.58	Asset management in MV cables networks (2016-2019)	Dave L	



9. Membership of the Australian Panel as at November 2023

Name	Position	Organisation	Туре
Russell WHEATLAND	Convenor	AusNet	Utility
Eddie VAN DER DRAAI	Secretary	Powerlink Queensland	Utility
Mohanad AL-HASANI	Representative	Vector	Utility
Ryan ATKINSON	Representative	Marinus Link	Consultant
Kenneth BARBER	Representative	Istana Park Pty. Ltd.	Consultant
Graeme BARNEWALL	Representative	Essential Energy	Utility
Claude BASSO	Representative	ENERGY QUEENSLAND	Utility
Rob BRADLEY	Convenor Elect	Ausgrid	Utility
Peter BUTTERFIELD-ROSSI	Representative	ElectraNet Pty Ltd	Utility
Jeffree CAIRNS	Representative	TransGrid	Utility
Greg CALDWELL	Representative	Energy Queensland	Utility
Billy CHEUNG	Representative	Power Water corporation	Utility
Chandima EKANAYAKE	Representative	The University of Queensland	Academic
Joska FERENCZ	Representative	Basslink Pty Ltd	Asset Owner
Nimal GUNATILAKA	Representative	WesternPower	Utility
Jarad HUGHES	Representative	TasNetworks	Utility
Mark JANSEN	Representative	CitiPower/Powercor	Utility
Richard JOYCE	Representative	Transpower New Zealand Ltd	Utility
Henry KENT	Representative		Consultant
Dooham james KIM	Representative	Taihan Electric Australia Pty Ltd.	Manufacturer
Dong-churl LEE	Representative	Mondo	Service Provider
William LEONG	Representative	APD Engineering	Consultant
Albert MAJADIRE	Representative	Prysmian	Manufacturer
Samir MD ARIS	Representative	SA POWER NETWORKS	Utility
Nicola (nic) MOFFA	Representative	PROTOP Engineering Services	Consultant
Gian MOFFA	Representative	Jacobs	Consultant
Sudesh NAIR	Representative	GHD	Consultant
Peter NEW	Representative	Snowy Hydro Ltd	Utility
Jayson PATRICK	Representative	ELEK Software	Consultant
Colin PEACOCK	Representative	Pavocon	Consultant
Goran PEVEC	Representative	LS Cable and System Australia Pty Ltd	Manufacturer
Timothy POPKISS	Representative	INTERTECH Engineering Pty Ltd	Consultant
Kerry PRICKETT	Representative	UDCS Consulting	Consultant
Peter ROBINSON	Representative	Cable Systems Engineering	Consultant
Robert SEVIOR	Representative	Powerplant Project Services	Consultant
Givantha SILVA	Representative	Daly's Constructions	Service Provider
Pallavi SINGH	Representative	Aurecon	Consultant
David SPACKMAN	Representative	Tesla Consultants Limited	Consultant
Yohan WEERASINGHE	Representative	CableGrid	Manufacturer
Amali WICKRAMASINGHE	Representative	Endeavour Energy	Utility
Frank (tony) AUDITORE	Specialist	Voltoni Limited – HV Engineering Solutions	Consultant
Rajitha VITHARANA	Specialist	CitiPower & Powercor	Utility

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



AU B2 Overhead Lines

1. Study Committee Scope

Study Committee B2 covers the design, construction and operation of overhead lines. This includes the mechanical and electrical design and experimental validation of new line components (conductors, ground wires, insulators, accessories, structures and their foundations), the study of in-service line performance and assessment of aged line components, line maintenance, the refurbishment and life extension as well as upgrading and uprating of existing overhead lines.

- Regular Members from 37 countries
- Observers from 17 countries
- 28 active Working Groups
- Ca. 600 experts in Working Groups from 48 countries
- Approx. 8% female members in WGs
- Approx. 3% from Next Generation Network

B2 has issued 93 Technical Brochures since 1994

2. Specific Activities of the Study Committee

#	Group name	Acronym	Area/ discipline	Convenor	Secretary
1	Strategic Advisory Group	SAG	Overall strategy of the B2 committee including selection of preferential subjects for future WG's and Technical Committee meetings	Pierre V Dyke	Vivek Chari
2	Customer Advisory Group	CAG	Review of new ToRs and reporting to SAG for recommendations	Kjell Halsan	Wolfgang T
3	Technical Advisory Group	TAG04	Electrical Performance	Javier Iglesias	-
4	Technical Advisory Group	TAG05	Tower/Foundation/Insulators	Joao Da Silva	-
5	Technical Advisory Group	TAG06	Mechanical behaviour of conductors and fittings	Cécile Rozé	Tetsuya Yamanaka
6	Technical Advisory Group	TAG07	Asset Management – Reliability and availability of OHL	Balint Nemeth	Asif Bhangor

2.1 Customer Advisory Group

Ongoing Terms of Reference review:

- Monitoring, forewarning and melting of ice on transmission lines
- Transposition guidelines and recommendations for overhead lines
- Impact of pollution level of insulator strings for HVDC lines design operation
- Update on Construction methodologies for Overhead Transmission Lines

Future Terms of Reference to be submitted for review 2024:

- Maintenance and aging of HTLS conductors
- Long overhead line span crossings
- Al Augmented image-based TL inspection and condition assessment
- Composite insulated crossarm
- Transition facilities OH lines and underground cables
- Extreme weather events and impact on design of overhead transmission lines



2.2 Strategic Advisory Group

The Convenor provided a highlight on the number of papers received for the Paris session

- PS1: Challenges from renewables integration and influences of energy transition on OHL No. of Papers received for review: **63**
- PS2: Asset management, strategies, technologies, and methods for OHL No. of Papers for review: **74**
- PS3: Lessons learned for TSO/DSO, studies and practical experiences from a changing environment No. of Papers for review: 24

No. of Papers for review:

Tutorials for Paris 2024

• B2.59 – Forecasting Dynamic Line rating

2.3 TAG04

Publications; Tutorials

- Lightning & amp; Grounding for rebuilding & amp; refurbishing projects. W. Chisholm and N. Hudi (Sendai, Oct. 2023)
- Green Book Compact Lines. R. Stephen & amp; J. Iglesias. (Expected 2024)

2.4 TAG05

TAG05 is split in 3 sub-groups, towers, foundations, and insulators.

6 WG are active working.

New demands:

- Towers: 5 new potential groups
- Foundations: 1 "old" demand on standby
- Insulators: 3 new demands
- Construction: 1 demand
- 2 green books are in preparation.

2.5 TAG06

• Technical brochure 905 – published in 2023 – "Sustainability of overhead line conductors and fittings – Conductor condition assessment and life extension Volume 1: State of the art"

2.6 TAG07

31 Regular members, 29 Corresponding members WG status: Active 9 (including 2xJWG)

New Proposals ToR: 2

- Proposal 1: OHL construction methodology
- Proposal 2: Al augmented based-transmission line inspection and condition assessment
- Proposal 3: Climate Change and impact on OHL design & operations

Topics of interest:

- o Effect on OHL in close proximity of wind turbines
- Operational Experience with Robotics used for inspection and corrective maintenance

3. **Preferential Subjects**

Preferential subjects selected by the Study Committee for the future Paris Session 2024.

- B2 PS1 Challenges from Renewables Integration and Influences of Energy Transition on OHL
- B2 PS2 Asset Management, Strategies, Technologies and Methods for OHL
- B2 PS3 Impacts from Climate Change on OHL

Paris/France – August/September – Annual B2 SC meeting

- The preliminary schedule for Paris 2024, is as follows:
- Tuesday August 27, 9:00-17:00: SC B2 Committee meeting



- Wednesday August 28, 16:10-18:00: SC B2 tutorial
- Thursday August 29, 9:00-12:30: SC B2 Poster session
- Friday August 30, 8:45-18:00: Group discussion meeting

4. **Proposed New Working Groups**

The following new working groups were established by the Study Committee B2.

- B2.88 "Safety guidelines for OHL construction & maintenance" approved in 2023, Convenor John McCormack (ANC)
- B2.89 "Impact of rain upon the characteristics of corona discharge from HV AC and DC overhead transmission lines" approved in 2023, Convenor Bo Zhang (China)

5. Specific Activities of the Australian Panel

In 2023, the Australian Panel activities included:

- Active participation the B2 Sendai Colloquium 2023 by:
 - Technical paper presented in the Sendai Colloquium 2023
 - Support to the Sendai B2 Technical committee in the form of Session Chairs (Asif Bhangor, John McCormack and Bing Lin).
 - NGN forum chair Bing Lin
- September 2023 Publication of technical brochure TB216 Correct Handling of Fittings and Conductors.

Credit to **Australian Convenor Peter Dulhunty** for leading the working group B2.50 since 2018 to conclude the works with a technical brochure in 2023.

• Workshop held to fast track the preparation of synopses in July 2023. As a result over 6 paper synopses were prepared by the Panel representatives and successfully uploaded to CIGRE Paris.

Paper abstract submitted for Paris 2024	Prepared by
Innovative Method of Recovering from a Tower Failure	Angus KETLEY
How regular inspections and allowances for degradation in OHL's combine to underpin network reliability, and the implications for design and residual strength requirements given downturns in reliability and aging networks	Nathan Spencer and Johnny Shan
Case study for refurbishment of 33 kV line with surge arresters on the earth wire	Anne Williams
GIS database for overhead lines resilience to extreme ice events	Anne Williams
Insulator set cold end fitting failures; understanding failure mechanisms and prioritizing replacements.	Andreas Lem and Michael Wilson
Asset management, strategies, technologies and methods for OHL	Matthew Heath, Charles K. Brendan S

Technical seminar – Cairns 2023
 Session held in Cairns during CIGRE Cairns Chapter
 Technical presentations (upto 10 organised for local attendees and for online attendance)

6. Meeting Report: Australian Panel

The panel met in Cairns during the CIGRE Cairns Chapter on the 07th of September 2023 (Venue: Pullman Hotel).

6.1 Administration



- Over 35 attendees in Pullman Hotel
- 44 attendees online
- Venue and facilities sponsor: Energy Queensland and Powerlink
- Dinner sponsored by: GS Engineering & Construction, Yurika

6.2 Technical Presentations

- 1) 500kV Lightning Performance
- 2) Recent tower failure recover case study
- 3) Planned 500kV construction in Queensland and associated technical and resource challenges
- 4) An overview of the failure events in transmission lines learnings and suggestions
- 5) Danubio susceptibility to double circuit back flashover
- 6) An Introduction to EHV and UHV EGLA Applications in China
- 7) Surviving a longwall mining operation under a powerline
- 8) Fall protection systems
- 9) Mine subsidence in the vicinity of transmission line structures
- 10) Impact of Bushfire on Conductor Performance Prioritising Rectification Works

6.3 Working group updates/ general

- 17nos of working group updates by Australian Representatives
- Introduction of CIGRE New Zealand for Distribution Lines
- KMS training by Rodney Hughes

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

Discussion for 2027/ 2029 for SC B2 to meet in Australia (discussed during 2023 Sendai Session B2 Study Committee meeting). Another contender was Cigre, China for the B2 Symposium to be held in China. This will be open for discussion in Paris 2024 session.

8. ANC Members on Working Groups

The following are all the current AU representatives on Working Groups. We are proud to have five (5) of our Australian National Members lead the working groups as Convenors.

WG	Title	ANC Member role	Supported by ANC
B2.88	Safety guidelines for OHL construction & maintenance	John McCormack (Convenor1)	Yes – Sendai 2023 trip supported for expenses
B2.87	Live line and vicinity working on overhead lines – Safe management guidelines	-	-
JWG.C1/B1.86	Approach for Asset Management of Overhead Transmission Lines	Gary Brennan (Representative)	-
B2.85	Emergency Restoration Systems for Overhead Lines – Guide for Design, Planning and Installation	Bing Lin (Convenor2)	Yes – Sendai 2023 trip supported for expenses
B2.84	Assessment of the methodologies to analyze wind induced overhead line conductors' motion: applications and limitations	-	-
B2.83	Mitigation of induced noises by corona activity in overhead AC and DC lines	Hoang Tong (Representative)	
B2.82	Overhead line foundations for difficult soil and geological conditions	-	-
B2.81	Increasing the Strength Capacity of Existing Overhead Transmission Line Structures	Raju Upadhyaya (Representative)	



WG	Title	ANC Member role	Supported by ANC
B2.80	Numerical Simulation of electrical fields on AC and DC Overhead Line Insulator Strings	-	-
B2.79	Enhancing OHL Rating Prediction by Improving Weather Parameters Measurements	-	-
B2.78	Use of High Temperature conductors in new OH line design	-	-
B2.77	Risk Management of Overhead Line networks: A model for identification, evaluation & mitigation of operational risks	Asif Bhangor (Convenor3)	-
JWG C4/B2.76	Lightning & grounding considerations for OHL rebuilding and refurbishing projects (AC and DC)	Anne Williams (Representative)	-
B2.75	Application guide for insulated and un- insulated conductors used on medium and low voltage overhead lines	-	-
B2.74	Use of unmanned aerial vehicles (UAV's) for assistance with inspections of overhead power lines	-	-
B2.73	Guide for prevention of vegetation fires caused by overhead line systems	P Dulhunty (Convenor5)	-
JWG D2/B2.72	Condition Monitoring and remote sensing of overhead lines	-	-
B2.71	Recommendations for Interphase spacer for Overhead Lines	-	-
B2.70	Aircraft warning markers and bird flight diverters for overhead lines	-	-
B2.69	Coatings for Power Networks	Francis Lirios (Representative)	-
B2.68	Sustainability of OHL, conductors, and fittings – Conductor condition assessment and life extension	John McCormack (Representative)	-
B2.67	Assessment and testing of wood and alternative material type poles	N.Spencer (Convenor4)	
B2.66	Safe Handling and Installation Guide for High Temperature Low Sag Conductors	Michael Wilson (Representative)	-
B2.65	Detection, prevention and repair of sub-surface corrosion in OHL supports, anchors and foundations	John McCormack (Representative)	-
B2.60	Affordable overhead transmission lines for Sub-Saharan countries	-	Closed
B2.59	Forecasting dynamic line ratings	John McCormack (Representative)	-
B2.57	Survey of operational composite insulator experience and application guide for composite insulators	-	Closed
B2.50	Safe handling of fittings and conductors	P Dulhunty (Convenor5)	Closed

9. Membership of the Australian Panel

#	Name	Organisation	Туре
1	Greg Chapman	Pvt Ltd	Consulting



#	Name	Organisation	Туре
2	Edlyn Colaco	APD	Consulting
3	Anne Williams	Aurecon	Consulting
4	Steve Redhead	Aurecon	Consulting
5	Gary Brennan	BCA	Consulting
6	Kulkarni Raghavendra	GHD	Consulting
7	Tony Gillespie	GPC	Consulting
8	Michael Lee	MJLEE Consult	Consulting
9	Jack Roughan	Pvt Ltd	Consulting
10	Robert Lake	Rob Lake Consulting	Consulting
11	Arun Arora	WSP	Consulting
12	Nathan Spencer	COENG	Contractor
13	Frank Yao	CPP	Contractor
14	Franz Ritky	Downer	Contractor
15	Andreas Lem	Enerven	Contractor
16	Andrew Mansour	Enerven	Contractor
17	Amir Jesmi	UGL	Contractor
18	Elias Elkhoury	UGL	Contractor
19	Wasantha Kumara	UGL	Contractor
20	Denis McCrohan	Pvt Ltd	Manufacturer
21	Sandy	Dulhunty	Manufacturer
22	Scott Coles	IUPoles	Manufacturer
23	Glenn Ford	AusGrid	Transmission
24	Francis Lirios	AusNet	Transmission
25	Stephanie Phillips	AusNet	Transmission
26	Raju Upadhyaya	ElectraNet	Transmission
27	Steve Brooks	Energy Queensland	Transmission
28	Christian Matheson	EQL	Transmission
29	Michael Pitton	EQL	Transmission
30	John Mordacz	Ergon	Transmission
31	Alan Delac	Powerlink	Transmission
32	Glenn Stapleton	Powerlink	Transmission
33	Paul Cullen	Powerlink	Transmission
34	Rikus Bekker	Powerlink	Transmission
35	Andrew Taylor	PWC	Transmission
36	Angus Ketley	TasNetworks	Transmission
37	Charles Kurniawan	TransGrid	Transmission
38	Hoang Tong	TransGrid	Transmission
39	John McCormack	TransGrid	Transmission
40	Matthew Heath	TransGrid	Transmission
41	Neil Bennett	TransGrid	Transmission



#	Name	Organisation	Туре
42	Sanu Maharjan	TransGrid	Transmission
43	Michael Wilson	Transpower	Transmission
44	Shaya Azizi	Western Power	Transmission
45	Danny Miles	Yurika	Transmission
46	David Parker	Yurika	Transmission

Convener: Asif Bhangor

Email: <u>bhangorian@gmail.com</u>

Phone: 0409375981



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.



Figure 1: Distribution of SC.B3 Members

2. Specific Activities of the Study Committee

- CIGRE Symposium September 2023
- Birmingham A3 and B3 Colloquium
- Paris CIGRE 2024 Event: 99 papers have been received.



Preferential subjects for 2024:

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

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

PS2 : Return on Operational Experiences for Sustainable Substation Management

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

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

SC. B3 has 8 active WG's, 2 joints WGs and 1 Special project with 7 recent Technical Brochures being published.



4. Future Topics of Interest from the Advisory Areas



AA1: Substation Concepts

- Guidelines for Managing Black Start Resilience in substations
- Offshore Substation Operational Experience
- Earthing system design guidelines for high voltage systems
- Harmonization of voltage designations and definitions across different HVDC component technologies

AA2 GIS, GIL, SF6 and Alternative Gases

- New WG B3/A3.60 "Guideline for assessing the toxicity of used SF6 gas onsite and in the lab of T&D equipment"
- Completing the Greenbook in Spring 2024

AA3: Air Insulated Substations

New WG B3.64 "Guidelines on Optimising Seismic Design of Substations for Power Resiliency"

AA4: Substation Management

- Greening substations (B3/A3/D1)
- Standardization spin off from B3.56, incl. asset register and ongoing changes

5. Australian Panel Working Groups Activities

The following AP.B3 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.B3.54 Earthing System Testing Methods

• Stephen Palmer WG Convener

WG B3.56 Application of 3D Technologies in Substation Engineering Works

- Todd Margitich: Member
- WG. A3.46 Generator Circuit Breaker
 - Crina Costan is a corresponding 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.



WG.B3.64 Guidelines on optimising seismic design of substations for power resiliency

• Doralba Valencia and Joseph Pinheiro are members of this working group

WG.B3.65 Guidelines for the selection and design of escape routes for substations rated above 1 kV AC and 1.5 kV DC $\,$

• TBC – proposed members were Alex Baitch and Steve Palmer

6. New Technical Brochures

No	WG	Title	Convener	HV GIS above 52 kV
869	B3.55	Design guideline for substations connecting battery energy storage solutions (BESS)	Suriya Prungkhwu- nmuang (TH)	Guidelines for Fire Risk Management in Substations Impact on Engineering and
870	B3.51	Service Continuity Guide for HV GIS above 52 kV	Mark Kuschel (DE)	Knowledge transfer of substation engineering and
886	B3.53	Guidelines for Fire Risk Management in Substations	Shinki Noguchi (JP)	Mobile Substations Incorporating HV GIS
895	B3.57	Impact on Engineering and Lifetime Management of Outdoor HV GIS	Toshiyuki Saida (JP)	WG B3.41
898	B3.58	Knowledge transfer of substation engineering and experiences	Akira Okada (JP)	P. BERGAR, and M. 1 1 0.6 March 2000 0 <td< td=""></td<>
907	B3.41	Mobile Substations Incorporating HV GIS	Paul Fletcher (GB)	
IEW 914	B3/A3. 59	Guidelines for SF6 End-of-Life Treatment of T&D Equipment (>1kV) in Substations	Maik <u>Hyrenbach</u> (DE)	Regress III The second response is shown if the second response is shown in the second respons

7. Year 2023 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 and other CIGRE panels
- One day AP. B3 annual meeting on the 3rd of September in Cairns
- Participation to CIGRE Symposium in Cairns and 11 papers submission and the 25th of November with 3 guest speakers
- Liaison with the Australian Standards Committees
- Site visit to the National Measurement Institute Sydney

8. 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
- BHP



	Name	Company
1.	Alan Crombie	UGL
2.	Alan Goodridge	Peracon
3.	Doralba Valencia	Transpower
4.	Andreas Laubi	Aurecon
5.	Crina Costan	ElectraNet
6.	Blake Christian	Endeavour
7.	Doug Ray	Vector
8.	Peter Legg	Western Power
9.	Michael Verrier	TasNetworks
10.	Rajhiv Perera	GE Grid
11.	Tara-Lee Macarthur	Energy Queensland
12.	Stephen Palmer	Safearth
13.	Peregrine Tonking	PWC
14.	Terry Krieg	Powernetwork Consulting
15.	Matthew Wiese	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.	Daniel Stafford	Jacobs
26.	Joseph Pinheiro	Powerlink
27.	Hao Tian	Individual member
28.	Chris Grinter	AusNet
29.	James Warr	СРР
30.	Brody Ward	NGN - Jacobs
31.	Alex Pejkinoski	Jemena
32.	Andrew Daetz	GHD
33.	Sam Mulquiney	Essential Energy

Convener: Crina-Miana Costan

Email: <u>crina.m.costan@gmail.com;</u>



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 2023.
- 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 2023.
- 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 2023.
- 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 ecigre by 2023.



• 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.





3. **Preferential Subjects**

The preferential subjects for the 2023 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
 - o Service and operating experience of converter stations including off shore platforms.
- PS 2: DC and Power Electronic (PE) for distribution systems
 - o DC deployed in distribution systems;
 - PE and FACTS devices applied in distribution projects including the economics and reliability;
 - o 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;
 - o Application of new technologies in FACTS and other PE equipment;
 - o 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:

- C4/B4.52 Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems (TB 909) – Chandana Karawita
- B4/B1/C4.73 Surge and extended overvoltage testing of HVDC cable systems *currently under 60-day review* Markus Saltzer

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



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	1.14. TF B4/B1 88	Insulation coordination procedure for DC cable	Kees Koreman
		systems in HVDC stations with Voltage Source	
	1 1F D4 00	Converters (VSC)	
	1.15. B4.89	Condition Health Monitoring and predictive	Nadine Chapalain
		maintenance of HVDC Converter Stations	
NEW	1.16. B4.90	Operation and maintenance of HVDC and FACTS	Les Brand
		Facilities	
NEW	1.17. B4.91	Power-electronics-based transformer technology,	Marco Liserre
		design, grid integration and services provision to the	
		distribution grid	
NEW	1.18. B4.92	STATCOMs at Distribution Voltages	John Wright-Smith
NEW	1.19.	WG B4.93 – Development of Grid-Forming	Dechao Kong
		Converters for Secure and Reliable Operation of	_ conso nong
	4.00	Future Electricity Systems	
NEW	1.20.	by b	Christer Norlander
		and System Design	
NFW	1 21	WG B4 94 – Application of grid-forming VSC-HVDC	
		system in black start restoration	Arash Fazel Darbandi
NEW	1.22.	TF B1/B3/B4/C4/D1.95 – Harmonization of voltage	Drune Disevueli
		designations and definitions across different HVDC	Bruno Bisewski
		component technologies	
NEW	1.23.	JWG C4/B4.72 – Lightning and Switching Induced	Oinamin Li
		Electromagnetic Compatibility (EMC) issues in DC	
		power systems and new emerging power	
		electronics-based DC equipment	
NEW	1.24.	WG B4.95 – Developments in Power Semiconductor	Joerg Dorn
NEW	1 25	WG B4.96 $-$ HVDC connection of power system with	-
	1.20.	high proportion of photovoltaic (PV) generation	Qi Guo
NEW	1.26.	JWG C4/A3/B2/B4.75 – Guide to procedures for the	
		creation of contamination maps required for outdoor	Massimo Marzinotto
		insulation coordination	
NEW	1.27.	JWG B4/C1.97 – Benchmarking of simulations	Araab Fazal Darbandi
		models for control interaction in meshed AC	Alashi Fazel Dalbahul
		networks with multiple converters	
NEW	1.28.	JWG C1/B4.49 – Offshore transmission planning	Cornelis Plet

6. Specific Activities of the Australian Panel

Key activities of the AU B4 panel during 2023 include:

- Significant contribution by Australian and New Zealand members to the Green Book on FACTS:
 - o Babak Badrzadeh
 - o Peeter Muttik
 - o Rizah Memisevic
 - o 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 2023 Annual Meeting eSession was held Sunday $3^{\rm rd}$ September in Cairns.

Members attended the meeting.

AGENDA

DAY Sunday 3rd September, 2023

Location: Cairns International Convention Centre

Host: CIGRE Cairns 2023 International Symposium

No	Торіс	Approx. Time
1	 Introduction and Welcome Attendance Register Meeting format discussed and agreed Confirmation of agenda Apologies Changes to CIGRE Australia CEO leadership Update on CIGRE Australia Panel Convenors CIGRE AP A3 KMS website 	9:00 – 9:15
2	Minutes of the Previous APB4 Meeting	9:15 – 9:30
3	Action items from APB4 Meeting	9:30 - 10:00



4	 Review of AP B4 membership New Members Update Membership List 	10:00 -10:15
	Coffee Break (30 mins)	10:15 – 10:45
5	 Report and Update on SC B4 SCB4 Working Group Activities SCB4 Annual Meeting - Outcomes New Working Groups Green Books AP B4 Activities Australian Panel contributions to SC B4 Working Groups NGN Update Webinars Paris 2024 	10:45 – 12:00
	Lunch (1 hr)	12.00 - 12.30
6	Member Presentations (20 mins each)	12:30 - 14:30
	Coffee Break (30 mins)	14:30 - 14:45
8	Member Presentations (20 mins each)	14:45 – 16:45
9	 Closing / Recap Actions Next year's APB4 meeting - Location, Format, Site Visit, Hosting Ideas for AP B4 activities Any other business Conclusions, further discussions over dinner 	16:45 – 17:00
	Dinner – C'est Bon Restaurant, 20 Lake St, Village Lane, Cairns – set menu	6.30pm

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

In the Paris 2022 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

Collective/Individual	Panel	Representative
John Wright-Smith	B4	John Wright-Smith
Steven De Clerck	B4	Steven De Clerk
AEMO	B4	Mark Shilliday
AEMO	B4	Nadesan Pushparaj
AEMO	B4	Maddy Binet NGN
Amplitude	B4	Les Brand
APT Management Services	B4	Stuart Dodds
Basslink	B4	Greg Mather
DigSilent	B4	Jaleel Mesbah
ElectraNet Pty Ltd	B4	Andrew Van Eyk
GE Grid Solutions	B4	Peeter Muttik
GHD	B4	Rajesh Nighot
Global Power Energy	B4	Greg Elkins
Hatch	B4	Nalin Pahalawaththa
Hitachi ABB Power Grids	B4	Colin Wood
Stehen Northwood	B4	Stephen Northwood
Hydro Tasmania	B4	Rajith Perera
Powerlink Queensland	B4	Tuan Vu
QUT (Gardens Point Campus)	B4	Gerard Ledwich
Siemens Energy	B4	Angelo Iacono
Tasmanian Networks Pty Ltd	B4	Mark Davies
TransGrid	B4	Richard Xu
Transpower New Zealand Ltd	B4	Michael Dalzell
University of NSW	B4	Georgios Konstantinou
Western Power	B4	Yau Hing Chow



Convener:John Wright-SmithEmail:john.t.wright-smith@bigpond.comPhone:+61 (0) 488 200 458



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 B5 Study Committee participated in the Cairns 2023 International Symposium.

- 31 presentations on symposium themes were presented over 6 sessions (each followed by question/answer time).
- One B5 tutorial on 'applying synchrophasor technology for protection of the power system' was arranged by the CIGRE Australia B5 panel and presented mostly by CIGRE Australia representatives. It included a summary from a recently released synchrophasor technical brochure and also presented a six applications that have been deployed on the power systems of the Australasian region.
- Study Committee Meeting

25 B5 Working Groups are presently active.

3. Future Preferential Subjects

During the 2023 SC B5 meeting three Preferential Subjects were agreed for 2025:

- 1. Interoperability of IEDs of different manufacturers and technologies integrated in one PACS
- 2. PACS Life Cycle Performance and Longevity
- 3. Experiences and possibilities on revised principles and policies related to modern protection IEDs

4. **Proposed New Working Groups**

During the 2023 SC B5 meeting three new working group topics were agreed:

- 1. PACS interfaced asset management and condition monitoring using innovative technologies
- 2. Recommendations and constraints for development and interfacing of virtual IED implemented in PACS
- 3. Protection, Control and Monitoring principles of synchronous condenser and generation with fly wheel

5. Specific Activities of the Australian Panel

During 2023 the panel enjoyed fully resumed in person activities while also keeping in contact online



Cairns Symposium Participation and associated AU B5 Organised Events – SEAPAC and B5 Tutorial:

The main CIGRE Australia B5 panel event for 2023 was the September Cairns Symposium, which also incorporated the B5 panel organised 'South East Asia Protection Automation and Control' (**SEAPAC**) conference sessions. Significant panel effort has gone into the AU B5 panel planning and involvement in symposium activities including SEAPAC and the local B5 tutorial presentations. The international B5 study Committee was one of the 11 study committees participating in the Cairns symposium.

The CIGRE AU B5 panel organises the SEAPAC conference every two years. The principal objective is the ongoing Australia/new Zealand development of fundamental knowledge and skills for application, design and operation of the substation and power system protection, control, metering, condition monitoring equipment and associated interfaces to primary plant, SCADA and telecommunication systems.

After three years of planning, the SEAPAC 2023 event was held over a full day on 5th of September 2023. 22 papers were presented in 4 themed sessions. Delegates benefited from the wide range of local and international presenters. Also the symposium attracted many subject matter experts to the SEAPAC sessions and this led to a rich question/answer session discussion after each set of presentations.

Many thanks to the SEAPAC 2023 organising committee of Frankie Lu from Siemens, Rob Coggan from Energy Queensland, Bruce Capstaff from Powerlink Queensland, Ian Young from Schneider, Akhtar Kalam from Victoria University Marino Pallotta from Electranet South Australia, Terry Killen from CIGRE Australia and Peter Bishop from Transpower NZ Ltd. Also many thanks to SEAPAC session chairs comprising Rob Coggan from Energy Queensland, Satendra Bhola from TasNetworks, Justin Brown from Beca consultants and Frankie Lu from Siemens.



As this was a regional symposium event, the international B5 study asked the CIGRE Australia B5 panel to arrange and provide presenters for the **B5 tutorial** that was held on the 7th September.

The B5 tutorial topic was 'applying synchrophasor technology for protection of the power system'. It highlighted the visibility and reliable control of our changing power system through high resolution time stamped phasor measurements of voltages and currents. The in person only tutorial was well attended by a diverse range of delegates, with over 300 delegates present. It also highlighted the required interaction and involvement between groups within the power system industry for planning, implementing and co-ordination of synchrophasor schemes. The presentations included an introduction to synchrophasors, a summary of a recent published synchrophasor technical guideline and six Australasian synchrophasor application presentations:-

- Market Operator AEMO Wide Area Monitoring System (WAMS) Synchrophasor Project & Associated Standard Data Guidelines
- South Australia **Wide Area Protection Scheme** (WAPS) Synchrophasor Application associated with increased renewables and interstate connection
- Powerlink Synchrophasor WAMPAC Anti-islanding scheme Application
- Synchrophasors TasNetwork's Experience and Applications
- Applications of Synchrophasors to distribution networks An Evaluation of a grid scale data acquisition trial
- Transpower New Zealand Synchrophasor Synchronism Check Auto-reclose Application





Many thanks to the Australian/New Zealand tutorial presenters comprising Ritesh Bharat (Electranet), James Guest (AEMO), Filip Ivanovski (CSE Uniserve), Daniel Moulds (Powerlink), Muhammad Zakir (TasNetworks), Martin van der Linde (NojaPower) and Peter Bishop (Transpower NZ Ltd).

Feedback on all the B5 related activities at the Symposium was very positive.

Panel Working Group Contributions and Green Book Second Edition:

The panel continues to contribute to international working groups with AU B5 being represented on 16 of the 25 active B5 working groups. In addition, 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".

During 2023 the following CIGRE Australia corresponding members were accepted for the following recently created working groups:

B5.81	Obsolescence Management for Protection, Automation and Control	Peter Bishop (C)
B5.82	Education, Qualification and Continuing Professional Development of Engineers in Protection, Automation and Control	Lara Kruk (C)
B5.83	Protection for modern distribution networks	Diptiman Yadav (C)

The AU B5 convenor has also been convenor (and Co-Editor) of the SC B5 Green Book on IEC 61850 Principles and Applications to Electric Power Systems. In July 2022 the book was published after three years of online meetings and collaborative work by the Task Force. In May 2023 the second edition of the Green Book was published - <u>link to IEC 61850 Green Book</u>. It contains publisher quality corrections. The technical content remains unaltered.





Topics of Relevance Online Sharing via Knowledge Management System (KMS):

During 2023 the AU B5 panel has continued to use the CIGRE Knowledge Management System (KMS) to share knowledge and experience on different protection, automation and control topics such as low impedance restricted earth fault protection issues and setting considerations, downed conductor survey and single pole tripping & auto-reclose.

6. Australian Panel Meeting Report

25 organisation representatives attended the fully in person annual AU B5 panel meeting in Perth (Western Australia) from 31 May to 2 June 2023. During the meeting several changes in membership representation were recognised, working group activity was reviewed, specific topics of relevance to Australia and NZ were actively discussed and presentations were given on AU/NZ experiences & developments.

The topics of relevance discussed included:-

- Experience & developments associated with downed conductor protection particularly for distribution networks
- Experience and practices associated with IEC 61850 associated system testing

Local presentations presentation topics included:-

- Advanced auto-reclose techniques for the New Zealand transmission system
- A distribution utility arc flash journey
- National Electricity Rule changes
- South Australia Wide Area Protection scheme
- Queensland HV static Var compensators recent faults
- Power system restoration protection aspects after a recent flood that submerged much of the substation

During the meeting it was noted that panel membership had grown to 41 organisation representatives (44 as of November 2023). However there was discussion and planning for increasing panel activities to a wider and more diverse audience than just panel members. This would include more webinars workshops. Associated focus groups were set up on the following topics - downed conductor detection, digital substation testing, and autoreclose practice.

It was agreed to hold the SEAPAC 2025 conference in Melbourne during March. An organising committee was formed.

The meeting concluded with a visit to Western Power's Shenton Park Zone Substation, where innovative protection and automation features were viewed and discussed.







An end of year panel update video conference presentation and question & answer session was held on 1 December 2022. This presented highlights from the 2022 Paris Hybrid session, including outcomes from the August SC B5 meeting and updated the panel on several other activities. Another end of year panel update video conference is scheduled for 5 December 2023. It is planned to summarise highlights from the Cairns Symposium and Rob Coggan (the new AU B5 panel convenor) will discuss future plans for the panel.

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

Nothing to note.

8. ANC Members on Working Groups

WG	Title	Australian Member	
B5.51	Methods & Application of Remotely Accessed Information for SAS Maintenance and Operation	Taren Hobson	
B5.56	Optimization of Protection Automation and Control Systems	Tuan Vu	
B5.57	New challenges for frequency protection	Chris Wembridge	
B5.58	Faster protection and network automation systems: implications and requirements	Stephen Pell	
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	
B5.69	Experience feedback and Recommendation for implementation of process bus in PACS	Frankie Lu (C)	
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)	

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



WG	Title	Australian Member	
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)	
B5.77	Requirements for Information Technologies (IT) and Operational Technology (OT) managed of Protection, Automation and Control Systems (PACS)	Rob Susanto-Lee	
B5.78	New requirements of network protection and control for renewable energy integration	Mitchell Tap	
B5.81	Obsolescence Management for Protection, Automation and Control	Peter Bishop (C)	
B5.82	Education, Qualification and Continuing Professional Development of Engineers in Protection, Automation and Control	Lara Kruk	
B5.83	Protection for modern distribution networks	Diptiman Yadav (C)	
B2.73	Guide for Prevention of Vegetation Fires Caused by Overhead Line Systems	Boris Celic (C)	

9. Membership of the Australian Panel

Name	Organisation	Туре
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
C Choo	PSC	Consultant
M Doherty	GHD	Consultant
T Foxcroft	Power Test Services	Consultant
L Kruk	Jacobs	Consultant
M Richie	APD Engineering	Consultant
M Huang	Aurecon	Consultant
A Turner	DEL	Consultant
M James	Essential Energy	Distribution



Name	Organisation	Туре
M Stanbury	Ausgrid	Distribution
R Coggan	Energy Queensland	Distribution
B Celic	SA Power Networks	Distribution
M Browne	Endeavour Energy	Distribution
Brendan May	Evoenergy	Distribution
R Simpkin	United Energy	Distribution
D Yadav	Jemena	Distribution
N Kamenyitzky	Snowy Hydro	Generation
R Acevedo	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
D Lee	Western Power Corporation	Transmission
	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
D Abetz	Siemens	Vendor
F Pambrun	Grid Solutions	Vendor
P Sabeti	Dynamic Ratings	Vendor
T Congo	Omicron	Vendor
S Sudakov	Моха	Vendor
S Kumar	ВНР	Manufacturer
Alan Luc	Ausgrid	NGN Rep
S Chiu	PowerCo	CIGRE NZ B5

Convener: Peter Bishop

Email: peter.bishop@transpower.co.nz 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).

Further to these the increasing impact of hydrogen has also been an area of interest for SC1 in terms of energy storage, energy transmission, and flexible demand.

3. **Preferential Subjects**

The C1 preferential subjects agreed at the 2022 Paris summit, and reconfirmed at the GM in Cairns 2023, focus on solving technical challenges that the power system of the future will have to overcome. These are continuation previous subjects:

- PS1: Steering the Energy Transition: cooperation, achieving top-down targets through bottomup investment decisions (Interconnections & System Integration):
 - Governance of the different sectors of the integrated energy system, role of system operators, role of regulation & markets; achieving public targets through private investments, coordinated decision-making processes and international cooperation.
 - Power-to-Gas & Hydrogen as energy carrier and as long-term storage; energy efficiency & infrastructure efficiency in the interconnected electricity/gas/hydrogen system; large interconnection projects
 - System aspect aggregation of the electrification of transport, industry, and buildings: conditions and barriers, role of stakeholders in the End-to-End system.



- PS2: Flexibility as pivotal criterion for system development (Grid Planning & System Development):
 - Including in the planning process the flexibility options both within and outside the grids; non-network-assets and non-electric solutions: Storage, Demand Response, Energy Communities, behind-the-meter resources.
 - Matching flexibility needs with flexibility sources: market design evolution, value of various flexibility products, optimal flexibility portfolio; prioritization of sector coupling initiatives; role of forecasts of demand and variable generation.
 - Storage device evolution, technical & economic performances, short/medium term measures for balancing the grid, and managing the energy system in the longer term, including thermal & molecular long duration energy storage.
- PS3: Resilience as pivotal criterion for system development (Asset Management & Economics):
 - Metrics and criteria to plan resilience and strength of the future power system; flexibility means as enhancers also of resilience.
 - Optimal planning and efficient use of resilience measures: risk assessment, prevention, mitigation, adaptation, re-start measures.
 - Resilience improvements from grid architecture and grid components: including the role of power electronics control and grid forming features, smart load shedding, and fast restoration methods.

Preferential subjects were discussed at the 2022 Paris meeting of Committee C1 and agreed to continue to focus on Steering the energy transition (PS1), Flexibility (P2), and Resilience (P3).

4. **Proposed New Working Groups**

Committee C1 has proposed four new working groups to commence in 2024, conveners are being sought while terms of reference are being drafted, with developments to be discussed at the next SC1 meeting in Q1 of 2024:

- Offshore transmission planning.
- Global sustainable energy systems coupling electricity and hydrogen.
- Assessment of system reserves and flexibility needs in the power systems of the future.
- Virtual Power Plants role and deployment in large power systems' operation and planning.
- Forecasting demand to include consumer behaviour decisions influenced by market signals.

5. Specific Activities of the Australian Panel

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

- Local initiatives such as site visits, or dedicated workshops during face to face meetings
- General work to support the activities of the C1 Study Committee by contributing Australian perspectives to the preferential subjects.
- Preparation of workshops and seminars for the 2024 Paris event.
- Proposed local committee seminars or workshops for 2023.

All the above will be member participation and interest pending.



6. Meeting Report: Australian Panel

Committee AU C1 met three times during 2023, all meetings were held via video conferencing. A reduced member meeting was also held at the Cairns Symposium to discuss contributions to the 2024 C1 Tutorial on power system resilience.

Our first meeting in January focused on reviewing the AU and international SC1 activities, AU ATC activities, and work planning for the year ahead. At the January meeting the AU C1 agreed to focus our technical discussions and research on several transmission planning impacting matters:

- Social Licence in transmission infrastructure expansion
- Role of network planning in managing the energy transition
- Impact of new technologies on power system planning
- Electrification and vector coupling, and its impact on the electrical network
- Planning under uncertainty
- Integrated planning
- Planning standards

For these topics of interest, AU C1 members have been nominated/volunteered to coordinate a summary of the status of these matters in relation to transmission planning and network expansion, as well as asset management. Pending progress, the output of this work may be used to prepare an Electra contribution or a paper for a later CIGRE symposium.

Looking ahead, AU 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 AU 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.

With a present membership of 22, AU C1 has strong representation from across the Australian energy sector, with every Australian and New Zealand TNSP represented and one Australian DNSP. 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, AU 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. EnergyCo responded positively and has contributed an active member.

The last meeting of 2023 will be held on 17 November 2023 and used to discuss:

- The AU AGM of November 2023.
- The 2024 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 potential members for the AU 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. Exception being the recent 2023 Cairns Symposium, at which the international C1 committee met.



8. ANC Members on Working Groups

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

WG	Title	Australian Member
C1/C6.37	Optimal transmission and distribution investment decisions under increasing energy scenario uncertainty	Alex Baitch
C1/C6.42	Planning tools and methods for systems facing high levels of distributed resourcing	Rama Ganguli
C1.45	Harmonised metrics and consistent methodology	Prateek Beri
	(CBA) of electric interconnection projects.	Henry T. Nguyen
C1/C4.46	Optimising power system resilience in future grid design.	Christian Schaefer
C1.47	Energy Sectors Integration and impact on power grids.	Christian Schaefer
C1.48	Role of green hydrogen in energy transition:	Herath Samarakoon
	opportunities and challenges from technical and economic perspectives.	Cameron Potter
C1.51	The potential roles of energy storage in electric power systems	ТВА

9. Membership of the Australian Panel

Name	Organisation	Туре
Christian Schaefer	GHD (Convener)	Consultant
Brad Parker	ElectraNet	Transmission
Enrique Montiel	Powerlink Queensland	Transmission
YiSiang Ooi	AEMO	System Operator
Eli Pack	AEMO	System Operator
Julian Swartz	GSMT Consulting	Consulting
Christine Hill	TransPower	Transmission
Mark Parker	EPEC	Consulting



Name	Organisation	Туре
Herath Samarakoon	TasNetworks	Transmission
Athmi Jayawardena	Hatch	Consulting
Donald Vaugh	Entura	Generation/Consulting
Tom Bakker	Aurecon	Consultant
Ben Bristow	Western Power	Transmission
Stephen Hodgkinson	ETSE Consulting	Consulting
Matthew Webb	AusGrid	Distribution
Nathan Crooks	Aurecon (NGN Representative)	Consulting
Jony Kaushik	Transgrid (NGN Representative)	Transmission
Peter Rasmus	Jacobs	Consulting
Lulu Shao	EnergyCo	Government
Kevin Hinkley	Transgrid	Transmission
Herman De Beer	AusNet	Transmission
Sunil Verma	FGC Consulting	Consultant

Convener: Christian Schaefer Email: christian.schaefer@ghd.com Phone: 0428 867 171



AU C2 Power system operation 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

Technical Direction

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 focuses on the real-time power system operations;

TD2 – System Operational Planning and Performance Analysis focuses on the operational planning, impact analysis and follow up of system operations in terms of security, quality and economic efficiency and also the interaction between involved parties in the operational process; and

TD3 – Control Centre Infrastructure and Human Resources for System Operation focuses on the Control Centres and the integration of human and technical resources to achieve secure and efficient system operations, including operational personnel education, initial and continuous training and certification.

Publications and Tutorials

Two Technical Brochure (TB) were published during the year, reflecting the findings and recommendations from Working Groups:

- TB 911 Power system restoration accounting for a rapidly changing power system and generation mix (WG C2.26).
- TB 917 Wide Area Monitoring Protection and Control Systems Decision Support for System Operators (WG C2.18)

Three tutorials and webinars were presented by Study Committee C2 during the year:

- Presentation of results from survey on the impact of the growing use of ML/AI in the operation and control of power networks (WG C2.42) Webinar June 2023
- Mitigating the Risk of Fire Starts and Consequences of Fires Near Overhead Lines for System Operations (WG C2.24) – September 2023 – Cairns Symposium
- Power System Restoration Accounting for a Rapidly Changing Power System and Generation Mix (WG C2.26) – September 2023 – Cairns Symposium

The best paper from the 2022 Paris Session was published in the CIGRE Science and Engineering Journal:

 Inertia Measurements in the GB Power System used for Operations and Planning Improvements



3. Preferential Subjects

Preferential subjects selected by the Study Committee for the 2024 Paris Session are:

- 1. Create operational resilience to extreme / unpredictable events:
 - a. Natural phenomena forecasting applied to operations planning studies and real-time decision support;
 - b. Threats and hazards from other systems that affect supply / demand of electricity;
 - c. Lessons learned and best practices to deal with high impact / low probability events on system operation; and
- 2. Changes in system operation and control considering the energy transition:
 - Disturbances and system restoration in power systems with a high share of inverterbased resources;
 - b. Flexibility and ancillary services for high Renewable Energy System (RES) share environments;
 - c. Power system operation strategies and operation planning studies considering a high share of RES.

4. Proposed New Working Groups

Two new Working Groups have been established during 2023:

- WG C2.44 Operational strategies to manage power system minimum operating conditions.
- WG C2.45 Estimation, evaluation and provision of power system inertia in networks with a high share of renewable generation.

The Convenor of WG C2.44 is Greg Hesse, the retiring Convenor of Australian panel C2.

Other topics for possible new Working Groups include:

- Power system operational resilience indices;
- System operation and cyber security (joint with D2?) possible focus on DER
- Influence of changing climate policies on system operation (joint with C3?)
- Changes in Control Centres due to technology changes and new functionalities available in Distribution Management System.

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;
- Chaired two of the six C2 paper sessions at the Cairns Symposium;
- Five synopses were submitted for the 2024 Paris Session, with three being accepted for preparation of full papers;
- A total of 14 Australian papers were presented at the C2 sessions at the Cairns Symposium; and
- Sharing of local learnings through completion of surveys to support the work of working groups.



6. Meeting Report: Australian Panel

The AU C2 panel met on 3 September 2023, prior to the start of the Cairns Symposium. The Convenor provided an update on the activities of SC C2 and CIGRE internationally. Potential Australian contributions for the Large Disturbance Workshop at the 2024 Paris Session were identified and discussed.

Other topics of interest that were discussed included:

- With increasing deployment of new technologies what hidden risks might being introduced into the power system – e.g. does DC inverter equipment have a vulnerability to DC ground currents from solar flare activity?;
- The need for simulations tools that can detect and model interactions between multiple System Integrity Protection Schemes (SIPS); and
- With a highly variable power system that depends on weather patterns (solar and wind) how do we plan to operate the power system with so many varying parameters.

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 met in Cairns on 5 September 2023 in conjunction with the Cairns Symposium.

8. ANC Members on Working Groups

The following are all the AU C2 representatives on Working Groups during 2023.

WG	Title	Australian Member
C2.18	Wide area monitoring protection and control systems – decision support for system operators	James Guest
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 /	Danial Lavis Russell Gordon
C2.42	The impact of the growing use of ML-AI in the operation and control of power networks from an operational perspective	Karin Rodrigues
C2.44	Operational strategies to manage power system minimum operating conditions	Greg Hesse (Convenor) Nilesh Modi
C2.45	Estimation, evaluation and provision of power system inertia in networks with a high share of renewable generation	ТВА



Name	Organisation	Туре
Dugald Bell	Western Power	Transmission
Stuart Donaldson	Ausgrid	Distribution
Duncan Griffin	Power and Water Corporation	Operator / Transmission / Distribution
Greg Hesse	GH Energy Advisory	Transmission
Jennifer Hughes	Transgrid	Transmission
Hesam Marzooghi	PSC Consulting	Consultant
Chong Ong	TasNetworks	Transmission / Distribution
Alexandra Price	Energy Queensland	NGN
Matthew Rigano	Energy Queensland	Distribution
Emma Rogers	Powerlink	Transmission
Richard Sherry	Transpower	Operator / Transmission
Rob Susanto-Lee	APD Engineering	Consultant
Colin Taylor	ElectraNet	Transmission
Tjaart Van Der Walt	AEMO	Operator
Bradley Vogel	Essential Energy	Distribution

9. Membership of the Australian Panel

Convener: Greg Hesse

Email: greg@ghenergyadvisory.com.au

Phone: 0418 783 840



AU C3 panel name

1. Study Committee Scope

Responsible 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 lifecycle assessment (LCA), environmental product declarations (EPD), global benchmarking, etc. are included in the scope.

The committee works closely 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 11 active working groups.

Working Group	Convenor
AG C3.01 EMF and Human Health	Michel Plante (CA)
WG C3.09A Sustainable corridor management	Aleš Kregar (SL)
WG C3.12 Methodologies for greenhouse gas inventory and reporting for T&D utilities	Pending
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	
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	
WG C3.20 Sustainable development goals in the power sector	Lou Cecere (USA)
WG 3.21 Including stakeholders in the investment planning process	Susana Batel (PT)
WG 3.22 Vegetation management in substations	Vincent Du Four (BE)
WG C3.23 Eco-design methods for TSOs/DSOs under environmental transition	Guillaume Busato (FR)
JWG B1/C3 85 Environmental impact of decommissioning of underground and submarine cables	Kieron Leeburn (ZA)

During the SC C3 meeting in Sendai 2023, members were reminded to be focused on finalising working groups and progressing to Technical Brochures. In some cases, the convenors or members are no



longer available, and commitment and participation was encouraged to assist in finalising the various working groups.

3. Preferential Subjects 2024

The current preferential subjects, subject to approval by the Technical Council include:

PS 1: Public acceptance and stakeholder engagement in power system – generation, transmission and distribution infrastructure

- Experiences in dealing with public acceptance of new and existing infrastructure
- Strategies, tools, indicators and methods that allow for effective stakeholder engagement
- Role of mitigation, compensation and offsetting measures (permitting processes)

PS 2: Climate change and impact on power system, a holistic approach

- Potential variations in the climate variables in different scenarios and impacts on power infrastructure and system operations
- Risk assessment methodologies and experiences
- Adaptation measures: lessons learned and criteria to be considered for the future and existing infrastructure

PS 3: Sustainability starting for the supply chain

- Inclusion of eco-design and circularity criteria: solutions to reduce impact along the whole of life for assets
- Green procurement: experiences and methodologies to incorporate sustainability aspects in tendering decisions
- Decarbonisation: accounting for scope 3 emission and reduction strategies

4. **Proposed New Working Groups**

During the SC C3 meeting at the Sendai 2023 Colloquium, a new working group was proposed by Frode Johansen from Norway on:

Methods of reducing electrocution of birds from power lines: a focus on low voltage networks.

I referred Frode to work being undertaken by TasNetworks on the interaction of the Tasmanian eagle with thin wire distribution powerlines.

5. Specific Activities of the Australian Panel

During 2023, the Australian C3 panel held two meetings including one virtual meeting on 2 August 2023 and a face-to-face meeting hosted by Powerlink in Brisbane on 1 and 2 November 2023.

A focus was made on increasing panel activity and participation.

6. Meeting Report: Australian Panel

In Brisbane, the Australian C3 panel meeting discussed a range of important topics, including:

- Transmission line land access issues and challenges
- Social licence to operate
- Sendai overview
- ESG / Sustainability goals
- Waste management zero waste pathway
- Impacts of the Commonwealth's "Nature positive plan" emphasis on offset implications
- Training development and delivery (online/face to face)
- Biosecurity
- Standard environmental clauses in contracts.

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

Preparations are underway for attending the Cigre Paris 2024 Session.

8. ANC Members on Working Groups



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

WG	Title	Australian Member
WG C3.09A	Sustainable corridor management	Brett Hayward

Given the change over in previous members, the focus of this year has been on increasing panel participation by member organisations. Success has been achieved in advancing the guiding Cigre principles of knowledge sharing through organisational support for attendance and participation in meetings. The next phase will be to encourage greater participation at the international level.

9. Membership of the Australian Panel

Name	Organisation	Туре
Brett Hayward	Essential Energy	Distribution
James Hart	Ausgrid	Distribution/Transmission
Gina Pavlovic	Endeavour Energy	Distribution
Ed Parker	TasNetworks	Distribution/Transmission
David Donahue	Transgrid	Transmission
Lynde Murray	Energy Queensland	Distribution
Russell McKenna	Powerlink	Transmission
Scott Haynes	Electranet	Transmission
James Widenbar	Western Power	Distribution/Transmission
Steve Oag	AEMO (NGN)	Regulator

Convener: Brett Hayward

Email: brett.hayward@essentialenergy.com.au

Phone: 0409 603 005



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 systems dynamics and numerical analysis (PMNA)
- Power quality (PQ)
- Electromagnetic compatibility and interference (EMC)
- Insulation co-ordination (IC)
- Lightning (L)

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 2020 SC meeting held during the Paris E-Session, the composition of the SC was confirmed as follows:

- Chair and Secretary
- 30 Regular Members
- 16 Observer Members

The membership of SC C4 presently encompasses 42 countries.

Figure 2: SC C4 structure



From Australia, Babak Badrzadeh is a member of SAG. Babak is also a Regular Member of the SC.



3. Specific Activities of the Study Committee

3.1 Active Working Groups

SC C4 currently has Forty-Four (44) active Working Groups (WG) divided into the following areas:

- PMNA: 16
- PQ: 5
- EMC: 5
- IC: 8
- L: 10

A detailed list of active working groups including their most recent reports is shown below. Note that this list includes some of the already published Technical Brochures since a working group is considered active until officially disbanded often following the delivery of the respective tutorial.

WG #	Title	Convener	Dates (Creation - Disbanding)	WG Reports
<u>WG C4.36</u>	Winter Lightning – Parameters and Engineering Consequences for Wind Turbines	<u>M. Ishii (Japan)</u> - <u>bio</u>	2014 - 2017	<u>2023</u>
<u>JWG</u> C4.40/CIRED	Revisions to IEC Technical Reports 61000-3-6, 61000-3- 7, 61000-3-13, and 61000-3-14	<u>M. Halpin (USA)</u>	2015 - 2018	<u>2023</u>
<u>JWG</u> C4.42/CIRED	Continuous assessment of low-order harmonic emissions from customer installations	<u>I. Papič (Slovenia)</u>	2015 - 2018	<u>2023</u>
<u>WG C4.43</u>	Lightning problems and lightning risk management for nuclear power plants	A. Tatematsu	2017 - 2020	<u>2023</u>
<u>WG C4.44</u>	EMC for Large Photovoltaic Systems	E. Salinas (Sweden)	2017 - 2019	<u>2023</u>
<u>WG C4.47</u>	Power System Resilience (PSR WG)	<u>M. Panteli (Cyprus)</u>	2017 - 2020	<u>2023</u>
<u>WG C4.49</u>	Multi-frequency stability of converter-based modern power systems	<u>Ł. Kocewiak</u> (Denmark)	2018 - 2021	<u>2022</u>



WG #	Title	Convener	Dates (Creation - Disbanding)	WG Reports
<u>WG C4.50</u>	Evaluation of Transient Performance of Grounding Systems in Substations and Its Impact on Primary and Secondary Systems	<u>B. Zhang (China)</u>	2018 - 2021	<u>2023</u>
<u>WG C4.51</u>	Connection of Railway Traction Systems to Power Networks	<u>D. Vujatovic (UK)</u>	2018 -2021	<u>2023</u>
<u>JWG C4/A3.53</u>	Application Effects of Low-Residual-Voltage Surge Arresters in Suppressing Overvoltages in UHV AC Systems	<u>J. He (China)</u>	2019 - 2021	<u>2022</u>
<u>WG C4.54</u>	Protection of high voltage power network control electronics from the High-altitude Electromagnetic Pulse (HEMP)	<u>W.A. Radasky</u> (USA)	2019 - 2022	<u>2023</u>
<u>WG C4.55</u>	EMC related very-fast transients in gas- insulated substations - EMC interferences, measured characteristics, modelling and simulations	<u>A. Ametani (Japan)</u>	2019 - 2022	<u>2023</u>
<u>WG C4.57</u>	Guidelines for the Estimation of Overhead Distribution Line Lightning Performance and its Application to Lightning Protection Design Scope	<u>K. Michishita</u> (Japan)	2019 - 2022	<u>2023</u>
<u>JWG</u> <u>C4/C2.58/IEEE</u>	Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems	<u>U. Annakkage</u> (Canada)	2019 - 2021	<u>2022</u>



WG #	Title	Convener	Dates (Creation - Disbanding)	WG Reports
<u>JWG</u> <u>C4/C2.62/IEEE</u>	ReviewofAdvancementsinSynchrophasorHeasurementApplicationsHeasurement	<u>A. Rajapakse</u> (Canada)	2021 - 2023	<u>2023</u>
<u>WG C4.59</u>	Real-timeLightningProtectionoftheElectricitySupplySystems of the Future	<u>C. Tong (China)</u>	2019 - 2022	<u>2023</u>
<u>WG C4.60</u>	Generic EMT-Type Modelling of Inverter- Based Resources for Long Term Planning Studies	<u>A. Haddadi (USA)</u>	2020 - 2023	<u>2022</u>
<u>WG C4.61</u>	Lightning transient sensing, monitoring and application in electric power systems	<u>J. He (China)</u>	2021 - 2023	<u>2023</u>
<u>WG C4.63</u>	Harmonic power quality standards and compliance verification – a comparative assessment and practical guide	<u>N. Shore (UK)</u>	2021 - 2024	<u>2023</u>
<u>WG C4.64</u>	Application of Real-Time Digital Simulation in Power Systems	<u>C. Fang (Canada)</u>	2021 - 2023	<u>2023</u>
<u>WG C4.65</u>	Specification, Validation and Application of Harmonic Models of Inverter Based Resources	<u>J. David (Australia)</u>	2021 - 2024	<u>2023</u>
<u>WG C4.66</u>	New concept for analysis of multiphase back-flashover phenomena of overhead transmission lines due to lightning	<u>M. Miki (Japan)</u>	2021 - 2024	<u>2023</u>
<u>WG C4.67</u>	Lightning Protection of Hybrid Overhead Lines	<u>A. Piantini (Brazil)</u>	2022 - 2025	<u>2023</u>



WG #	Title	Convener	Dates (Creation - Disbanding)	WG Reports
<u>WG C4.68</u>	Electromagnetic Compatibility (EMC) issues in modern and future power systems	<u>P. Munhoz-Rojas</u> (Brazil)	2021 - 2024	<u>2023</u>
<u>WG C4.69</u>	Quantifying the lightning response of tower- footing electrodes of overhead transmission lines: methods of measurement	<u>S. Visacro (Brazil)</u>	2021 - 2023	<u>2023</u>
<u>WG C4.70</u>	Application of space- based lightning detection in power systems	<u>J. Montanyà</u> (Spain)	2022 - 2025	<u>2023</u>
<u>WG C4.71</u>	Small signal stability analysis in inverter based resource dominated power system	<u>S. Goyal (Australia)</u>	2022 - 2025	<u>2023</u>
<u>WG C4.73</u>	Insulation Coordination of HVDC Overhead Lines	I. Uglesic (Hungary)	2022 - 2025	
<u>WG C4.74</u>	Accurate Line and Cable Models for Steady-State and Transient Studies	<u>H. Xue (China)</u>	2023 - 2027	<u>2023</u>
<u>WG C4.76</u>	Overvoltage Protection in Switching Inductive Devices with Vacuum Circuit Breaker	<u>Q. Yang (China)</u>	2023 - 2026	<u>2023</u>
<u>JWG</u> <u>C4/A3/B2/B4.75</u>	Guide to procedures for the creation of contamination maps required for outdoor insulation coordination	M. Marzinotto (Italy)	2023 - 2026	<u>2023</u>
<u>JWG C4/B4.72</u>	Lightning and switching induced electromagnetic compatibility (EMC) issues in DC power systems and new emerging power electronics-based DC	<u>Q. Li (China)</u>	2022 - 2025	<u>2023</u>



WG #	Title	Convener	Dates (Creation - Disbanding)	WG Reports
	equipment			
<u>JWG A1/C4.52</u>	Wind generators and frequency-active power control of power systems	<u>N. Miller (USA)</u>	2015 - 2018	<u>2022</u>
<u>JWG B1/C4.69</u>	Recommendations for the insulation coordination on AC cable systems	<u>T. du Plessis</u> (South Africa)	2018 - 2021	<u>2022</u>
<u>JWG</u> <u>B4/B1/C4.73</u>	Surge and extended overvoltage testing of HVDC Cable Systems	M. Saltzer (Sweden)	2016 - 2017	<u>2022</u>
<u>JWG B4/C4.93</u>	Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity Systems	<u>D. Kong (UK)</u>	2022 - 2025	<u>2022</u>
<u>JWG B5/C4.61</u>	Impact of Low Inertia Network on Protection and Control	<u>R. Zhang (UK)</u>	2017 - 2020	<u>2022</u>
<u>JWG C1/C4.36</u>	Review of Large City & Metropolitan Area power system development trends taking into account new generation, grid and information technologies.	<u>V. Jesus (Brazil)</u> <u>S. Utts (Russia)</u>	2017 - 2019	<u>2022</u>
<u>JWG B2/C4.76</u>	Lightning & Grounding Considerations for Overhead Line Rebuilding and Refurbishing Projects, AC and DC	<u>William A. Chisholm</u> (Canada)	2019 - 2022	<u>2022</u>
<u>JWG C1/C4.46</u>	Optimising power system resilience in future grid design	<u>Christian Schaefer</u> (Australia)	2021 - 2022	<u>2022</u>
<u>JWG B5/C4.79</u>	Protection Roadmap for Low Inertia and Low Fault Current Networks	Mukesh Nagpal (Canada)	2022 - 2024	
JWG B4/C4.97	Benchmarking of	Arash Fazel	2023 - 2025	2023



WG #	Title	Convener	Dates (Creation - Disbanding)	WG Reports
	simulation models for control interaction in meshed AC networks with multiple converters	Darbandi (Canada)		

3.3 Green Books

The first C4 led Green Book entitled Power System Modelling and Analysis in Evolving Networks is expected to be published in July 2024. This is a Major Reference Work (MRW) with several contributions from Australia as follows:

- Chief Editor; Babak Badrzadeh
- Secretary: Genevieve Lietz
- Chapter lead: Nilesh Modi
- Key contributor to multiple chapters: Genevieve Lietz
- Other key contributors
 - Andrew Halley
 - o Sachin Goyal
 - o Aditya Upadhye
 - o Hitesh Bavarva

3.4 CIGRE Science and Engineering Journal and Electra Articles

The following reference material has been published by SC C4 members over the last twelve months in the CSE Journal:

- Oscillatory Interaction Between Large Scale IBR and Synchronous Generators in the NEM, E. Farahani, P. F. Mayer, J. Tan, F. Spescha, M. Gordon, CSE 028, March 2023.
- Simulation of a Grid with 100% Inverter-Based Generation and Synchronous Condensers for Grid Reference, J.R. Ramamurthy, A. Jalali, N. Modi, F. Spescha, CSE 30, October 2023.

All documentation is available via the e-CIGRE website.

3.5 Webinars

A webinar was presented in April 2022 based on the work conducted by CIGRE WG C4.56 on Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter connected generation. The presenters include Babak Badrzadeh (Convener) and Sorrell Grogan both from Australia as well as Jean Mahseredjian from Canada.

Furthermore, the following C4 webinars were presented in the past 12 month:

- Guidelines for subsynchronous oscillation studies A summary of TB 909
- Modelling and analysis of power networks with high percentage of inverter resources

3.6 Published Technical Brochures

The following TB have been published by SC C4 in 2022/2023



TB 913: Evaluation of Temporary Overvoltages in Power Systems due to Low Order Harmonic Resonances

TB 909: Guidelines for Subsynchronous Oscillation Studies in Power Electronics Dominated Power Systems

TB 900-904: High-Frequency Transformer and Reactor Models for Network Studies (Parts A – E)

TB 885: Guide on the assessment, specification and design of synchronous condenser for power system with predominance of low or zero inertia generators

3.7 International Events: Cairns Symposium

SC C4 accepted 46 papers for which it received 45 presentations scheduled in 9 sessions. As indicated below this was the highest number of papers among all study committees.

Study Committee	Number of papers
SC A3	11
SC B1	6
SC B3	15
SC B5	30
SC C1	25
SC C2	29
SC C4	45
SC C5	19
SC C6	30
SC D1	11
SC D2	22
Grand Total	243

Approximately 70% of C4 papers were submitted from Australia, 80% of which were aligned with PMNA.

Paper ID	title	submitting_author	sa_organisation
	Assessment to Quantify the Impacts of Omitting the Frequency Dependent Modelling of Existing IBR Plants on Grid Harmonic Impedance Computation for New		
<u>1113</u>	Connections	Perera, Lasantha	APD Engineering
1121	Commissioning of major power system upgrades	Robinson, Luke	AEMO
1152	Commissioning experiences with Inverter Based Renewable plants: Observed plant behaviours and issues	GOYAL, Sachin	POWERLINK QUEENSLAND
<u>1162</u>	Revision and Validation of IBR Harmonic Models Using Field Measurements	David, Jason	<u>University of</u> Wollongong



<u>1163</u>	Certainty in power quality compliance, from desktop to evolving reality	Jansen, Marius	<u>Optimised Network</u> Equipment
1206	Comprehensive voltage regulation performance analysis of Virtual Synchronous Generator	Xu, Jingzhe	Monash University
1210	Application of impedance scan stability techniques to support new generator connections in the Australian NEM	Hagaman, Scott Andrew	DIgSILENT Pacific
1230	Tuning of Inverter-Based Renewable Generation in Australian NEM: Opportunities, Issues and Challenges	Coetzee, Tyler Wayne	PSC
1234	Challenges in connection of renewable energy sources to Australia's electricity grid	Mehrtash, Amir	Power Systems Consultants
<u>1235</u>	Reliable Protection of Wind Farm Assets from Lightning Strikes and TOVs Considering Surge Arrester Failure Probability	<u>Mahamedi,</u> <u>Behnam</u>	<u>Arcadis Australia</u> Pacific
1238	Benefits in harnessing the latent reactive current injection capability of inverter-based resources in the Australian power system	Wembridge, Christopher James	TasNetworks
1240	Negative sequence control of six-pulse inverters for improved performance during network faults	Wembridge, Christopher James	TasNetworks
1241	Transient Stability Investigation of Grid-forming Inverters in the Presence of Various Types of Current Limiters	Me, Si Phu	Monash University
1249	Dynamic modelling and simulation of grid-forming and grid-following inverter-based resources for system restoration studies	Badrzadeh, Babak	Aurecon
1253	A Comparative Analysis of Grid Forming and Grid following Control in Full Power Fed Wind Turbines in the Australian Grid	John, Blessy	Goldwind Australia
1254	Assessing the response of electric vehicles during network fault conditions	Franklin, Evan	University of Tasmania
<u>1255</u>	A Comprehensive and Innovative Approach to Manage Harmonics for Renewable Energy Zones (REZ)	<u>Vu, Tuan</u>	<u>Powerlink</u> Queensland
1268	Wind Power Integration in Weak Grids	Kabiri, Roozbeh	Vestas
1289	Small signal model development and testing of inverter-based renewable plants	GOYAL, Sachin	POWERLINK QUEENSLAND
1301	Impact of Distributed Photovoltaic System on System Strength	GOYAL, Sachin	POWERLINK QUEENSLAND
1313	Impact of external conditions on the development of frequency domain models of Inverter Based Resources	<u>David, Jason</u>	University of Wollongong
1322	Real-time oscillatory instability monitor – development and field test results	Cella, Umberto Maria	DIgSILENT
<u>1323</u>	Harmonic assessment and emission allocation for future grid	<u>Cella, Umberto</u> <u>Maria</u>	DIgSILENT
1334	Voluntary grid-forming specifications to support the transition to low-carbon power system	Modi, Nilesh	Australian Energy Market Operator
1338	Management of power system frequency excursions	Fracalossi, Daniel	Marinus Link



	with the integration of large HVDC interconnection		
1340	Fading oscillations in grid with low damping	Cella, Umberto Maria	DIgSILENT
1386	Accounting for capabilities and limitations of new and emerging generation technologies	Crooks, Nathan	Aurecon
1394	Dynamic challenges of a hybrid plant with a grid forming technology in a remote area.	Hadavi, Sajjad	GridWise Energy Solution
1410	Challenges of Modelling Complex Industrial Loads for System Studies	Fonseka, Jagath	Powerlink Queensland
1415	Investigation of reactive current injection of grid- following and grid-forming inverter-based resources during fault conditions	Badrzadeh Babak	Aurecon
1110	Virtual Synchronous Generators: Small-signal Stability Analysis under Varying Operating Points, Grid	Dadizadon, Dabak	
1418	Strengths, and Control Parameters	Mohammed, Nabil	Monash University

Furthermore, C4 organised a four-hour workshop on *new and emerging forms of system stability*. This workshop was chaired by Babak Badrzadeh, including Australian presenters from WG C4.71 namely, Sachin Goyal, Huajie G and Qiming Zhang. This workshop was attended by 250 conference participants.

4. Paris Sessions

4.2 Contributions from AU-C4

6 synopses sent by AU-C4 for 2024 Paris Session all of which accepted for preparation of full papers.

Synopsis title	PS	Authors	Affiliation
Methodologies including modelling tools and techniques, model validation, metrics and data analytics	1	Shahil Shah, Jingwei Lu, Nilesh Modi	NREL, AEMO
Large scale grid forming BESS replaces synchronous generation enabling high renewable penetration & low system load in Australia's major northern grid	1	Brendan Truoung, Stanislav CHEREVATSKIY, Stephen SPROUL, Vimeshan Pillay, Heath LANG	PWC, Hitachi Energy
Maximizing the Generator Hosting Capacity Using Grid-Forming BESS	1	Cheng Tan, Jiacheng Li, Athmi Jayawardena, Nalin Pahalawatta	Hatch
Development of A Type-4 Wind Turbine Generator Prototype To Test Grid- Forming Control Capabilities	1	Vishmidhan Ravindrababu, Siddhant Arya, Sean Leslie Martin, Harith Udawatte, Salah Hajtaleb, Behrooz Bahrani	Monash University
Impact of Inverter-Based Generating Systems on Synchronous Machine Subsynchronous Torsional Interactions	1	Aleksandar Karisik & Tony Bertes	DIgSILENT Pacific



PowerQualityAssessmentin2RenewableEnergyZone

Yilun	Sun,	Jiacheng	Li,	Salim	Hatch
Anwar	i, Nalir	Pahalawat	tta		

5. Other Specific Activities of the Australian Panel

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.

Working Group	AU.C4 Representative	WG participation level	Year formed	Status
C4.63	<u>Chandana</u> <u>HERATH</u>	Corresponding Member	2021	In progress
JWG B2/C4.76	Anne WILLIAMS John MCCORMACK Glenn STAPLETON	Regular Member Corresponding Members	2019	In progress
JWG C1/C4.46	<u>Christian</u> <u>SCHAEFER</u>	Convenor	2021	In progress
JWG B4/C4.93	<u>Behrooz</u> BAHRANI	Member	2022	In progress
C4.71	Sachin GOYAL Andrew HALLEY Qiming Zhang Alex Hugall	Convenor Regular Members	2022	In progress
JWG C4/C2.62/IEEE	<u>Devinda</u> PERERA	Corresponding Member	2021	In progress
C4.65	<u>Jason DAVID</u> <u>Sarath</u> <u>PERERA</u>	Convenor Member	2021	In progress



Working Group	AU.C4 Representative	WG participation level	Year formed	Status
C4.60	Ahvand JALALI	Member	2021	In progress
	<u>Behrooz</u> BAHRANI	Corresponding Member		
C4/C2.58/IEEE	<u>Ehsan</u> FARAHANI	Member	2019	In progress
	<u>Babak</u> BADRZADEH			
C4.56	<u>Babak</u> BADRZADEH	Convener	2019	In progress
	Sachin GOYAL	Corresponding		
	Mark DAVIES	members		
	<u>Sorrell</u> <u>GROGAN</u>			
	Jingwei LU			
C4/B4.52	<u>Babak</u> BADRZADEH	Member	2018	In progress
	<u>David</u> VOWLES	Corresponding members		
	Sachin GOYAL			
C4.51	Igor Perin	Members	2018	In progress
	<u>Phillip</u> COUGHLAN			
	<u>Cheryl</u> NORONHA	Corresponding		
	Craig Blizard			
C4.47	<u>Julian</u> EGGLESTON	Member Member	2017	In progress.
	<u>Terry</u> LAMPARD	Member		
	<u>Pierluigi</u> <u>MANCARELLA</u>			
C4.42/CIRED	Tim BROWNE	Corresponding	2015	In progress. Due
	<u>Sarath</u> PERERA	Member		tor completion in 2021



Working Group	AU.C4 Representative	WG participation level	Year formed	Status
	Vic Gosbell			
C4.40/CIRED	Alex BAITCH Sarath PERERA Vic Gosbell	Member Member	2015	In progress. Due for completion in 2021.
C4.39	Thomas DALY	Corresponding Member	2015	In progress

5.2 AU C4 Panel Meeting and Technical Seminar

The panel meet quarterly online and annually in a full-day annual general meeting (AGM) and technical workshop. The latter was conducted on 2 September 2023 in Cairns prior to the CIGRE Cairns Symposium. The meeting was attended by 25 members in person and virtually. In the first part of the meeting the Panel Convener, Babak Badrzadeh, provided a summary of the worldwide SC C4 and Australian Panel activities, and discussed about the opportunities and expectations from the members. The session was also attended by SC C4 Chair, Marta Val Escudero, who shared CIGRE and SC C4 strategic initiatives and focus areas.

Table below summarises a list of presentations made from various members representing transmission and distribution network service providers, developers, consultants, academia and system operator.

Title	Presented by
How initial screening can be used in IBR tuning for better system performance?	Manjula Dewadasa (remote)
Grid Connection Uncertainties from a Developer's Perspective - Renewable Energy and Green Hydrogen Development	Hieu Nguyen
Utility-Scale Hydrogen Electrolysers	Mehdi Ghazavi Dozein
Power System Simulation	Genevieve Lietz
StepsTowardsDistribution-ConnectedGenerationStandardisation & Transparency	Sorrell Grogan (remote)
Stability Enhancing Measures for Weak Grids Study - An ARENA- funded Study	Behrooz Bahrani
Small-signal and Transient Stability Analysis of inverter-based resources - A CSIRO/GPST Study	Behrooz Bahrani
Update on Transmission Network Operations and Planning Activities	Andrew Halley
Rethinking System Restart with High Penetration of DERs	Shabir Ahmadyar
Harmonic Amplification Factor Interpretation and Application	Tim Browne



Questionnaire on CIGRE WG C4.63 ("Harmonic power quality standards and compliance verification – a comparative assessment and practical guide")	Tim Browne
Impact and Management of Harmonics for Renewable Generators	Jason David (remote)
Avoiding Double-circuit Transmission-line Outages Caused by a Single Lightning Stroke	Don Geddy
Investigation of an isulation Coordination Failure	Peter Woloszyn
Relevant ElectraNet activities	Devinda Perera
The progress in developing the Future Network	Neville Watson
DC Coupled Hybrid Systems	Amir Mehrtash
Marinus Link	Paul Rayner

6. Membership of the Australian Panel

The AU C4 Panel consists of forty-one (41) members as of November 2023.

Name	Organisation	Туре
Navid Aghanoori	Transgrid	Network Service Provider
Shabir Ahmadyar	KPMG	Consulting
Salim Anwari	Hatch	Consulting
Behrooz Bahrani	Monash	Academia
Alex Baitch	Alex Baitch BES (Aust) Pty Ltd	Consulting
Errol Bebbington	PBA	Consulting
Babak Badrzadeh	Aurecon	Consulting
Tim Browne	Qualis Power	Consulting
Umberto Cella	DigSilent	Consulting
Wei Jian Chan (NGN)	Energy Queensland	Network Service Provider
Jason David	University of Wollongong	Academia
Manjula Dewadasa	Powerlink Queensland	Network Service Provider
Mehdi Dozein	Monash University	Academia
Don Geddey	TransGrid	Network Service Provider
Sorrell Grogan	Ausnet	Network Service Provider
Andrew Halley	Tasmanian Networks Pty Ltd	Network Service Provider
Miron Janjic	Beca	Consulting
Yugal Kishore	Siemens	OEM
Ben Li	Ausnet	Network Service Provider



Genevieve Lietz	AEMO	Market Operator
Hadi Lomei	Essential Energy	Network Service Provider
Amir Mehrtash	Power System Consultants	Consulting
Rizah Memisevic	EPEC Group	Consulting
Nilesh Modi	AEMO	Market Operator
Michael Negnevitsky	University of Tasmania	Academia
Hieu Nguyen	Amp Energy	Consulting
Huuson Nguyen	Western Power	Network Service Provider
Tony Palechek	Trina Solar	OEM
Lasantha Perera	APD	Consulting
Devinda Perera	ElectraNet Pty Ltd	Network Service Provider
Sarath Perera	University of Wollongong	Academia
Albert Pors	Endeavour Energy	Network Service Provider
Paul Rayner	Marinus Link	Network Service Provider
Steven Senini	Energy Queensland	Network Service Provider
Stephen Sproul	Hitachi-ABB	OEM
Aditya Upadhye	Grid Wise Energy	Consulting
Ping Wang	GE Grid	OEM
Neville Watson	University of Canterbury	Academia
Peter Woloszyn	Ausgrid	Network Service Provider

7. Panel contact details

For further information or questions, please contact:

Convener:Babak BadrzadehEmail:Babak.Badrzadeh@aurecongroup.comPhone:0466 504 953

Secretary: Jason David

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AU-C4 KMS Home Page:

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



AU C5 Markets and regulation Study Committee Scope

Our Mission

The Mission of Study Committee C5 (SC C5) is to facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of electricity markets and regulation.

SC C5 members provide needed insight to the wide variety of market and regulatory requirements involved with providing reliable energy with the changes in energy policy, technology development, consumer choice, and climate conditions.

Scope of SC C5

The scope of Study Committee C5 is to facilitate and promote the progress of engineering and international exchange of information and knowledge in the field of electricity markets and regulation.

SC C5 Electricity Markets and Regulation covers the design, implementation and operation of electricity markets and supporting regulatory arrangements. SC C5 activities include:

- Market design, efficiency and regulation;
- Integration of renewable resources into market structures;
- Generation and transmission investment;
- Congestion pricing and management; and
- Market
- Governance arrangements

The study committee conducts the Large Disturbance Workshop in Paris Sessions in conjunction with study committee C2.

The structure of the Study Committee

The structure of the Study Committee and key individuals is shown in the following diagram.



1. SC C5 and AU C5 MEMBERSHIP

The current membership of the study committee is available at <u>https://c5.cigre.org/GB/about-sc-c5/our-members</u>. The study committee has 24 ordinary members and 17 observers. Together, the members and observers represent 38 different countries.

The Australian C5 Panel has 17 members from east and west coast and also New Zealand and Singapore as these countries do not have sufficient members to support a panel of their own. This diversity of membership is most welcome as it brings broad perspectives and experiences to activities of the panel. A full listing of members is provided at the end of this report.

2. WG MEMBERSHIP

The working group membership and demographics are examined in March of each year. There were 6 working groups. There were 118 members in the working groups plus others in Joint Working Groups convened by other study committees. The C5 WG members were spread across 31 countries. Our working groups had 14% female membership and a smattering of NGN members.



3. PRINCIPAL AREAS OF INTEREST

The study committee focuses on three key areas:

Market structures and products. Market design, physical & financial markets and their interaction, isolated and interconnected systems, interactions with Hydrogen systems.

Market approaches and tools. Demand & price forecasting, financial risk management, demand management and active customer integration, integration of blockchain technologies.

Regulations. Regulatory objectives, regulatory approaches, transmission pricing, ancillary service pricing, reliability and economics).

In addition, the study committee is interested in:

- Changes in regulatory roles and jurisdiction related to the interaction between the transmission system and the distribution system.
- The role of markets, including: the integration and coordination of distributed energy resources; the impact on wholesale market price formation caused by non-wholesale market participants; the need for and development of distribution service providers.
- The impact of emerging technologies on system operations.
- Market clearing procedures, techniques and principles used to take advantage of the flexibility of aggregating large numbers of end-users.

Large Disturbance Workshop

The Large Disturbance Workshop is a highlight of Paris Sessions and is held in conjunction with Study Committee C2. Preliminary planning for the 2024 workshop commenced during the year and an initial flyer is planned to be released before the end of the year.

Tutorials

The study committee organized one tutorial at the Cairns Symposium on hydrogen certification. The tutorial followed a general introduction to hydrogen and issues for the deployment of hydrogen. The tutorial focused on the work of the C5/C1 Working group on hydrogen certification.

C5 Activities in the Existing and the New Working Groups

Australia was represented on a number of the WGs convened by C5 and Joint Working Groups with other study committees.

- WG C5.31 Wholesale and Retail Electricity Cost Impact of Flexible Demand Response
- WG C5.34
 Electric vehicle charge/discharge flexibility in wholesale energy markets
- JWG C5/C6.29 New Electricity Markets, Local Energy Communities
- JWG C5/C1.35 Integration of Hydrogen in Electricity Markets and Sector Regulation
- WG C5.36 Certification of electricity used to produce hydrogen
- WG C5.37 Regulatory framework on modernization and extension of useful life of transmission & distribution assets
- JWG C2/C5 Interventions in electricity markets (AU C5 member)

Technical Brochures

The Study Committee published two Technical Brochures. Australian panel members contributed to both:

• TB-877 Energy Price Formation in Wholesale Electricity Markets



 TB-874 Auction Markets and Other Procurement Mechanisms for Demand Response Services

Two current C5 Working Groups expect to complete their work and publish Technical Brochures in the near future.

- WG C5-31 Wholesale and Retail Electricity Cost Impact of Flexible Demand Response
- JWG C5/C6-34 New Electricity Markets, Local Energy Communities.

PENDING Panel Meetings

Date to be decided, in mid-year 2024 after receipt of Special Reporter question for Paris 2024.



Membership of the Australian Panel

There are 17 members of the Australian panel as follows. Industry experts with specialist expertise are also co-opted where appropriate. In the last two years gender and geographic diversity of membership has grown.

	Name	Company
1.	Jacqui Bridge	Powerlink
2.	John Cooper	Hydro Tas
3.	Julian Eggleston	DigSilient
4.	Victor Francisco	PSC
5.	Stephen Hinchliffe	Advisian
6.	Chantal Hopwood	Tasnetwork
7.	Rachel Johnson	Hydro Tas
8.	Rainer Korte	ElectraNet
9.	Kevin Ly	AEMO
10.	Li Zhenhui	EMC, Singapore
11.	Ramu Naidoo	TransPower NZ
12.	Jacinda Papps	Alinta Energy
13.	David Swift	Sole trader
14.	Greg Thorpe	Oakley Greenwood
15.	Pippa Williams	NGN, Hydro Tas
16.	Ben Vanderwaal	EY
17.	Rohan Zauner	Jacobs

Convener: Greg Thorpe

Email: Gthorpe@oakleygreenwood.com.au



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: isolated power systems and individual customer off-grid systems and solutions.

In 2023 one C6 technical brochure was published, as follows:

 TB 906 - Distributed Energy Resource Benchmark Models for Quasi-Static Time-Series Power Flow Simulations





3. Preferential Subjects

The preferential subjects for the 2024 Paris Session are:

PS1 - Flexibility Management in Distribution Networks

- Energy storage systems with the associated provision of their grid services to distribution and upstream networks
- Evolving planning and operational objectives and criteria with increased electrification, with changes in technology enabling end-to-end system operations
- Electric vehicle integration and impacts

PS2 - Power Electronic-based Solutions for Smart Distribution Systems

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

PS3 - Rural, Islanded and Industrial Electrification Standards, Practices and Technology Options

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

4. Proposed New Working Groups

In 2023 two new C6 working groups were approved:

- C6.46 Energy Efficiency in Distribution Systems
- C6.47 DSO-Customer Interfaces for Efficient System Operation

5. Specific Activities of the Australian Panel

Australian Panel C6 hosted its Conference on Integration of Distributed Energy Resources (CIDER) in Cairns on 4-5 September 2023, in conjunction with the CIGRE Cairns 2023 Symposium at the Cairns Convention Centre. CIDER shared a common registration with the Symposium and with SEAPAC, which meant that any attendee at the Symposium could attend a CIDER session (and vice versa). There are thus no separate registration figures for CIDER 2023 but it is estimated that the maximum number of attendees was of the order of 250, with an average across the two days of the order of 150. This made it the best attendance at any CIDER to-date.

This was the fifth CIDER run by Australian Panel C6, the previous conferences being in Brisbane in 2015, Sydney in 2017, Melbourne in 2019 and Adelaide in 2022. The 2023 conference included:

- a keynote presentation by Peter Price of Energy Queensland;
- two extended presentations, by Jenny Riesz of AEMO and by Jenny Gannon of Energy Queensland;
- 30 other presenters in a single-stream format, covering a number of issues including managing high penetration of DER, DERMS, dynamic operating envelopes, distribution state estimation, quality of supply, virtual power plants, electric vehicles, DER enablement, customer engagement, microgrids, grid shrinkage, community batteries, inverters and standardisation;
- an NGN panel on The Impact of DER on Planning and Operation of Electric Power Systems, from the Perspective of the Next Generation;
- an NGN activity, Save the Australian Power System from Imminent Collapse!, involving the audience voting on how to respond to a system event.

A total of 11 presentations that were originally submitted to the Symposium as papers were presented in CIDER.

Feedback for CIDER 2023, from both international and Australian delegates, was very positive.



6. Meeting Report: Australian Panel

Australian Panel C6 typically holds a one-day meeting when held in conjunction with CIDER (odd years) and a two-day meeting in other (even) years. However, no face-to-face meeting was held in 2023, as the full program of C6 activities at the Cairns Symposium meant there was no available time for an AU C6 meeting. AU C6 members were able to catch up with each other at the CIDER and Symposium events and at an AU C6 dinner held in Cairns on the evening of 4 September 2023.

Two AU C6 teleconferences were held throughout 2023, in February and May, with a third planned for early December.

7. Invitations for SC or WGs to meet in Australia

Study Committee C6 accepted the Australian National Committee's invitation to hold their meeting in 2023 in Cairns, in conjunction with the CIGRE Symposium. The meeting was held on 7 September 2023.

At this time, no other SC or WG C6 meetings are planned to be held in Australia.



8. 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
C1/C6.37/ CIRED	Optimal Transmission and Distribution Investment Decisions under Increasing Energy Scenario Uncertainty	Alex Baitch
C6.39	Distribution Customer Empowerment	Neha Moturi (secretary)
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
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
C6.44	Nodal Value of Distributed Renewable Energy Generation	Alan Luc
C6.44	Nodal Value of Distributed Renewable Energy Generation	Mitchell Tap
C6.45	The Impact of Distributed Energy Resources (DER) on the Resilience of Distribution Networks	Pierluigi Mancarella
C6.45	The Impact of Distributed Energy Resources (DER) on the Resilience of Distribution Networks	Alice Fleetwood
C6.47	DSO-Customer Interfaces for Efficient System Operation	Daniel Eghbal (convenor)
C6.47	DSO-Customer Interfaces for Efficient System Operation	Caitlin Trethewy (secretary)
C6.47	DSO-Customer Interfaces for Efficient System Operation	Tim Moore
C6.47	DSO-Customer Interfaces for Efficient System Operation	Andrew McConnell
C6.47	DSO-Customer Interfaces for Efficient System Operation	Mohsen Khorasany
C6.47	DSO-Customer Interfaces for Efficient System Operation	Alan Luc
AG C6.02	Quality Review	Ray Brown (convenor)


9. Membership of the Australian Panel

Name	Organisation	Туре
Graeme Ancell	Ancell Consulting	Consultant
Ken Ash	Energ-G Management Group	Consultant
Alex Baitch	BES	Consultant
Ray Brown	RBPE	Consultant
Warwick Crowfoot	Essential Energy	Distribution
Sean Elphick	University of Wollongong	University
John Fletcher	University of NSW	University
Jenny Gannon	Energy Queensland	Distribution
Pat Graham	AEMO	NGN Rep.
Victor Ho	SA Power Networks	Distribution
Laura Jones	Australian National University	University
Luke Koedijk	AGL	Retailer
Tony Law	Western Power	Distribution
Shuyi Li	AusNet Services	Distribution
Alan Luc	Ausgrid	Distribution
Janica Lukas	Western Power	Distribution
Jackson Lung	Wellington Electricity	Distribution
Pierluigi Mancarella	University of Melbourne	University
Andrew McConnell	United Energy	Distribution
Yateendra Mishra	Queensland University of Technology	University
Michael Negnevitsky	University of Tasmania	University
Albert Pors	Endeavour Energy	Distribution
Jenny Riesz	AEMO	Operator
Mohammad Seidaliseifabad	Power Systems Consultants	Consultant
Stephen Sproul	Hitachi Energy	Manufacturer
David Stephens	Horizon Power	Distribution
Caitlin Trethewy	AGL	Retailer
Mike Wishart	EcoJoule Energy	Manufacturer
Wai-Kin Wong	Hatch	Consultant
Richard Yan	University of Queensland	University
Ahmad Yousuf	Omicron	Manufacturer

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. Main areas of attention

The Study Committee deals with the performance of materials and electrical insulation systems (EIS) with respect to electrical, thermal, mechanical, chemical and environmental stresses. Based on this knowledge, test and measurement procedures are evaluated and developed, if necessary.

These procedures can be applied to generate new diagnostic tools for asset management of electrical apparatus to aid the work of equipment, subsystem and system committees. Special attention is paid to the area of emerging UHVAC and UHVDC technologies.

The Study Committee strives to facilitate and promote the progress of engineering and the international exchange of information and knowledge. This is achieved through the synthesis of state-of-the-art practices and developing recommendations and guidelines.

To support the development of international standards the Study Committee seeks to establish close cooperation with standardization bodies and provides the relevant technical information as well as the scientific background.

3. Specific Activities of the Study Committee

Topics of Working Groups

WG D1.58	Evaluation of Dynamic Hydrophobicity of Polymeric Insulating Materials under AC and DC Voltage
	Stress
WG D1.60	Traceable Measurement Techniques for very fast Transients
WG D1.61	Optical Corona Detection and Measurement
WG D1.62	Surface Degradation of Polymeric Insulating Materials for Outdoor Applications
WG D1.63	Partial Discharge Detection under DC Voltage Stress
WG D1.64	Electrical Insulation Systems at Cryogenic Temperatures
WG D1.65	Mechanical Properties of Insulating Materials and Insulated Conductors for Oil Insulated Power
	Transformers
WG D1.66	Requirements for partial discharge monitoring systems for gas insulated systems
WG D1.68	Natural and synthetic esters – Evaluation of the performance under fire and the impact on
	environment
WG D1.69	Guidelines for test techniques of High Temperature Superconducting (HTS) systems
WG D1.70	Functional properties of modern insulating liquids for transformers and similar electrical equipment
WG D1.72	Test of material resistance against surface arcing under DC
WG D1.73	Nanostructured dielectrics: Multi-functionality at the service of the electric power industry
WG D1.74	PD measurement on insulation systems stressed from HV power electronics
WG D1.76	Tests for verification of quality and ageing performance of cellulose insulation for power transformers
WG D1.78	Partial discharge properties of non-SF6 insulating gases and gas mixtures



WG D1.81	Methods and common data file format for Time-Domain Reflectometry
JWG B3/D1.63	Guideline for assessing the toxicity of used SF6 gas onsite and in the lab of T&D equipment above
	1 kV in substations
JWG D1/B1.75	Strategies and tools for corrosion prevention for cable systems
JWG D1/A2.77	Liquid tests for electrical equipment
JWG A2/D1.72	Retrofill of Mineral Oil in Transformers – Motivations, Considerations and Guidance
JWG B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC applications
JWG B1/B3/D1.79	Recommendations for dielectric testing of HVDC gas insulated cable sealing ends
JWG D1/A2.80	Functional properties of non-metallic solid materials for liquid filled transformers and reactors and
	their compatibility with insulating liquids

Publications in 2022 and 2023

TB 894 – March 2023	Basic principles and practical methods to measure the AC and DC resistance of conductors of power cables - WG D1.54
TB 888 – March 2023	Atmospheric and altitude correction factors for air gaps and clean insulators - WG D1.50
TB 861 – Feb 2022	Improvement to PD measurements for factory and site acceptance tests of power transformers - JWG A2/D1.51





4. SC D1 Preferential Subjects for Paris Session 2024

PS1 : Testing, Monitoring and Diagnostics

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

PS2 : Materials for electrotechnical purposes and modelling

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

PS3 : materials to enable the energy transitions

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

5. New Working Group Proposals

- 1. JWG D1/B1 on testing with long switching impulse, Oscillating waveforms
- 2. WG D1, Calibration of optical measurement systems
- 3. WG D1, Sensitivity verification of PD for alternative gases
- 4. JWG D1/A3/B3, Radio interference voltage test and corona test.

6. Specific Activities of the Australian Panel D1

- 1. AU D1 panel held annual meeting on 3 4 August 2024 at Uni Hill conference Centre Melbourne and via Webex for those who were not able to attend face-to-face.
- 2. AU D1 members participated 2023 CIGRE Cairns Symposium with 4 papers presented at the Symposium
- 3. One of the AU D1 papers was selected the best paper of the 2023 CIGRE Cairns Symposium

7. Meeting Report: Australian Panel D1

AU D1 panel held annual meeting on 3 - 4 August 2024 at Uni Hill conference Centre Melbourne A total number of 14 members and guests attended, with 4 via Webex. Omicron Australia sponsored meeting venue, refreshments, lunches and the meeting dinner drinks.

Below is a draft record of the meeting:

3 August 2023			
Time	Session Number	Session	
08:30 - 09:00		Arrival at the meeting room	
09:00 - 09:30	1	 Welcome by convenor Dr Yi introduction and meeting kick of at 09:10 and review of the agenda. 	



		3 August 2023	
		Welcome by Omicron host	
		 Wenyu (Omicron) provided an introduction and welcomed the guests to the meeting. 	
		Additional agenda items and presentation schedule	
		a. Adjusts made to the agenda based on scheduling conflicts.	
		Cigre Antitrust guidelines	
		• Self-introduction of members and guests (1-2 mins each)	
		a. Dr Yi Li, NMI, Convenor of the Australian and NZ D1 committee	
		b. Karl, Hi Voltage Solutions, Doble consultant	
		c. Chadliwa, Electranet, Senior Asset Performance,	
		d. Winston, NMI, HV calibrations and onsite work.	
		 Mark Cotton, Ausnet, Victorian TNSP and DNSP, Transmission background. 	
		f. Wenyu, Omicron Australia	
		g. Gustavo, Omicron Australia	
		h. Sam Murali, Transgrid	
		i. Hiba, Omicron Australia	
		j. Andy, Transpower (Remote)	
		k. Dharma, Powerlink (Remote)	
		I. James, Essential Energy (Remote)	
		m. Toan, UNSW (Remote)	
		n. Dr Tariq Nazir (RMIT University)	
		 Introduction and overview of the KMS site, invitations to the D1 advisory group meetings at Cairns. 	
		Confirmation of minutes of 2022 meeting	
		a. Meeting Minutes Confirmed	
		Matters arising from minutes	
		a. None	
09:30 – 10:00	2	 CIGRE Australia update – ACT 2022 annual report, Cairns Symposium 2023, CIGRE Paris Session 2024 	
		 Synopses to Cigre Australia 7th of August. 	
		AU D1 2022 Report	
		NGN updates	
		 Sam Murali provided an update on the NGN activities. 	
		 SC D1 – update on WGs, JWGs ad Tutorials 	
		 Yi Li provided an overview of the D1 activities. 	
10:00 – 10:30	3	Members Reports	
		Equipment/insulation failures or degradation, Research activities, new applications/ materials, non-standard or novel diagnostic techniques	
		 Mark Cotton – RIP bushing technology, Australia was one of the first countries to pivot to RIS technology. Ausnet prefer draw lead technology for lower voltages. Ausnet have not experienced issues with RIS bushings in their network. Corrosive Sulphur has a target of DBDS <5. Add passivator and monitor the oil. Ausnet's default bushing technology is RIP. RIS 66kV is typically installed if the transformer has poor oil quality. Ausnet have had issues with Partial Dsicharge from air pockets due to inadequate oil filling (without vacuum) in the 1980s. 	



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3 August 2023		
		 Karl (Doble) –Incorrect storage of RIP bushings has caused an explosive failure. The bushing tested 1% before installation but failed with two days. Ausnet stores spare bushings in tank.
		 Dharma – Transformer failure, the unit was 15 years old? Dharma's audio was not clear.
10:30 – 11:00 Morr	ning Tea	
11:00 – 12:30	4	Members Reports – continued
		 "Research experience at Australasian Transformer Innovation Centre", Dr Hui Ma, University of Queensland
		 Hui presented the TIC presentation. Several TIC projects were discussed and the benefits for the organisation such as retro filling with ester oil.
		• Update on NMI HV lab activities, Yi Li, NMI
		Yi Li discussed NMI's activities.
		• Experience of cable testing using HV DAC, Hao Zhang, Megger
		PD diagnostics of cables.
		Current practice for testing high voltage cables sometimes is soak.
		 Damped AC technology is proposed to test the cables.
		Examples of testing shown by use in other utilities.
1230 – 1330 Luno	ch (provided b	y Omicron at meeting venue)
13:30 – 15:00	5	Presentations on specific topics
		 Flame and electrically track resistive polymeric insulation with excellent thermal properties, Dr Tariq Nazir, RMIT University
		Outdoor insulator presentation.
		Dry band tracking can cause failure.
		Intumescent flame retardants are not suitable for electrical insulation.
		 Inclined plan test (IPT).
		Flammability performance
		 RTV4 emerged as the most promising RTV candidate
		 A Reference Measurement System for Calibration of High-voltage Transducers at frequencies up to 10 kH, Winston Yan, National Measurement Institute
		 Improvements since last meeting discussed.
		 Method improved of verifying the frequency response.
		Linearity and test comparisons show cased.
		 The project is part of the power quality of future electricity networks project.
		Improvements highlighted.
		 A System for On-site Calibration of High-Current Transducers with Composite Signals up to 10 kHz, Winston Yan, National Measurement Institute
		 Improvements of the double circuit method from the previous meeting showcased.
		Ratio linearity demonstrated.
		Magnetic current transformer test
		 The project is part of the power quality of future electricity networks project.



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3 August 2023			
		Proposed cyber-attacks on power transformers.	
15:00 – 15:30 (Af	ternoon tea)		
1530 – 1700	6	Presentations on specific topics	
		 Accuracy testing of an inductive voltage transformer under rated fundamental voltage and superimposed harmonics, 	
		a. Laboratory overview of testing apparatus	
		b. Mobile testing solutions	
		c. Insulator mechanical testing.	
		A report on research activities at UNSW	
		a. Inclined Plane Tests	
		b. Leakage current measurements	
		c. Partial discharges under repetitive pulses voltage excitation	
		IMB300 Asset failures	
		a. Quartz filled units, manufactured in 2012, there are a total of 86 IMBG units in service	
19:00 - 21:00		Meeting dinner: Base Plenty Valley, Shop 53/400 McDonalds Rd, Mill Park VIC 3082	

4 August 2023			
Time	Session Number	Session	
8:30 – 10:00	7	Continuation of presentations on specific topics	
		I ransgrid's alternate gas strategy	
		a. Sam Transgrid's strategy on the non-SF6 strategy.	
		 Digital post-processing filter for broadband time domain signals to assist in cable fault localization, Omicron 	
		a. Localisation using MP800	
		b. Focus on short cables.	
		c. Peak to peak or pulse start point measurement.	
		 Comparison of PD sensors for MV GIS applications – coupling capacitor, HFCT, VPO and TEV / Omission 	
		VDS and TEV, Umicron	
		a. Pionan presented PD detection using unconventional coupling methods.	
		 VDS interface, significant variations in capacitance. 	
		c. Simulations and Separate measurements on VDS.	
		 d. Comparison of VDS, TEV and HFCTs used in decoupling partial discharge. 	
		Altanova bushing and transformer case study:	
		a. Influence of humidity of the test results on bushings	
		b. Ratio testing	
		c. Short-circuit testing.	
		d. 22kV XLPE offline PD testing using Damped AC Voltage.	
10:10 – 10:30 Mor	ning Tea		
10:30 – 11:30	8	Continuation of presentations on specific topics	
11:30 – 12:00	9	Technical tour of Omicron Office/Lab (close by the meeting venue)	



4 August 2023			
		 Technical tour was organised well and Omicron show cased lots of products and technologies. 	
12:00 – 12:30 Lunc	ch (provided b	by Omicron at meeting venue)	
12:30 – 15:30	9	 Transpower SF6 Emissions Reduction Activities Zero tolerance on leaks Working with OEMs to reduce leaks. Improvements on SF6 gas level inventory. New generation SF6 leak detectors – D-TEK Stratus A significant increase with spares to manage SF6 leaks. 15 x LTA CO2/O2 DCBs Discussion on improving engagement for D1, involving students in the NGN and other cigre committees. Initiatives were discussed to improve engagement such as presenting 	
		 at university lectures. Tour of RMIT University High Voltage Laboratory at Uni Hill Campus 	
15:30		Meeting Close	

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

There are no current invitations for WG or DC's to meet in Australia.

9. 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 (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)

10. Membership of the Australian Panel

Name	Organisation	Туре
Dr Yi Li	National Measurement Institute	Other
Sam Murali	TransGrid	Transmission
Andrew McMahon	Transpower	Transmission
Wenyu Guo	Omicron	Manufacturer
Mark Cotton	AusNet Services	Transmission
James Baker	Essential Energy	Distribution
Karl Haubner	Doble	Manufacturer
Atanu d-mondal	Hitachi Power Grids Australia	Manufacturer
Andrew Wilkinson	ElectraNet	Transmission
Sam Murali	TransGrid	Transmission



Australian National Committee Panel Report 2023

Name	Organisation	Туре
Dharmendra Shah	Powerlink	Transmission
Hui Ma	University of Queensland	University
Prasanna Wickramasuriya	Energy Queensland	Distribution
Toan Phung	University of NSW	University
Trevor Blackburn	University of NSW	University
Hao zhang	Megger	Manufacturer
David Alan	University of Queensland	University

Convener:	Yi Li
Email:	<u>yi.li@measurement.gov.au</u>
Phone:	0423 557 620



AU D2 Information Systems and Telecommunication

1. Study Committee Scope

SC D2's mission is to develop, facilitate collaboration, and disseminate knowledge within the power industry in the areas of Information Systems, Telecommunications, and Cyber Security.

2. Specific 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. IT/OT solutions to improve the efficiency and resilience of electric power systems.
- b. Cybersecurity in emerging application domains and technologies for securing energy organisations.
- c. Meeting the challenges of energy transition with reliable, scalable, and efficient telecommunications networks.

The SC D2 Strategic Plan is as follows:

- a. Build on SC D2 strong foundation to enable agility and stay relevant in its contribution to the industry.
- b. Increase public awareness of Cybersecurity coverage in D2.
- c. Improve publication quality.
- d. Be a more open organisation.

The SC D2 Symposium was held between 4th and 7th September 2023 as part of the International Cairns Symposium and saw 21 papers presented from 10 countries with 4 papers from D2 Australia. The SC D2 regular meeting was held and SC D2 presented two Tutorials at the Symposium as follows:

- Time in Communications Networks, Protection and Control Applications
- Enabling Teleprotection over Packet Based Switched Networks

3. **Preferential Subjects**

Cairns International Symposium

The theme of the Cairns International Symposium was The End-to-End Electricity System: transition, development and integration and was divided into three topic streams:

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

The D2 papers received were grouped into three distinct topics:

- Digital transformation and AI in asset management
- Network infrastructure and telecommunications
- Cybersecurity

Paris Session 2024

In 2024, the Paris session preferential subjects are as follows:

- a. IT/OT solutions to improve the efficiency and resilience of electric power systems
 - i. Internet of things (IoT) architectures and applications in improving the resilience of electric power systems.
 - ii. Applications and platforms of artificial intelligence, big data and analytics in operational technology.
 - iii. Improving efficiency and resilience of power utilities with cloud technologies.
- b. Cybersecurity in emerging application domains and technologies for securing energy organisations
 - i. Cybersecurity for DER, microgrid and energy communities' control infrastructures.



- ii. Cybersecurity for electric vehicle charging and discharging control.
- iii. Cybersecurity in cloud-based applications of power utilities.
- c. Meeting the challenges of energy transition with reliable, scalable, and efficient telecommunications networks
 - i. Building scalable and resilient networks with management, automation and orchestration solutions and methods.
 - ii. Integration of current and new wireless technologies in meeting the requirements of power utility applications.
 - iii. Techniques and methods in building resilient networks and migrating legacy networks to support critical utility applications.

4. **Proposed New Working Groups**

There are 3 new proposed working groups for D2 currently under review:

- Cybersecurity of Energy Operators Supply Chain Several CIGRE technical brochures have identified the security risks in EPU supply chains. If not addressed these risks will only get worse. Furthermore, regulators are expecting utilities to re-think supply chain security to ensure attention is given to security at each stage in the design, development, and production of the solution they offer. Early discussions with EPU stakeholders identified the need to balance due diligence and the cost to implement a supplier security assessment. A framework is needed to allow utilities to tailor both technical and organizational requirements to seamlessly integrate supplier security assessment.
- An assessment of EPU digital certificate management schemes Digital certificates provide several functionalities, including confidentiality, integrity, non-repudiation, authentication, and authorization. Both client-side and server-side certificates can be utilized to strengthen various authentication, encryption, and communication protocol security systems. Previous technical brochures by CIGRE and other open literature highlight the complexities and inherent risks in managing these certificate schemes. Client-side data validation is of particular concern due to potential malicious activity. Although the requirements for cross-certificate signing are well-defined the challenges to implement the collaboration and coordination of multiple CA signing in a timely manner is not well understood.
- Monitoring, Maintenance and Control of Packet Network & Services It is crucial to maintain
 rigorous control over the quality of mission-critical communication services by continuously
 monitoring quality metrics such as delay, which have become variable due to store-and-forward
 mechanisms in packet-switched networks. This Working Group's objective is to revisit, review,
 and update the previous work conducted by the Working Group "Operation & Maintenance of
 Telecom Networks" (D2.33, July 2014), which has largely become obsolete.

5. Specific Activities of the Australian Panel

A Roundtable Update is a meeting outside of our annual regular panel meeting with the purpose 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.

A Roundtable Update session was held on 2nd March 2023 with 27 participants and the following presentations:

- Telstra, 5G Technologies and Applications John Carter, David Sexton & Mark Atkinson
- IOT Development at Origin Energy Ahmad Taufiq
- Testing Applications of 5G Technology Muen Chen

The D2 AU Panel was highlighted in a new section of the SC D2 newsletter called "country in focus" that shares the work and contributions of the specific countries Panels.

A Roundtable Update session is proposed for early 2024 with topic to be advised.





6. Meeting Report: Australian Panel

The D2 Annual Panel meeting was held in person on 8th September 2023. This was the first in person event for the panel since 2019 and 23 members enjoyed being able to network and meet with each other again.

This year was a condensed panel meeting to align with the Cairns International Symposium D2 Paper presentations that were held the day prior.

There were 15 panel member update presentations where the following trends and topics were covered:

- a. Data networks resiliency and growth
 - i. IP/MPLS & MPLS-TP migrations from TDM
 - ii. Synchronisation and timing
 - iii. Renewables and growth of DER big growth proposed in Queensland.
 - iv. Asset management and monitoring systems
 - v. Asset management with drones
- b. Supply chain issues have mostly resolved since Covid-19 however businesses are now managing skills shortages in telecommunications networking and cyber security, with aging workforces becoming an issue.
- c. Wireless networks
 - i. Telstra 3G Decommissioning is ongoing (mid 2024 target)
 - ii. IOT applications and proof of concepts
- d. Cyber Security with much increased focus on Operational Technology
 - i. AESCSF benchmarking
 - ii. Security Operation Centre (SOC) development and improvements
 - iii. Encryption
 - iv. Securing legacy systems
 - v. Vulnerability management in OT environments
 - vi. Cyber security uplift in staff numbers
- e. Native birds roosting in towers.
- f. Ongoing major asset replacement
 - i. DC System replacements
 - ii. Maintaining ongoing major asset replacements in addition to other areas of growth is becoming a problem for some.
 - iii. Data networks and now more focus on transition of protection signaling.

Minutes of the meeting along with presentations were uploaded to the KMS.

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

Not Applicable.

8. ANC Members on Working Groups

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

WG	Title	Australian Member
D2.52	AI Application and Technology on Power Industry	Ainhirn Florian
D2.53	Technology and Application of Internet of Things in Power Systems	Paul Guy
D2.51	Implementation of Security Operations Centers (SOCs) in Electric Power Industry as Part of Situational Awareness System	Lindbergh Caldeira



9. Membership of the Australian Panel

Aaron Gates	Western Power	Transmission
Adam Hoare	Transgrid	Transmission
Ahmad Taufiq	Origin Energy	Generator
Aruna Yahampath	Endeavour Energy	Distribution
Dave Blackwell	Transpower	Transmission
David Conway	Powercor	Distribution
David Paramandan	CommTel	Distribution
David Taddeo	GHD Pty Ltd	Vendor
James Cole	Evoenergy	Transmission, Distribution
Josh Cunningham	TasNetworks	Transmission
John Grace	Genesis Energy	Distribution
Louise Watts	SA Power Networks	Distribution
Mark Mullins	Tesla Consultants	Contractor
Mark Remmer	Powerlink	Transmission
Mark Yeomans	Wellington Electricity	Distribution
Nigel Zeinert	AusNet	Transmission, Distribution
Nitin Mangalath	APD Eng	Contractor
Paul McKeen	Energex	Distribution
Phil Western	Horizon Power	Distribution
Rohan Fernandez	ElectraNet	Transmission
Ross Gaspard	PSC Consulting	Contractor
Stuart Colsell	РВА	Contractor
Sumith Withanage	Power and Water Corporation	Transmission, Distribution
Tony Myatt	SA Power Networks	Distribution
Victor Tan	VTan Consulting	Contractor
Warren McLean	Essential Energy	Distribution

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CIGRE Conference Presented by AU C6

Conference on Integration of Distributed Energy Resources 2023

1. Details of the Conference

Australian Panel C6 hosted its Conference on Integration of Distributed Energy Resources (CIDER) in Cairns on 4-5 September 2023, in conjunction with the CIGRE Cairns 2023 Symposium at the Cairns Convention Centre. CIDER shared a common registration with the Symposium and with SEAPAC, which meant that any attendee at the Symposium could attend a CIDER session (and vice versa). There are thus no separate registration figures for CIDER 2023 but it is estimated that the maximum number of attendees was of the order of 250, with an average across the two days of the order of 150. This made it the best attendance at any CIDER to-date.

This was the fifth CIDER run by Australian Panel C6, the previous conferences being in Brisbane in 2015, Sydney in 2017, Melbourne in 2019 and Adelaide in 2022. The 2023 conference included:

- a keynote presentation by Peter Price of Energy Queensland;
- two extended presentations, by Jenny Riesz of AEMO and by Jenny Gannon of Energy Queensland;
- 30 other presenters in a single-stream format, covering a number of issues including managing high penetration of DER, DERMS, dynamic operating envelopes, distribution state estimation, quality of supply, virtual power plants, electric vehicles, DER enablement, customer engagement, microgrids, grid shrinkage, community batteries, inverters and standardisation;
- an NGN panel on *The Impact of DER on Planning and Operation of Electric Power Systems, from the Perspective of the Next Generation*;
- an NGN activity, Save the Australian Power System from Imminent Collapse!, involving the audience voting on how to respond to a system event.

A total of 11 presentations that were originally submitted to the Symposium as papers were presented in CIDER.

Monday + Ocptember 2020	
Adrian Lloyd Yukika	Introduction to the Australian Electricity System
Jenny Riesz AEMO (Extended Presentation)	DER and System Security - Managing a 100% DER Power System
Cathryn McDonald SA Power Networks	Operational Experiences from a 100% Solar Network
Sera Tarpis AEMO	Scheduling and Dispatch in a High DER System
Evert de Haan Liander (Netherlands)	Five-stage Framework for Flexibility Based System Optimisation
Joshua Snodgrass POWER Engineers (USA)	ADMS Success through Road Mapping of Existing Grid Modernization Programs
Wilson Bow Energy Queensland	Procuring a Distributed Energy Resources Management System
Tim Moore Australian National University	CSIP-AUS - Using IEEE 2030.5 for Flexible Management of DER

2. Conference Program

Monday 4 September 2023



Alex Guinman Energy Queensland	Basic Methodology for Calculating Dynamic Operating Envelopes
Brendan Banfield GridSight	Model Free Dynamic Hosting Capacity and Operating Envelopes
Ashley Niebling SA Power Networks	Successful State Estimator Deployment in Active Distribution Grids - SA Power Networks' Challenges and Learnings
Peter Kilby Energy Queensland	Developments in Distribution Voltage Management with Increasing DER
Sean Elphick University of Wollongong	Impact of Renewable Energy on Power Quality in Distribution Systems
Daniel Martin	Implications of Managing Distribution Network Assets with a Very High Level of Solar Generation: New Zealand Experience
Pat Graham (Moderator)	NGN Panel Session The Impact of DER on Planning & Operation of Electric Power Systems, from the Perspective of the Next Generation
	Harry Evans (GHD, UK) Ellen Power (ElectraNet) Mehdi Ghazavi Dozein (University of Melbourne) Caitlin Trethewy (AGL) Ishan Jagaty (JET Charge)

Tuesday 5 September 2025	
Caitlin Trethewy AGL	The VPP Landscape in Australia
Jonathon Dore Ausgrid	Dynamic Pricing for Network Capacity Management in Two-sided Markets
Laura Jones Australian National University	Vehicle to What? Making Bidirectional Charging Work for People
Justus van Biljon JET Charge	Managing EV Charging to Mitigate Grid Impacts
Andrew McConnell United Energy	Integrating DER for Operational Management
Matthew Gibson Ausgrid	Impact of DER on Transformers
Peter Price Energy Queensland (Keynote Address)	Firming the Load - Keeping the Grid Functional and Affordable
Niraj Lal ANU / AEMO	An Australian DER Bill of Rights and Responsibilities
Pierluigi Mancarella University of Melbourne	Techno-economics of Distributed Energy Markets: Findings from Project EDGE



NGN	Save the Australian Power System from Imminent Collapse!
David Stephens Horizon Power	Microgrid Frequency Control
Albert Pors Endeavour Energy	Co-designing for Resiliency: The Bawley Point and Kioloa Community Microgrid
Janica Lukas Western Power	Western Power's Transition to a Modular Distribution Grid
Sophie Allen Energy Queensland	Stand-alone Power Systems (SAPS) are One Piece of the Puzzle in Energy Queensland's Fringe of Grid Strategy
Marnie Shaw Australian National University	Neighbourhood versus Household Batteries: A Comparison of Benefits for the Grid and for Households
Mike Wishart EcoJoule Energy	Pole-mounted Community Energy Storage System to Capture the Full Value Stack
Naomi Stringer University of NSW	Reverberating Disturbances: Towards a Secure Decentralised Power System
Georgios Konstantinou University of NSW	Future-proofing Power System Planning, Operational and Stability Analysis through DER and Load Bench-Testing and Modelling
Jenny Gannon Energy Queensland (Extended Presentation)	Evolving DER Standards
Ray Brown	Concluding Remarks

3. Conclusion

CIDER 2023 received very positive feedback from attendees. This included comments directly from both international and Australian delegates during and immediately after the Symposium and specific comments about CIDER included in the survey sent to all Symposium attendees after the event.





Name: Sean Elphick, Jenny Gannon, Pat Graham, Ken Ash and Ray Brown Email: ray@rbpe.com.au



CIGRE Conference organised by AU B5 Protection & Automation

"South East Asia Protection, Automation and Control Conference"

1. Details of the Conference

The South East Asia Protection, Automation & Control Conference (SEAPAC) is a regional conference organised by the CIGRE Australia B5 panel. The first conference took place in 2007 and normally occurs once every two years. The previous conference was held in Sydney during March 2019. It provides opportunities for sharing local and international knowledge relevant to the region.

SEAPAC 2023 is a restart of this in-person interactive event after a gap due to Covid. Normally it is held as a two day standalone conference in March. This year the event was incorporated within the September Cairns 2023 symposium and took place over one full day. This has resulted in an increased international participation both in presenters and audience.

CIGRE Australia's B5 Protection & Automation Panel's principal objective is the regional ongoing development of fundamental knowledge and skills for application, design and operation of the substation and power system protection, control, metering, condition monitoring equipment and associated interfaces to primary plant, SCADA and telecommunication systems.

The scope of the conference provides wide opportunity to present and discuss protection and automation related project strategies, justification, implementation and project management. The scope also provides opportunity to share experiences as well as design objectives and solutions for green field projects and brown field developments, through to full life cycle management of the asset.

2. Conference Program

22 papers were presented across 4 themed sessions. At the end of each session there was time for questions and answers. Delegates benefited from the wide range of local and international presenters. Also the symposium attracted many subject matter experts to the audience in the SEAPAC sessions and this led to a rich question/answer session discussion after each set of presentations.

A large range of vendors, consultants and utilities authored and collaborated on the papers. Countries represented by papers include - USA, Canada, India, Sweden, Germany, Netherlands, United Kingdom, Australia and New Zealand.

The four themed sessions were:-

- Protection Automation & Control Systems (PACS) experience & event investigation
- PACS associated with renewable generation
- Testing and new technology
- Protection and automation design and implementation

There were a diverse range of protection and automation fields covered by the paper presentations, including those associated with digital substation implementation, teleprotection schemes, adaptive autoreclose, new protection standards, and the negative impacts of new renewable generation on traditional protection (plus suggested solutions). All were relevant to Australia New Zealand context.

Satendra Bhola TasNetworks Pty Ltd	To Trip or not to Trip at lightning speed
Ian Young Schneider Electric	IEC 61850 quality implementation applied to relay protection and logic
Lara Kruk Jacobs Consultants	Experiences with various special protection schemes

Session 1 - Protection Automation & Control Systems (PACS) experience & event investigation:



John Bettler	Performance of IEC 61850 Sampled Values Relays for a Real-World Fault
Schweitzer	
Engineering	
Laboratories, Inc.	

Session 2 - PACS associated with renewable generation:

Leonardo Torelli CSE-Uniserve	Apply the Underreach Distance Zone to Connect Renewable Sources
Bogdan Kasztenny Schweitzer Engineering Laboratories, Inc	Line Distance Protection Near Unconventional Energy Sources
Ritwik Chowdhury Schweitzer Engineering Laboratories, Inc	Line Current Differential Protection in Systems with Inverter-Based Resources—Challenges and Solutions
Alexander Apostolov Omicron Electronics	Accelerated protection schemes for systems with high penetration of Inverter Based Resources
Ritesh Bharat Powercor	Changing Dynamics of Protection due to Increased Renewable Integration
Gurinder Saluja Transgrid	Protection and integration of Phase Shifting Transformers and SynchCons in TransGrid network- Project Energy Connect

Session 3 – Testing and new technology:

Daniel Abetz/ Niclas Wetterstrand Siemens Ltd	Functional digital twins of relays and test equipment enable significant cost and time savings
Jarrad Raumati Transpower NZ Ltd	System-based testing of protection and automation schemes - a transmission utilities perspective
Amadou Louh Stedin Netbeheer B.V.	Implementing IP/MPLS network-based synchronization for line differential protection and control
Daniel Abetz Siemens Ltd	Optimal Use of IEC61850 Test Modes in Substations
Dinesh Babu Nagalingam Megger	Power Swing Detection / trip Testing in IEDs using smart testing Methodology
Dinesh Babu Nagalingam Megger	Inrush / Fault Current Detection for Accelerated Fault Clearance to Enhance Transformer Life

Session 4 – Protection and automation design and implementation:

Daniel Abetz	A new adaptive Auto Reclosure Approach utilising Secondary Arc Detection	
Siemens Ltd		



lan Young Schneider Electric	Relay design for future PACS
Matthew Priestley Beca Consultants	Implementation of Phasor Measurement Units
Leonardo Torelli CSE-Uniserve	Distance protection in a six multi-ended transmission line scheme: Application review
Ian Young Schneider Electric	Challenges and solutions for IEC 60255-187 CT model
Chirag Mistry GE Vernova	Adaptive Transmission Line Autoreclosing and The Effects on System Stability









3. Conclusion

The 2023 SEAPAC conference was a restart of this regular face to face interactive event after a gap due to Covid. On this occasion, SEAPAC 2023 was incorporated as a one day event within the Cairns symposium to take advantage of the many local and international delates attending the symposium, instead of arranging a separate event. It was well received with 22 presentations communicated on a diverse range of current topics relating to protection, automation and control. The presentations and associated papers shared knowledge on protection performance experience, event investigation, challenges/solutions associated with renewable generation, testing, new technology, design and implementation. Question and answer time after each of the four themed SEAPAC sessions prompted further exploration of the session topic.

An audience best paper presentation poll was held. Results were close but the winning presentation was titled 'Line Distance Protection Near Unconventional Energy Sources' by Bogdan Kasztenny representing Schweitzer Engineering Laboratories, Inc. This presentation and other associated session presentations highlighted real case maloperations of tradition protections from different manufacturers (commonly used



in Australia and New Zealand) and the latest solution options. It also prompted rich discussions as different international manufacturer and utility subject matter experts were present.

Very positive verbal and email feedback of the event was received from local, international and younger generation delegates.

Many thanks to the SEAPAC 2023 organising committee of Frankie Lu from Siemens, Rob Coggan from Energy Queensland, Bruce Capstaff from Powerlink Queensland, Ian Young from Schneider, Akhtar Kalam from Victoria University Marino Pallotta from Electranet South Australia, Terry Killen from CIGRE Australia and Peter Bishop from Transpower NZ Ltd. They were involved with many hours of meetings planning the event, including reviewing synopses, papers and presentations. Also many thanks to SEAPAC session chairs comprising Rob Coggan from Energy Queensland, Satendra Bhola from TasNetworks, Justin Brown from Beca consultants and Frankie Lu from Siemens.

Also a big thank you to Terry Killen and Debbie Haddock for conference administrative and venue organisation.

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Working Group B2.77

Risk Management of Overhead Line networks: A model for identification, evaluation and mitigation of operational risks

1. Working Group Scope

Transmission & Distribution Lines exposed to extreme climatic events causing loss of reliable supply of energy leading to environmental damage and causing financial loss to network operators.

The TOR was developed with the aim to provide a risk model in order to identify hazards and likelihood of occurrence of extreme events, identify methods to mitigate risk and produce risk-based decision process for Network Owners/ Operators and Regulators.

Work stream divided into 3 main areas focusing on Risk Model, Risk Mitigation and Decision Process supported by Case Studies.

Link to the ToR

https://cigregroups.org/x/04KODQ

2. Working Group Activities

2.1 Recent activities

- Survey questionnaire completed; responses lodged
- KMS site draft report commenced
- Chapter 1 Risk Model Chapter 1st draft completed
- Chapter 2 Decision Process 1st draft input completed
- Chapter 3 Mitigation Commenced draft input
- Chapter 4 Case studies initial input compiled

Risks Impacting Overhead Lines and Electrical Networks

- Developed risk list and grouped risks.
- o Commenced narrative around risk types and grouping

Risk Model - initial development phase



Recommended Risk Model

• Discussed several processes and models.



- Completed some work on asset resilience type model based on asset health data.
- $\circ~$ Discussed how resistance side of the equations but need to make sure the risk side fully works with the model.

Meeting locations and dates

Met 2 times in 2023 – 16th May 2023 and 16th November 2023 (Online TEAMS meetings)

Achievements in 2023.

- Case studies chapter commenced with actual publicly available case studies shared from the Global incidents
- KMS input commenced with online file upload and drafting of text/ input

Areas of particular relevance to the Australian Power Industry

- Increase in extreme weather events and addressing resilience of the existing networks
- Assessment on the future spent on capital refurbishment programs by the Regulator
- Risk Management to avoid network failure events due to ageing infrastructure

3. Working Group Program

Describe the overall program of the activities of the Working group.

- ToR approved May 2020
- Draft TB for review target of September 2024

Forecast completion date and the current status.

o Final TB Mid 2025

Convener: Asif Bhangor Email: bhangorian@gmail.com Phone: 0409375981



Working Group B2.85 Emergency Restoration Systems for Overhead Lines – Guide for Design, Planning and Installation

1. Working Group Scope

A description of the purpose and goals of the Working Group.

The WG aim to achieve the followings:

- Surveying and collating the typical failure modes of damaged OHLs and experiences of users of ERS.
- Defining ERS and preliminary design consideration.
- Specifying the various options of the ERS installation arrangement to suit different conditions, on items such as number of circuits, system voltage level and width of right-of-way.
- Preparing a procedure for design, types, and selection of materials and the production of emergency structures.
- Recommendation for design and installation of temporary anchors, guy wires and foundations in different placements of structure/site conditions.
- Recommendation for selection of conductors, shield wires, insulators and fittings.
- Guideline for installation and dismantling of ERS.
- Managing an OHL failure.

The ToR is located here:

https://www.cigre.org/userfiles/files/News/2021/TOR-WG%20B2 85 Emergency%20Restoration%20Systems%20for%20Overhead%20Lines%20-%20Guide%20for%20Design%2C%20Planning%20and%20Installation.pdf

2. Working Group Activities

- WG ToR sign off: 07.2021
- Kick off (Hybrid, Paris):
 08.2022
- Meeting #2a & #2b (online): 09.2022
- Meeting #3a & #3b (online): 12.2022
- Meeting #4a & #4b (online): 03.2023
- Meeting #5a & #5b (online): 05.2023
- Meeting #6a & #6b (online): 07.2023
- Meeting #7 (Hybrid, Sendai): 09.2023

Note: meetings a & b organised to suit members in different time zones.

Hybrid meetings helps members making the in-person connections but do require signification commitments.

Achievement this year:

- Completed WG outlines.
- Gathered members to represent most parts of worlds.
- Developed understanding of members and WG related work of them.
- Kicked off the TB drafting.
- Finalised the survey questions.

Highlight areas of particular relevance to the Australian Power Industry



- WG topic is quite relevant to the Australian power industry considering the emergency restoration events over the last 10 years in the nation.
- Strong interest from the Australian power industry with 1 regular member, 1 corresponding member, 1 specialist and 3 NGN members.
- Members from Australia gain knowledge and experience from others around the world.

3. Working Group Program

Focuses for the next stage:

- Completion of the survey.
- Continue working on the TB draft.

Forecasted TB completion date: 08/2025

Note: WG had initial date of 12/21, but was formally kicked off in 08/2022, due to communication constraints and convener change over.

We also notice significant resource constraints due to work commitments of the WG members around the world.

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* Bing took over from the former convener Masoud Negarpour (Iran) in July 2022.



Working Group B4.92 – STATCOMS at distribution voltages

1. Working Group Scope

Scope, deliverables and proposed time schedule of the WG:

Background: An increasing integration of green energy resources, such as renewable energy sources and electric vehicles, challenges the management of the distribution grids. It requires an extensive infrastructure upgrade, to avoid voltage limit violations or over loading of lines. This comes with a large investment cost.

Power electronics-based STATCOMs, also referred as Volt Var Optimisers (VVO), allows better grid controllability and facilitate the integration of green energy resources, limiting or deferring the infrastructure upgrade. Power electronics-based STATCOMs provides dynamic injections and absorption of reactive power into the distribution system, which enhance distribution grid with more flexible and reliable voltage control and power quality improvement including damping of flickers and harmonics control as compared to other device such as capacitors.

A number of distribution VVO STATCOMs are currently being developed and installed in the world such as USA, Canada and UK. It would be necessary and beneficial to collect and evaluate the design and operational experience gained from these newly developed distribution STATCOMs, and prepare general guidance for the future application of STATCOMs in distribution systems.

Scope:

This WG will focus on providing guidelines for the VVO STATCOM grid integration and grid services capabilities based on and with reference to existing service experience. The TB will provide recommendations to the following:

- Topologies and architectures of VVO in distribution grids.
- Definition and control of VVO stages.
- Type and factory tests for acceptance of VVO in distribution grids.
- Guidance of application of STATCOM for connecting and operating the VVO in AC at medium voltage level, and in radial and meshed configurations.
- Service provision for distribution grids.
- Economical assessment and business cases.

A liaison expert from SC C4 and C6 will be invited to participate this WG.

2. Working Group Activities

2021

1st Meeting Friday 29th October, Teams Meeting hosted by John Wright-Smith **2022**

2nd Meeting March, 2022, Teams Meeting hosted by John Wright-Smith

3rd Meeting Thursday 1st September, CIGRE Paris Meeting for day



2023

4th Meeting Teams, February, 2023
5th Meeting in Cairns, 2023
6th Meeting in Vienna, 12th September, 2023

3. Working Group Program

The draft Technical Brochure is now **95** pages and going through final edit.

It is planned at this stage that a draft Technical Brochure document, ready for comment, will be completed in Q1 2024 for the SC Chair to review.

The TB document can then be finalized, along with a tutorial and Electra article prepared in Q3 2024.

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WG C4.65 - Specification, Validation and Application of Harmonic Models of Inverter Based Resources

1 Working Group Scope

- a) Summarise existing approaches and industry practices used (technical documents, guidelines etc.) in pre-compliance steady-state harmonic emission studies conducted on large solar and wind farms. List advantages and disadvantages of the approaches used and establish the level of confidence placed on vendor provided harmonic models. This is to include approaches such as RMS modelling in the harmonic domain, EMT modelling, hybrid RMS/EMT processes.
- b) Collate methods followed by vendors in the development of harmonic domain Norton/Thévenin (or other equivalent) models of converters/inverters (including positive, negative and zero sequence variations) used in large wind and solar farms. Establish evidence of comparison with field measurements and EMT models as provided by vendors. This task may be undertaken in conjunction with WG C4.49 and/or C4.60.
- c) Quantify discrepancies observed, e.g. determine degree of error associated with using vendor provided Norton/Thévenin or other equivalent models compared with actual measured values.
- d) Determine margin of error of harmonic domain models due to operational variations such as converter/inverter set-points and external conditions such network characteristics and power quality (PQ) emission levels, e.g. background harmonic distortion and other PQ emission levels, SCR at the PCC and harmonic cross-coupling aspects.
- e) Collate outputs of existing working groups C4.49, C4.56 and C4.60, i.e. EMT type simulation models that can replicate the practical behaviour of converters/inverters in relation to steady-state harmonic emissions. Compare their results with the outcomes from vendor provided Norton/Thévenin models.
- f) Reach overall conclusions based on observed technical efficacy related to the robustness of modelling processes such as Norton/Thévenin equivalent models, EMT modelling and hybrid RMS/EMT models for the purpose of undertaking steady-state harmonic emission compliance studies.
- g) Specify appropriate processes to develop and validate adequate Norton/Thévenin or other equivalent models, make suggestions/updates based on findings of previous items or provide pragmatic alternatives to allow harmonic emission studies to be undertaken that meet required accuracy bounds without significantly increasing time required to undertake such studies.

2 Working Group Activities

Three papers presented at CIGRE Cairns Symposium

Face-to-face meeting held during IEEE PES GM, Orlando 2023

Regular virtual meetings held quarterly (approximately)

Sub-groups developed to focus on completing technical tasks

Recently formed liaison with IEEE harmonic modelling task force. Intend to maintain contact to avoid both groups undertaking identical tasks



3 Working Group Program

WG started April 2021

Introductory and background TB sections currently being collated and drafted

Expected submission of TB: Q3 2024

Convener: Jason David

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Working Group D1.60 raceable measurement techniques for very fast transients

1. Working Group Scope

- 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.
- Literature survey of fast transient measurement techniques, not limited to, but relevant to high-voltage field, including hardware (dividers, probes) and digital algorithms.
- Coordinate development of suitable hardware and software for traceable measurement.
- Round-robin test of reference measurement systems (e.g., 100 kV, rise time 10 ns)

2. Working Group Activities

- A working group meeting was held online on 29 October 2021, where tasks for drafting the technical brochure "Traceable measurement techniques for very fast transients" were discussed. There have been a number of contributions to the Technical Brochure since the 2021 meeting.
- The working group met again on 25 August 2023 in Sweden after the IEC TC42 meeting. The latest draft of the technical brochure v12 was discussed. Tasks for completing the technical brochure were allocated. The meeting agreed that a proposal be made to IECTC42 that a new technical report be developed for measurement of high-voltage fast transients.

3. Working Group Program

The working group plan to complete the Technical Brochure by the end of 2023 or early 2024.

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