

Australian Technical Committee of CIGRE 2019 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 2019.

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David Bones
Chair of the Australian Technical Committee
December 2019

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 (AP) matching the scope of their corresponding CIGRE international Study Committee.

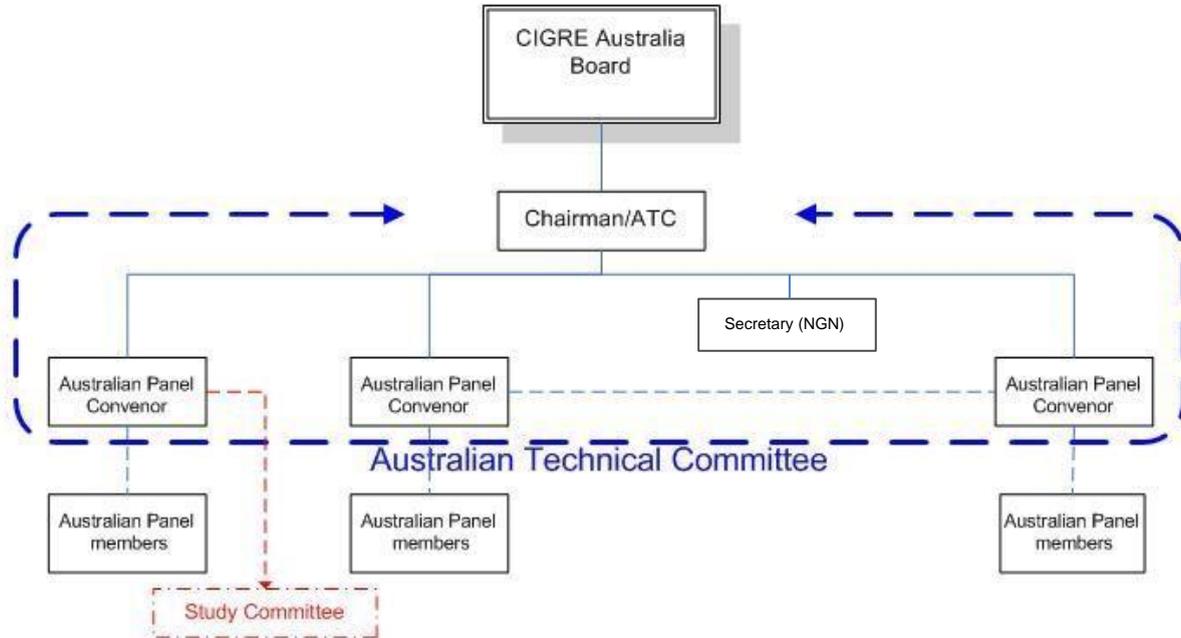
The Technical Committee provides a forum for the ATC members to:

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

The Australian Technical Committee is convened by the ATC Chairman. The Chairman is also a member of the CIGRE Australia Board. The CIGRE Australia Executive Manager provides administrative support to the ATC and a linkage between the CIGRE Australia Board and the Australian Panels for all financial and administrative decisions. The ATC Secretary, is an NGN member which provides an avenue for the NGN to contribute to and develop a greater understanding of the technical activities occurring within Australia.

The membership of the Australian Panels comes from individual and collective CIGRE members in Australia and New Zealand, who are expert in the particular technical areas relevant to their Panel. Typically, a Panel has in the order of 20 members although a number of the panels have larger membership. The largest panel currently has 34 members and the smallest has 9 members.

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



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



The ATC conducts most of its activities during the year via bimonthly teleconferences. The main face-to-face meeting was held on the day before the ATC Technical Seminar. During 2019 the ATC endorsed adopting the abbreviation AU when referring to the Australian Panels to avoid any international confusion. This report adopts the revised nomenclature ie AUC1 refers to Australian Panel C1.

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. At the 2019 CIGRE Australia Annual General Meeting, three Panel Conveners retired:

- Les Brand retired as Convener of the Australian Panel B4 – DC systems and power electronics. Les served as Panel Convener and member of the SC B4 for six years fostering a vibrant Australian Panel and supporting international activities in a variety of ways including convening and contributing to a number of working groups. Les will be succeeded by John Wright-Smith who took on the role of Panel Convener at the 2019 AGM.
- Graeme Ancell retired as Convener of the Australian Panel C1 – Power system development and economics. Graeme served as Panel Convener and member of the SC C1 for six years leading the Australian Panel and supporting international activities through a range of activities including convening and contributing to a number of working groups and organising the SCC1 poster session for the 2018 Paris conference. Graeme will be succeeded by Christian Schaefer who took on the role of Panel Convener at the 2019 AGM.
- Joe Tusek retired as Convener of the Australian Panel D1 – Materials and emerging test techniques. Joe served as Panel Convener and member of the SC B4 for eight years leading the Australian Panel and supporting international activities through a range of activities including convening and contributing to a number of working groups, serving on the SCD1 SAG and CAG. Joe will be succeeded by Yi Li who took on the role of Panel Convener at the 2019 AGM.

CIGRE Australia enjoys excellent access to the international technical activities of CIGRE through Alex Cruikshank's role as the SC C5 Chairman and member of the CIGRE Technical Council. With Alex in this role CIGRE Australia is enjoying an extended period of influence over the technical direction of CIGRE having had three Study Committee Chairmen from Australia with overlapping terms on the international Technical Council (Phil Southwell, Terry Krieg and Alex Cruikshank).

Peter Wiehe is the Secretary for Study Committee A1 Rotating Machines and a number of Australian Panel conveners and Panel Members are active members of advisory groups within their respective Study Committee. The full membership of the ATC during 2019 is shown in attachment 1.

Australian Panels

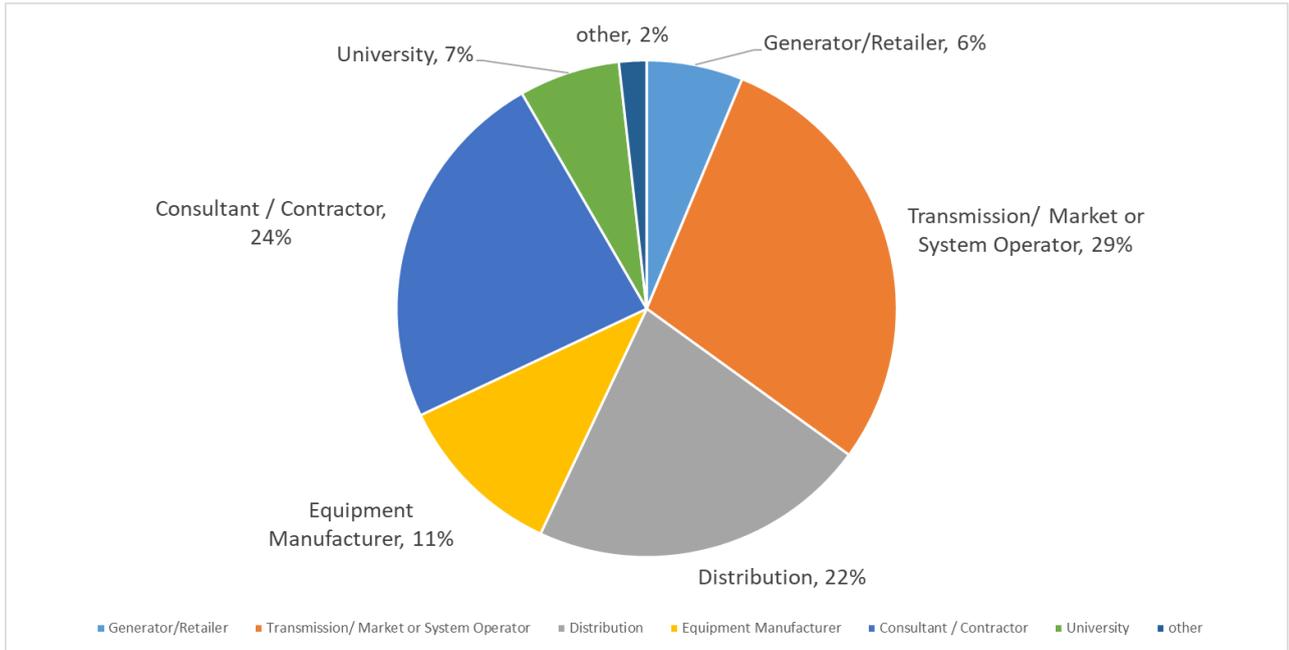
Locally, ATC members have convened meetings of their Australian Panels across various Australian States or in New Zealand. These meetings form an important communication forum for CIGRE and its members.

Membership of Australian Panels declined slightly across 2019, with total panel member numbers declining by 1.8% compared to the numbers reported in 2018. Sector representation is shown in the following figure, there has been no material change in the sector representation since the 2018 report. 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 2019 ATC report.

Each Panel Convener also delivered a presentation at the ATC Seminar held of the day before the 2019 AGM. Those presentations highlighted SC activities of particular relevance to Australia. Copies of the presentation are available from the CIGRE Australia internet site <https://www.cigreaustralia.org.au/our-work/technical-committee/>.



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. Attachment 3 lists the Technical Brochures published by CIGRE in 2019. All of these brochures are available for CIGRE Australia members via the e-cigre (<https://e-cigre.org/>). During 2019, 14 webinars were also made available via e-cigre.

At any time there are over 300 active Working Groups. Historically CIGRE Australia members have participated in about 55% of active working groups. Statistics compiled by the ATC in late 2019 reveal that across 2019 a similar level of performance was achieved with CIGRE Australia members contributing to just under 50% of the 317 active working groups. 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.

This limited funding is allocated through a rigorous process which considers the relevance of the working group to the Australian Power Industry and the significance of the contribution that will be made by person seeking the travel support. The following table lists the working groups for which funding was provided during 2019.

WG/TF No	WG or TF Name	Convener/Member
A2-58	Site Installation and Pre-commissioning of Power Transformers and Shunt Reactors	Ross Willoughby (C)
B2-64	Inspection and Testing of Equipment and Training for Live-Line Work on Overhead Lines	Alex Price (M)
B2-67	Assessment and Testing of Wood and Alternative Material Type Poles	Nathan Spencer (C)
C1-38	Valuation as a comprehensive approach to asset management in view of emerging developments	Graeme Ancell (C)
C1-41	Closing the Gap in understanding between stakeholders and electrical energy specialists	Phil Southwell (C)
C3-19	Responsible management of the Electric and Magnetic Field Issue	James Hart (C)
C4-56	Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter-based resources	Babak Badrzadeh (C)
C5-30	The Role of Block Chain Technologies in Power Markets	David Bowker (C)
D2.43	Enabling software defined networking for EPU telecom applications	Victor Tan (C)

Each of the conveners or working group members listed in the preceding table have prepared a report on the key outcomes from their 2019 working group meetings. These reports follow the Australian Panel Annual Reports and are also listed in attachment 2 of this report.

During the 2019 the following working groups previously supported by CIGRE Australia completed their work with technical brochures published or finalised:

- A2.49 – Condition assessment of power transformers convened by Peter Cole
- C4-40 – Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14, Sarath Perera member
- C5-22 - Mitigating systemic market risk in electricity markets convened by David Bowker
- D1-71 – Understanding and mitigating corrosion convened by Joe Tusek

Technical Brochures for completed Working Groups will be published via e-cigre and can be downloaded by CIGRE Australia members from <https://e-cigre.org/>

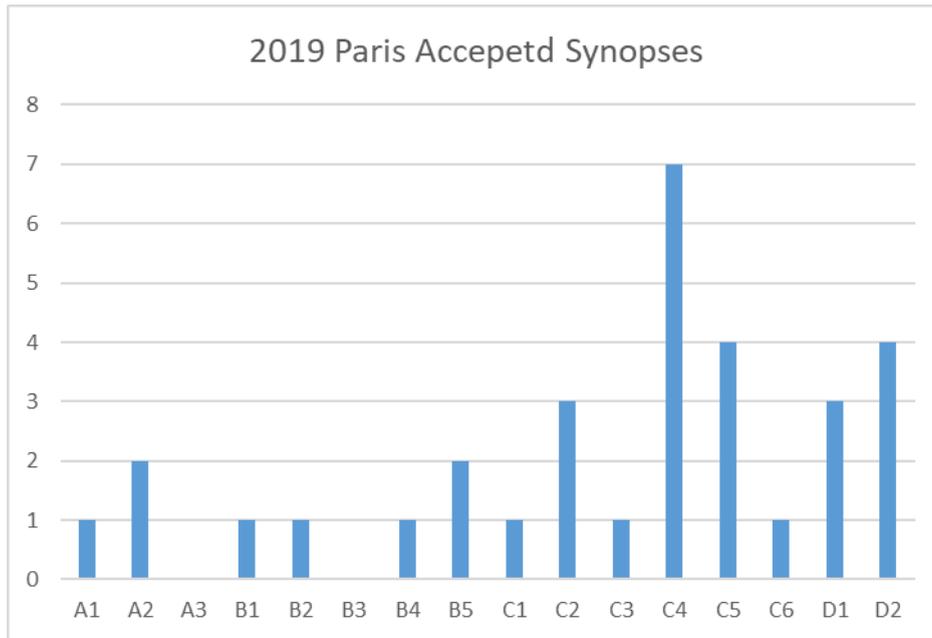
Study Committee Meetings in Australia

CIGRE Australia did not host any Study Committee meetings in 2019.

CIGRE 2020 Session

A record number of synopses submitted by CIGRE Australia have been accepted for the 2020 Paris Session. 32 Synopses were accepted. The following figure shows the distribution of CIGRE Australia synopses across the 16 Study Committees.

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 14 February 2020.



Seminars, Conferences and Training

Four seminars/workshops were organized by Australian Panels in 2019. Each event helps to disseminate technical knowledge and promote the value of CIGRE. A report on each for the following events is also included in attachment 2.

- **Transformer Workshop** - A workshop was held in Sydney on 3 April 2019, and was attended by 69 delegates and 11 speakers. The workshop focused on transformer tap changers
- **SEAPC** - The 2019 South East Asia Protection, Automation & Control Conference (SEAPAC) was held at the Star Hotel in Sydney on 19-20 March. The SEAPAC conference is held every two years and brings together the leading expertise in the protection and automation fields across Australia, New Zealand and the South East Asia region to participate at paper presentations and network at the technical exhibition. 139 delegates attended the 2019 SEAPAC.
- **CIDER** - AUC6 hosted its third Conference on Integration of Distributed Energy Resources (CIDER) in Melbourne on 20-21 August 2019. It was held at the Pullman Melbourne on the Park, with 88 delegates attending
- **Substation Seminar** – AUB3 hosted a substation conference on the 7th and 8th of November 2019. The conference had over 100 delegates and 6 exhibitors with 17 papers presented.

Australian Panels have also organised a number technical sessions associated with their annual panel meetings. The format of the session varied from a formal seminar with papers presented to technical workshops open to CIGRE members who are not members of that panel and guests of the organization hosting the panel meeting.

Information on events is available on the CIGRE Australia website.

Health of Technical Activities – ATC KPI

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

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

Measure	Targets	August 2018	August 2019
Technical contribution	Financial support provided 10 working groups pa	GREEN	GREEN
	10 In The Loop (ITL) WG articles pa	RED	GREEN
	3 technical seminars pa, achieving positive feedback (preparation on track and positive feedback post event)	GREEN	GREEN
	Annual reports provided to members for each Panel, event and funded WG	GREEN	GREEN
	55% WG have Australian member	GREEN	YELLOW
	20 papers for Paris session	GREEN	GREEN
	9 substantive roles during Paris session	GREEN	N/A
Sustainable structure	All panels have active NGN liaison	GREEN	YELLOW
	All panels have convenor and identified successor	YELLOW	YELLOW
	Panel membership reflects all industry sectors	YELLOW	YELLOW

The table above shows the performance against each measure in 2018 and 2019. Colours are used to identify whether targets have been achieved:

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

The measures relating to the technical contribution were achieved during 2019, with the exception of the number of Australian members on international Working Groups. The target of 55% was not met with approximately 50% of Working Groups having an Australian member.

The measures relating to the sustainability of Australian Panels indicate opportunities for improvement. This is a continuing area of focus for the ATC. Key issues identified include:

- 50% of panels have identified gaps in their membership when compared with the composition of the relevant parts of the power industry;
- Only 50% of panels have identified a successor for the current convener

Thank You

On behalf of the ATC and CIGRE Australia, I thank those member organisations in Australia and New Zealand who have most generously hosted and/or sponsored Australian Panel events during 2019.

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

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

David Bones

Chair of the Australian Technical Committee

David.bones@ghd.com

Attachment 1 – 2019 Members of the ATC

	Chairman ATC	David Bones
	Secretary ATC	Phil Coughlan
A1	Rotating electrical machines	Tri Tran
A2	Power transformers and reactors	Ross Willoughby
A3	Transmission and distribution equipment	Wayne Pepper
B1	Insulated cables	Russell Wheatland
B2	Overhead lines	John McCormack
B3	Substations and electrical installations	Crina Costan
B4	DC systems and power electronics	Les Brand
B5	Protection and automation	Peter Bishop
C1	Power system development and economics	Graeme Ansell
C2	Power system operation and control	Greg Hesse
C3	Power system environmental performance	James Hart
C4	Power system technical performance	Andrew Halley
C5	Electricity markets and regulation	Greg Thorpe
C6	Active distribution systems and distributed energy resources	Ray Brown
D1	Materials and emerging test techniques	Joe Tusek
D2	Information systems and telecommunication	Victor Tan
	SC C5 Chairman	Alex Cruickshank
	Executive Manager CIGRE Australia	Terry Killen

Attachment 2 – Annual Reports by the ATC

Australian Panel Annual Reports

CIGRE_Annual_Report_AU_A1_2019.pdf
CIGRE_Annual_Report_AU_A2_2019.pdf
CIGRE_Annual_Report_AU_B1_2019.pdf
CIGRE_Annual_Report_AU_B2_2019.pdf
CIGRE_Annual_Report_AU_B3_2019.pdf
CIGRE_Annual_Report_AU_B4_2019.pdf
CIGRE_Annual_Report_AU_B5_2019.pdf
CIGRE_Annual_Report_AU_C1_2019.pdf
CIGRE_Annual_Report_AU_C2_2019.pdf
CIGRE_Annual_Report_AU_C3_2019.pdf
CIGRE_Annual_Report_AU_C4_2019.pdf
CIGRE_Annual_Report_AU_C5_2019.pdf
CIGRE_Annual_Report_AU_C6_2019.pdf
CIGRE_Annual_Report_AU_D1_2019.pdf
CIGRE_Annual_Report_AU_D2_2019.pdf

Reports on Working Groups supported by ANC of CIGRE

CIGRE_Working_Group_Report_WG_A2-58_2019.pdf
CIGRE_Working_Group_Report_WG_B2-64_2019.pdf
CIGRE_Working_Group_Report_WG_B2-67_2019.pdf
CIGRE_Working_Group_Report_WG_C1-38_2019.pdf
CIGRE_Working_Group_Report_WG_C1-41_2019.pdf
CIGRE_Working_Group_Report_WG_C3-19_2019.pdf
CIGRE_Working_Group_Report_WG_C4-56_2019.pdf
CIGRE_Working_Group_Report_WG_C5-30_2019.pdf
CIGRE_Working_Group_Report_WG_D2-43_2019.pdf

2019 Event Reports

CIGRE_Event_Report_AUA2_Transformer Workshop 2019.pdf
CIGRE_Event_Report_AUB3_Substation Seminar 2019.pdf
CIGRE_Event_Report_AUB5_SEAPAC 2019.pdf
CIGRE_Event_Report_AUC6_CIDER 2019.pdf

AU A1 Rotating Machines

1. Study Committee Scope

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

2. Specific Activities of the Study Committee

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

A1-01 Turbine (Turbo) generators.

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

A1-02 Hydro generators

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

A1-05 Non-conventional rotating machines

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

A1-06 Power station motors and drives.

The scope of this group is power station motors >1kV and >800kW. Activity is focussed through working groups as described below. A number of working groups have been formed to look into benefits of High Efficiency Motor, the effects of VSD (Variable Speed Drive) on motors and impact of flexible operation on motors.

3. Preferential Subjects

Preferential subjects selected by the Study Committee for 2019 Colloquium in India were:

PS 1: High Renewable Penetrated Networks

- Methods and experiences for the evaluation of existing base load plant to handle new grid requirements such as cyclic loads, high values in the rate of change of frequency (Hz/s), fault ride through capability, extended U/f requirements, higher power factor requirements, etc.
- Usage of new as well as decommissioned power plant generators as synchronous condensers to solve power quality issues due to large scale renewable integration & comparison with other FACTS devices.
- Design improvements, technological advancement and operational experience of Hydro generators for prolonged and efficient operation as low and very low speed generators, synchronous condensers and pump-motors.
- Innovative trends in the field of Turbo generators, Hydro generators, wind turbine generators, large motors and high efficiency motors.
- Suitability of generators and motors in a renewable energy mix environment from a harmonics point of view.
- Latest designs implemented or proposed for Rotating Electrical Machines to endure severe load cycling.
- Wind Turbine generator experience: Failures, design challenges, maintenance philosophies and maintenance challenges.

- Concentrated solar power, solid waste and Biomass power plants: Design, specification, construction, efficiency, operation and maintenance experience.

PS 2: Operational Experience and New Developments

- Operational experience on state of the art technologies used for large turbo generators, hydro generators, wind turbine generators, high voltage motors and high efficiency motors.
- Latest designs and maintenance practices to improve efficiency, reliability, availability, robotic inspections, and reduce maintenance costs.
- Performance and reliability comparison of different designs of large motors of same ratings and duty cycles with regards to heating, efficiency, mean time to failure, life cycle costs, etc.
- Advanced and optimised condition monitoring and analysis making use of latest technologies, taking digitization, big data, advanced analytics, etc. into consideration.
- Experience with renovation, modernization and up-rating of aged power plants.
- Novel techniques to overcome known operational and design problems of hydro power plants especially for operation in silt prone water.

4. Proposed New Working Groups

A joint new Working Groups (A1&C4) JWG-66 - "Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators" was formed in 2019. Convenor is Mr. D. K. Chaturvedi. The main scope of this new working group is to produce a new application guide that covers the following areas:

- Overview of large-scale renewable generation including existing installed capacities and future penetration levels.
- Technical capabilities of conventional turbo/hydro generators versus PE interfaced renewable generation.
- Challenges faced by the power system due to reduced synchronous machine commitment.
- Effectiveness of synchronous condenser solutions to deliver:
 - Inertia
 - System strength including transient capability to supply short circuit current
 - Other dynamic stability contributions.
- Case Studies on the use of synchronous condensers to improve system operation.
- Comparison of synchronous condenser solutions with alternative technologies.
- Physical design of new purposely built synchronous condensers and options available depending on power system requirements, for example, added flywheel to increase inertia, optimised stator and excitation system design where limited steady state reactive power capability is required.
- Retrofit schemes whereby decommissioned/redundant thermal generators can be repurposed as synchronous condenser units.
- Modification of existing gas turbine generators to operate in both generator and synchronous condenser modes of operation.
- Benefits of synchronous condensers compared to other solutions.
- Impact of renewable energy on the electrical design of machines, such as sub-transient reactance.

5. Specific Activities of the Australian Panel

The annual AU A1 panel meeting was held in Cooma in July 2019 and the following presentations were shared:

- Murray 1 Rotor Winding Failure and Snowy 2 Generators.
- Hydro generator stator core joints failure modes and Asset management.

- Hydro generator core burning issue.
- Tarong power station Generator Rotor Refurbishment.
- Failure of Redundancy – Kogan Creek Pole Slip Event.
- Synchronous Condenser (latest activities in Australia).
- Rotating exciter retaining rings UT examination.
- Newman Generator Issues.
- The LCI (Load Commutating Inverter) installation and Commissioning.
- Electric vehicle charging standards.
- Dalrymple Battery.
- A 500MW turbo generator failure.

The AU A1 Australian Panel has the following main activities:

- Face to face panel once per year at alternative states. 2019 meeting was held at Cooma NSW and hosted by Snowy Hydro.
- Quarterly Skype meetings to discuss latest technical issues amongst members' organisations and assisting each other where possible.
- Maintain a network of common interests in electrical rotating machines across Australia's utilities, transmission and market operator organizations.
- Disseminate all Cigre news and updates.
- Working together as a team to support activities of the Study Committees

At the Colloquium, tutorial and WG meeting in India in September 2019, the following activities were also taken place:

- WG Session presentations on progress - 23/09/19
 - 4 WG (A1-29, A1-31, A1-37, A1-39) finished
 - 3 WG (A1-33, A1-48, A1-50) at final stage
 - 3 new WG (A1-63, A1-65, A1/C4-66) proposed with TOR approved
- SC A1 Chairman Summary - 24/09/19
 - Technical Council meeting and activities,
 - Review of Cigre membership status,
 - Women with Cigre, e-Cigre, KMS,
 - Proposal for 2021 Colloquium in Japan and 2023 in Russia.
- Four Tutorials were presented 25/09/19
 - Magnetic Core Dimensioning Limits in Hydro-Generators
 - Application of dielectric dissipation factor measurements on new stator coils and bars.
 - Guidance on the Requirements for High speed Balancing/over speed testing of turbine Generator Rotors following Maintenance or Repair
 - Guide for Cleanliness and Proper storage of Generators and Components

6. Meeting Report: Australian Panel

- Annual AU A1 panel meeting in Cooma as above (refer to meeting minutes).
- Quarterly AU A1 Skype meetings as above (refer to the meeting minutes)

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

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

8. ANC Members on Working Groups

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

WG A1.XX	Title	Australian Member
33	Guide to the Proper Storage and Cleanliness of Turbogenerators and Components	Tri Tran

WG A1.XX	Title	Australian Member
42	Influence of Key Requirements to Optimize the Value of Hydro-generators	Kapila Nanayakkara/ Peter Wiehe
44	Guidelines on Testing of Turbo and Hydro-Generators	Peter Wiehe
48	Guidance on the Requirements for High Speed Balancing / Overspeed Testing of Turbine Generator Rotors Following Maintenance or Repair	Len Gunn
50	Factory Quality Assurance Testing Requirements for Turbo-generator Components	Tri Tran
51	Monitoring, Reliability and Availability of Wind Generators	Tri Tran
55	Survey of Split Core Stators	Peter Wiehe
56	Survey on Lap and Wave Windings and their consequences on Maintenance and Performance	Peter Wiehe
57	Visual Inspection of Stator Windings and Cores of Large Turbo-generators	Tri Tran
59	Survey on Industry Practices and Effects associated with the Cutting out of Stator Coils in Hydro-generators	John Iles
60	Guide on economic evaluation for refurbishment or replacement decisions on hydro generators	Peter Wiehe
62	Thrust bearings for hydropower – A survey of known problems and root causes	Robert Dillon Howard Brown
66 (A1/C4)	Guide on the Assessment, Specification and Design of Synchronous Condensers for Power Systems with Predominance of Low or Zero Inertia Generators	Fabian Spescha Lingxiao Situ

9. Membership of the Australian Panel

Name	Organisation	Type
Tri Tran (Convenor)	AGL	Utility
Peter Wiehe	Acutel Consulting	Consultant/Utility
Marc Ransome	Hydro Tasmania	Utility
Fabian Spescha	AEMO	AEMO
Johan Strydom	Synergy	Utility
Kapila Nanayakkara	Snowy Hydro	Utility
Ashok Ojha	Alinta	Utility
Nik Walker	Alinta	Utility
Franco Rabines	CS Energy	Utility
Hossein Rahimpour	AmpControl	Consultant
Len Gunn	Origin Energy	Utility

Nic Buckley	Stanwell Corporation	Utility
Simon Nawrot	Delta Electricity	Utility
Viet Trinh	ElectraNet Pty. Ltd	Transmission
David Graham	Energy Australia	Utility

Convener: Tri Tran

Email: tri.tran@agl.com.au

Phone: 0407 185 048

AU A2 Transformers and Reactors

1. Study Committee Scope

The scope of SC A2 covers:

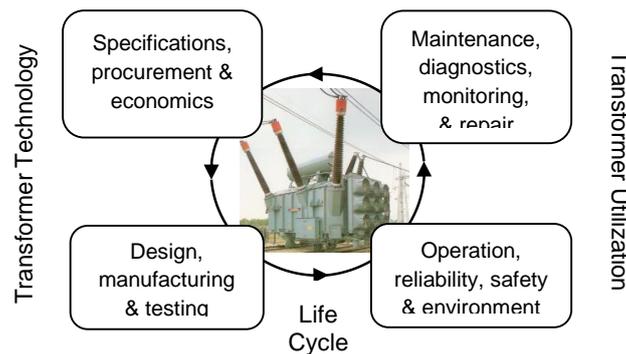
- All kinds of power transformers, including HVDC transformers converter and phase-shifting transformers;
- All kinds of reactors, including shunt reactors, series reactors, and HVDC smoothing reactors;
- All transformer components, including bushings, tapchangers, and other transformer accessories.

2. Specific Activities of the Study Committee

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

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

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



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

TC 10 “Fluids for Electrotechnical Applications”,
TC 14 “Power Transformers”
TC 122 “UHV AC Transmission”

The following is a list of the IEEE Working Group activity that has completed the balloting process and has been approved by IEEE for publication.

Working Group	Topic	Summary
P60214-2 (New)	Tap-Changers – Part 2: Application Guide	Approved 2019
PC57.93 (Revision)	Guide for Installation & Maintenance of Liquid Immersed Power Transformers	Approved 2019
PC57.104 (Revision)	Guide for the Interpretation of Gases Generated in Oil Immersed Transformers	Approved 2019
PC57.105 (Revision)	Guide for Application of Transformer Connections in Three-Phase Electrical Systems	Approved 2019
PC57.127 (Revision)	Guide for the Detection, Location and Interpretation of Sources of Acoustic Emissions from Electrical Discharges in Power Transformers and Power Reactors	Approved 2019

SC A2 activity overview,

- 2 new WGs have been approved
- 5 Technical Brochures and 1 Electra Paper have been published

Brochures and papers published since 2018

- Power Transformer Audible Sound Requirements – Electra 302, August 2019
- TB 755 – Transformer Bushing Reliability – February 2019
- TB 761 – Condition Assessment of Power Transformers – March 2019
- TB 771 – Advances in DGA Interpretation – July 2019
- TB 779 – Field Experience with Transformer Solid Insulation Ageing Markers – October 2019
- TB 783 – DGA Monitoring Systems – October 2019

Major meetings:

Joint Colloquium A2, B2 and D1, 18-22 Nov. 2019 in New Delhi, India.

3. Preferential Subjects

The proposed preferential subjects for the 2020 Paris Session are:

PS1: Transformer Technologies to Enable Integration of Distributed Renewable Energy Sources.

- Application, specification, design and construction
- Effect of harmonics, including interharmonics and supraharmonics
- Effect of extreme operating environments, including offshore and subsea

PS 2: Advances in Dielectric Design and Testing

- Specification of dielectric design requirements, especially for new and unusual applications
- New and advanced dielectric design concepts and techniques
- Challenges in dielectric testing and how to overcome them

PS 3: Improving Reliability for Transformers

- Long-term reliability studies and surveys for transformers
- Improving reliability through specification, design and construction
- Improving reliability through operation, maintenance, refurbishment, and repair

4. Proposed New Working Groups

JWG A3/A2/A1/B1.44 “Limitations in Operation of High Voltage Equipment Resulting of Temporary Overvoltage’s” was approved by central TC chair in August. Representation by an AU A3 member may be appropriate.

5. Specific Activities of the Australian Panel

AU A2 hosted an interactive workshop in Sydney, in conjunction with Techcon Asia Pacific. The workshop was titled “Transformers with a Focus on Tapchangers – An Interactive Workshop”. The event was in Sydney at the Hyatt Regency Hotel on Wednesday 3 April, 2019, and was attended by 69 delegates and 11 speakers. The workshop was held in conjunction with Techcon Asia Pacific, which was held later at the same venue on the 4 and 5 April. The workshop operated using 16:9 CIGRE format powerpoint presentations. The workshop had four parts, two sessions in the morning and one after lunch where speakers presented technical papers. The fourth and final session following the afternoon break involved a panel discussion where speakers received questions initially from the facilitator, which led into spontaneous questions and interactive discussion from the delegates.

Refer also to a separate comprehensive report, with photographs, for this 2019 CIGRE Event.

Another seminar, to be held on 25 March 2020 in conjunction with Techcon Asia Pacific, is being planned. The proposed workshop title is “Transformers – Improving Reliability – An Interactive Workshop”

The proposed topics align mainly with SC A2 Preferential Subject 3:

- CIGRE Tutorial on TB 771 – Advances in DGA Interpretation
- ANZ failure statistical evaluation results
- Experiences in Transformer Onsite Refurbishment (based on Robert Li’s PS3 paper)
- Application of Conditional Probability (based on Chris Beckett’s PS3 paper)
- Transformer failure modes listed and respective assessment criteria (based on work of WG A2.49 Tx Condition assessment and TB 761)
- Transformer site testing (Winding Resistance and Dielectric Response)

The next panel meeting will be convened in Melbourne on March 24, immediately before the 25-27 March 2020 Cigre/TechCon Conference, also in Melbourne. This will minimise travel expenses for 2020, facilitate preparation of contributions for the Paris Session in August 2020 and increase the likely attendance and involvement of the AU A2 panel membership in the Cigre Transformer Workshop held on March 25. The panel meeting will be hosted by one of the Victorian AU A2 membership employers.

6. Meeting Report: Australian Panel

The most recent AU A2 meeting was hosted by AusGrid and was held at the Primus Hotel, Sydney on 2nd April 2019. Members provided an update to the group of what was happening in their part of the industry as well as brief reports about any issues that they had experienced with transformers.

Working Group members provided updates about progress of their working group. Where appropriate the Convener added information based on reports provided to the Study Committee. An update about the activities of D1 was provided by the D1 convener.

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

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

8. ANC Members on Working Groups

The following are all the current AU on Working Groups.

WG	Title	Australian or NZ Member
A2/D1.51	Improvement to Partial Discharge Measurements for Factory and Site Acceptance Tests of Power Transformers	Nil
A2/C4.52	High Frequency Transformer Models for Non-Standard Waveforms	Nil
A2.53	Objective interpretation methodology for the mechanical condition assessment of transformer windings using FRA	Joe Tusek (corresponding) Hossein Rahimpour (corresponding)
A2.54	Power Transformer Audible Noise Requirements	Nil
A2.55	Transformer Life Extension	Ross Willoughby (observer)
A2.56	Power Transformer Efficiency	Rob Milledge (corresponding)
A2.57	Effects of DC Bias on Power Transformers	Nil
A2.58	Installation and Pre-Commissioning of Transformers and Shunt Reactors	Ross Willoughby (Convener) Matt Gibson (corresponding)
A2.59	On-Site Assembly, On-Site Rebuild, and On-Site High Voltage Testing of Power Transformers	Ross Willoughby (observer)
A2.60	Dynamic Thermal Behaviour of Transformers	Nil
A2.61	On-load Tapchanger Best Practice	Kevin Newman (nominee)
A2.62	Analysis of Transformer Reliability	Dan Martin
A2.63	Transformer Impulse Testing	Nil
A2.64	Condition of cellulose insulation in oil immersed transformers after factory acceptance test	Alan Vietch (according to WG progress report)

WG	Title	Australian or NZ Member
TF	The Condition of Transformer Solid Insulation at End-of-Life	Nil

9. Membership of the Australian Panel

Name	Organisation	Type
Kenneth Budin	Budin Philipp	Consultant
Mark Cotton	AusNet Services	Transmission
Santosh Dhakal	TasNetworks	Transmission
Derek Freeman	Origin Energy	Generator
Carlos Gamez	Western Power	Transmission
Lagath Ganepola	Powerlink Queensland	Transmission
Matthew Gibson	Ausgrid	Distribution
Wenyu Guo	Omicron Electronics Australia Pty Ltd	Manufacturer / Contractor
Michael Jordanoff	Transpower NZ	Transmission
Robert (Yi) Li	TransGrid	Transmission
Tara-Lee Macarthur	Energy Queensland	Distribution
Daniel Martin	Transformer Innovation Centre	University
Robert Milledge	ABB Australia Pty Limited	Manufacturer
Peter New	Snowy Hydro	Generator
Shawn Nielsen	Queensland University of Technology	University
Phil Onions	Stanwell Corporation Ltd	Generator
TBA*	Wilson Transformer Co. Pty Ltd	Manufacturer
Peter Scoles	SA Power Networks	Distribution
Marko Prokic	ElectraNet	Transmission
Tapan Saha	University of Queensland	University
Thomas Smolka	Reinhausen Australia	Manufacturer
Tri Van Tran	AGL	Generator
Joe Tusek	Ampcontrol ETM	Contractor
Walter Wasinger	Wasinger Transformers	Consultant
Kerry Williams	K-BIK Power Pty Ltd	Consultant
Ross Willoughby	GE Grid Australia Pty Ltd	Manufacturer / Contractor

The NGN Liaison allocated to AU A2 is Mohsin Bhatti of ABB Australia Pty Ltd.

* Mohinder Pannu, representing Wilson Transformers, retired on 31 July 2019. There has been no replacement nominated to date.

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

AU A3 Transmission & Distribution Equipment

1. Study Committee Scope

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

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

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

2. Specific Activities of the Study Committee

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

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

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

Prepare strong and smart power systems of the future

- WG A3.31: NCIT with digital output
- WG A3.35: Commissioning and Operation of Controlled Switching Projects

Making the best use of existing equipment and system

- WG A3.30: Overstressing aspects of substation equipment
- WG A3.35: Commissioning practices of controlled switching
- WG A3.36: Multi-physic simulation for temperature rise test
- WG A3.28: Capacitor switching and transmission and distribution systems
- 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

Answer the environment concerns

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

Develop knowledge and information

- All working groups, tutorials and green book

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

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

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

AG.A3.01: The Strategic Planning Advisory group monitors industry developments and crosschecks them with the Study Committee's strategy. It advises the Study Committee on issues that impact on the activities of the Committee and ensures the Committee responds effectively to these

developments. This Advisory Group coordinates the Working Groups and supports them in technical and organizational aspects. The Strategic Planning Advisory Group consists of the Study Committee Chairman, Working Group Conveners and others nominated by the Study Committee Chairman. It meets once a year between the Study Committee meetings.

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

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

AG.A3.03: The “Green Book” Advisory group have completed their task, with the publishing of the A3 Green Book titled Switching Equipment. It is anticipated that the Green Book will be revised periodically. The SC C1 Green Book on Asset Management will contain a chapter on Asset Management of Transmission & Distribution equipment; this work is currently being progressed within the A3 SC with an aim to complete this by the end of 2019.

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

- | | |
|----------|--|
| WG A3.31 | <p>Accuracy, Calibration & Interfacing of Instrument Transformers with Digital Outputs.</p> <p>The use of digital output for ITs (magnetic or electronic) requires development & adaptation of the accuracy testing procedures and the development of appropriate methods for in factory and on-site calibration which may become more frequent with the deregulation of electric power companies. The redundancy of various equipment and links will also need to be considered to achieve the high reliability and availability levels required for a modern electrical network. This accuracy testing & calibration activity is the main focus of this Working Group. The brochure is expected to be published in 2019.</p> |
| WG A3.35 | <p>Guidelines and best practices for the commissioning and operation of Controlled Switching Projects</p> <p>This working group will first update the previous 2001 CIGRE survey on installation records of Controlled Switching Switchgear in service, gather worldwide experience with and then provide a guide for the best commissioning practices along with several case studies. This guide will reflect the recent field experience with CSS including pitfalls to avoid. This working group completed its activities in 2019 and the brochure has been published as TB757.</p> |

- WG A3.36 Application and Benchmark of Multi Physic Simulations and Engineering Tools for Temperature Rise Calculation
- This working group will study a benchmark of multi-physics simulation and simplified engineering tools to predict temperature rise tests, describing the state of the art techniques regarding MV and HV switchgears and defining the critical parameters that affect the accuracy of thermal modelling. It will also show the benefits of simulation, whilst benchmarking more simplified tools, which can be used by non-experts and are adjusted by tests or advanced simulation techniques. The brochure is expected in 2019.
- WG A3.38 Capacitor switching in distribution and transmission systems.
- This working group is investigating the long term field experience of shunt capacitor bank switching focusing on MV switchgear comparing with the experience of HV switchgear. The WG is collecting information on alternative capacitive switching devices, filter bank applications and experience with vacuum devices (MV) and SF₆ devices (HV) separately. The draft TB is scheduled to completed in January 2020.
- 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 December 2020.
- WG A3.40 Technical requirements and field experiences with MV DC switching equipment.
- The working group will first collect available field experience of LVDC and MVDC switching equipment used in different applications and investigate whether their technical requirements and testing considerations can meet the recent requirements under changing the MV and LV network conditions due to the massive penetrations of DER and Energy Storage systems. The use of MVDC switching equipment in different system configurations such as a point-to-point or multi-terminal MV grid will be examined and to understand the switching phenomena in MVDC grids. The draft TB is due in 2022.
- WG A3.41 Interrupting and switching performance with SF₆ free switching equipment.
- This working group will collect available interrupting and switching performance data with different SF₆ free gas alternatives, and evaluate the expected lifetime and consider long term stability and impact on the maintenance works related to switching. It will review the advantages and disadvantages of all SF₆ free solutions in comparison with the state of the art solution based on SF₆. The final brouchure will provide a guideline to utilities to keep in mind which factors when they use SF₆ free gas as an alternate solution. The final report is due in 2021.
- 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 2021.

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 integration 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 automatically and provide the specific recommendations to the equipment users. These require the development of analytical tools which would be custom tailored to the specific switchgear equipment but expressed in simple and general ways. The final report is due in 2022.

3. Preferential Subjects

The A3 preferential subjects for 2020 Paris Session are planned to be:

- Development of Transmission and Distribution equipment
 - DC equipment
 - Measure to improve reliability
 - Developments of equipment with less environmental impacts
 - SF6 alternatives for switching and isolation
- Lifetime management of Transmission and Distribution equipment
 - Diagnostics and prognostics / monitoring of equipment
 - Influence of environmental and operating conditions
 - Experience and countermeasures for overstresses and overloads
- Impact on Transmission and Distribution equipment under the introduction of renewables, distributed generation and storage
 - New switching devices and emerging equipment
 - Incorporation of intelligence into the equipment
 - Impacts of RES / DER and energy storage on equipment requirements

4. Proposed New Working Groups

During the A3 Study Committee meeting in Bucharest in September 2019, the following topics were put for new working group topics to be starting in the near future:-

- *2014-2017 Equipment Reliability Survey*
- Methods for identification of frequency response characteristics of voltage measurement systems.
- Equipment operating at higher voltage than system voltage
- Generator circuit breakers: review of application requirements, practices, in-service experience and future trends.

5. Specific Activities of the Australian Panel

Australian Panel A3 members have decided to continue focus on the following key areas in 2017-19 period:

- **SF₆ gas management** – Provide practical information on design factors which contribute to SF₆ leakage for high voltage equipment from a practical experience perspective. Provide information on techniques to detect SF₆ gas leakage and mitigation techniques. Review current practices for the different utilities with regards to leak repairs.
- **Adoption of new equipment technology in Australia and New Zealand** – Evaluate processes, procedures and impediments to adoption of new technology and collaborate on

evaluation of key new technologies for adoption and leverage outcomes for all members. The idea is share information from leading innovators and gain from learnings from early adopters of technology for mutual benefit.

- **Asset based condition scoring and assessment of probability of failure for risk assessments** – Evaluate methods used for health and condition scoring and associated likelihood of failure assessments, Evaluate ageing models and their application for assessment of likelihood of asset failure. Provide guidance to AP A3 members on options for asset based condition scoring and assessment of probability of failure for risk assessments.

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

Currently there is no intention for the A3 Study Committee to meet in Australia. The next two non-Paris year study committee meetings will be held in India (2021) and Russia (2023). As there is limited AP-A3 involvement in existing working groups, it is not likely that working groups will be holding meetings in Australia due to the travelling distances involved.

7. ANC Members on Working Groups

The following are all the current AP representatives on 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

8. Membership of the Australian Panel

Name	Organisation	Type
Nandana Boteju	AusNet Services, VIC	Transmission & Distribution
Robert Scott	TasNetworks, TAS	Transmission & Distribution
Ankur Maheshwari	Western Power, WA	Transmission & Distribution
Wayne Pepper (convenor)	Ausgrid, NSW	Distribution
David Pita	Powerlink, QLD	Transmission
Matthew Ridgely	EnergyQueensland, QLD	Distribution
David Roby	ABB, NSW	Vendor
John Shann	Transpower, NZ	Transmission
Alan Tancin	GE Energy, NSW	Vendor
Andrew Wilkinson	Electranet, SA	Transmission

Convener: Wayne Pepper
Email: wpepper@ausgrid.com.au
Phone: 0408 667 076

AU B1 Insulated Cables

1. Study Committee Mission

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

The two technological fields of activity are

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

2. Study Committee Scope

Within its technical field of activity, the Study Committee SC B1 Insulated Cables, addresses topics throughout the asset management life-cycle phases; from conception, through research, development, design, production, deployment, operation, and end-of life.

At all stages, technical, safety, economic, environmental and social aspects are addressed, as well as interactions with, and integration into, the evolving power system and the environment.

All aspects of performance, specification, testing and the application of testing techniques are within scope, with a specific focus on the impact of changing interactions and demands due to evolution of the power system. Life cycle assessment techniques, risk management techniques, education and training are also important aspects.

Within this framework additional specific areas of attention include:

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

3. Specific Activities of the Study Committee

The Study Committee (SC) meets annually with the most recent being in Denmark in September 2019.

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

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

The Study Committee has approximately 410 experts within the B1 community and hosts 26 active Working Groups (WGs) or Task Forces (TFs), with a further 8 being Joint Working Groups (JWGs) with other SCs.



Overall SC B1 activities are very well attended with:

- All 24 regular members and 15 observer members attending this year's SCB1 meeting.
- National Committees from the 24 represented countries have been very active during the year
- A symposium was held in Aalborg, Denmark, June 4-7, 2019 focusing on the rapid transformation and challenges imposed on networks and markets by increased amounts of renewables in the energy mix.

In October 2018 we learnt of the passing of Eugene Bergin, a personal, long-time friend of many in the SC. Eugene was an expert recognized worldwide for his knowledge and judgement about cables and also utility systems in general. As a professional he was beyond reproach. But he also was a most enjoyable person. Eugene had an infectious smile. He will be missed for his expertise, his laughter and his companionship.

A minutes silence was observed at the Denmark SC B1 meeting in his memory.

4. Study Committee Statistics

The statistics from the SC were not available to publish at the time of writing this report.

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

5. Preferential Subjects

The preferential subjects agreed for 2020 are:

PS 1: Cables for future power systems

- Innovative cables and systems
- Prospective impacts on cable life-cycle from use and implementation of Big Data and Industry 4.0
- New functionalities expected from cable systems

PS 2: Recent experiences with existing cable systems

- Design, manufacturing, installation techniques and operation
- Advances in testing, including failure location, and relevant experience
- Lessons learnt from permitting, consent and implementation

PS 3: Environment, asset management and resiliency of cable systems

- Environmental challenges in current, planned and future cable systems
- Quality, monitoring, condition assessment, diagnostic testing, upgrading methodologies and relevant management
- Safety considerations, cyber and physical security and IoT and including case studies

6. Working Group Reports

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

During 2018, the SC published the following tutorials

- B1.28 Partial Discharge measurements On-site
- B1.41 Long-term performance of soil and backfill systems.
- B1.51 Fire issues for insulated cables in air
- B1.55 Recommendations for additional testing for submarine cables from 6 kV ($U_m = 7.2$ kV) up to 60 kV ($U_m = 72.5$ kV)

The following tutorials are in progress

- B1.45 Thermal monitoring of cable circuits and grid operators' use of dynamic rating systems
- B1.46 Conductor Connectors: Mechanical and Electrical Tests
- B1.50 Sheath Voltage Limiters and Bonding Systems (Design, Testing, Operation and Monitoring)
- B1.54 Behaviour of cable systems under large disturbances (earthquake, storm, flood, fire, landslide, climate change)

7. Proposed New Working Groups

Currently there are seven new working groups and two new task forces proposed for SC B1. They are:

Working Group	Title	Convener
WG B1.73	Recommendations for the use and the testing of optical fibres in land cable systems	Alexandra Burgos (ES)
JWG B1/B3.74	Recommendations for a performance standard of insulated busbars	China
JWG B1/D1.75	Interaction between cable and accessory materials in HVAC and HVDC applications	Anders Gustafsson (SE)
JWG D1/B1.75	Strategies and tools for corrosion prevention for cable systems	
JWG B1/B3 or B3/B1.xx	Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends	
New Task Forces		
TF B1.76	Increasing the role of quality assurance and quality control to reduce the cable failure possibility	
TF B1.78	Status detection, condition monitoring and rejuvenation for power cables	Fan Liu (CN)

8. Specific Activities of the Australian Panel

The Australian Panel held its annual meeting in Brisbane in early October 2018, hosted by Energy Queensland. Twenty five (out of a total of 28) AU B1 members (or their representatives) were able to attend, along with five guests including the local NGN member from Energy Queensland. The meeting was held over two days and gave the opportunity for each member of the panel to make a short presentation on “what’s happening in my patch”. As can be seen from the included members’ list, the panel has a wide variety of experience which leads to a very healthy discussion around many topics. There is a significant need to educate Australians in all aspects of insulated cables so a small subcommittee was formed to investigate the possibility of holding a cable seminar in the next year or so. Past international WG convenors could be invited to present their tutorials and be available for discussion groups.

AU B1 is a strong group of experienced, well educated, some expert, people in the field of insulated cables.

At the time of writing, the 2019 AU B1 meeting is scheduled but not yet realised.

9. Invitations for SC or WG’s to meet in Australia

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

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

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

10. AP B1 Members currently on Working Groups

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

Working Group	Title	AU / NZ Representative
JWG B1/B3:49	Standard design of a common, dry type plug-in interface for GIS	Peter R.
WG B1.54	Behaviour of cable systems under large disturbances (earthquake, storm, flood, fire, landslide, climate change) Final report expected Q4 of 2019.	Richard J.
WG B1.57	Update of service experience of HV underground and submarine cable systems	Carmelo N.
WG B1:58	Asset Management in MV Cables Networks	Dave L.
WG B1:60	Maintenance of HV Cable Systems	Joska F.
WG B1:61	Installation of HV Cable Systems	Peter R.
WG B1:58	Asset Management in MV Cables Networks	Dave L.
WG B1:60	Maintenance of HV Cable Systems	Joska F.
WG B1:61	Installation of HV Cable Systems	Peter R.
WG B1.67	Loading pattern on cables connected to windfarms	Kerry P.
WG B1.68	Condition evaluation and lifetime strategy	Rob B.
JWG B1/C4.69	Recommendations for the insulation coordination on AC cable systems	Tony A.
WG B1.71	Guidelines for safety risk management in cable system	Carmelo N.
WG B1.72	Cable ratings verification (2nd part)	David S.
TF B1.73	Recommendations for the use and the testing of optical fibres in land cable systems	Graeme B

11. Membership of the Australian Panel

Name		Position	Organisation	Type
Russell	Wheatland	Convener	AusNet Services	Utility
Peter	Robinson	Secretary	Cable Systems Engineering	Consultant
Tony	Auditore	Representative	Voltoni Limited	Consultant
Ken	Barber	Representative	Istanapark P/L	Consultant
Graeme	Barnewall	Representative	Essential Energy	Utility
Evan	Bayliss	Guest	Snowy Hydro	Utility
Neil	Bennett	Representative	TransGrid	Utility
Rob	Bradley	Representative	Ausgrid	Utility
Peter	Butterfield Rossi	Representative	ElectraNet	Utility
Andre	Cuppen	Representative	Unison Networks	Utility
Michelle	English	Representative	Western Power	Utility
Dean	Farrar	Representative	LS Cables & Systems	Manufacturer
Joska	Ferencz	Representative	Basslink	Asset Owner
Jarad	Hughes	Representative	TasNetworks	Utility
Nang	Huynh	Representative	Western Power	Utility
Mark	Jansen	Representative	Powercor Network Services	Utility
Richard	Joyce	Representative	Transpower	Utility
Seong Woo	Ju	Representative	Taihan	Manufacturer
Henry	Kent	Representative	Energy Action	Consultant
Dong-Churl	Lee	Representative	Select Solutions	Service Provider
James	Lyll	Representative	Retired	Academia
Albert	Majadire	Representative	Prysmian Group	Manufacturer
David	Mate	Representative	Endeavour Energy	Utility
Nic	Moffa	Representative	Protop Engineering Service	Consultant
Peter	New	Representative	Snowy Hydro Ltd	Utility
Carmelo	Noel	Representative	Energy Queensland	Utility
David	Paul	Representative	Vector Ltd.	Utility
Colin	Peacock	Representative	Pavocon	Consultant
David	Pearce	Representative	SA Power Networks	Utility
Tim	Popkiss	Representative	Intertech Engineering	Consultant
Kerry	Prickett	Representative	UDCS Consulting	Consultant
Naveed	Rahman	Representative	Nexans / Olex	Manufacturer
David	Spackman	Representative	Spackman Consulting	Consultant
Eddie	van der Draai	Representative	Powerlink	Utility

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

AU B2 Overhead Lines

1. Study Committee Scope

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

2. Specific Activities of the Study Committee

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

- Strategic Advisory Group (SAG) reviews SC performance and develops strategy for future direction of the SC; reviews/endorsers proposed ToR for publications; and General Session preferential subjects are critiqued and new WG's approved.
- Customer Advisory Group (CAG) reviews customer survey to assess the introduction of customer suggested study activities and to ensure alignment with these activities. The ToR for new WG's are reviewed by the CAG and relevant TAG, and recommended to the SC.
- Four Technical Advisory Groups (TAG) to assist in the coordination of new Working Groups (WG), oversees progress on publications and review content of proposed tutorials.

Australia has maintained its membership on the SAG and CAG, and in 2018 gained the position of TAG07 convenor.

SC/TAG Convenors & Australian membership as at October 2019 are:

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

SC Activities in 2019 include

- New Delhi Convention, Nov 2019
- 3 new WG's established
- 9 new ToR under consideration (including one proposed by the AP).
- TB publications (see appendix A)

3. Preferential Subjects

PS 1: Condition based maintenance for increased sustainability of OHL

- Monitoring, modelling
- OHL Health index, remaining life, degradation mechanisms
- Risk assessment

PS 2: Enhancing line performance

- Innovative designs and materials, compaction, changing AC to DC, voltage upgrade, etc.
- Earthing, lightning performance
- Current carrying capacity and losses

PS 3: Resources and design considerations

- Design with respect to lifetime, maintenance, and restoration (live line, ergonomics, skills for erection and maintenance, robotics)
- Design and refurbishment for a changing environment

4. New/Proposed Working Groups

WG Ref	Title	Convenor/ Proponent	ToR
JWG B2/D2.72	Condition Monitoring in remote sites	Ying Chen (China)	Review all available (CM) devices suitable for the power lines in uninhabited areas. Provide guidelines for design, selection, operation, tests, acceptance, & wide-area detection of CM devices.
B2.73	OHL electrical assets & fires	Peter Dulhunty (Australia) tbc	Identify range and frequency of different fire starts associated with electrical assets. Review means of preventing fire starts
B2.74	UAV's for power line inspections	Nishal Mahotho (South Africa)	Survey industry practice and provide guidelines (technical, safety, environmental, legal and economic) for use of UAVs on overhead distribution networks
B2.75	MV/LV Conductors	Bruce McLaren (South Africa) tbc	Survey industry practice and provide guidelines for selection & use of MV covered conductors
ToR TAG07	Risk Assessment Techniques for evaluating OHL	Asif Bhangor (Australia) tbc	Develop risk model for evaluation of OHL network
ToR TAG07	Risk model for Distribution Lines	Andreas Beutel (South Africa) tbc	Identify failure mechanisms; develop risk model to facilitate selection of appropriate mitigation solutions
ToR TAG05	Foundations for Difficult Soils	tbc	Survey industry practice and provide guidelines for selection of appropriate footing systems.
ToR TAG04	Lightning Performance & Grounding of OHL	tbc	Review effects of lightning and provide design guidelines
TAG05 Proposal	Construction Methodology	tbc	Construction processes, skills & training, safety, helicopter methods
TAG07 Proposal	Emergency Restoration Logistics Management	tbc	Design/construction interface/communications mgt, safety & resource/ fatigue mgt, temporary structure arrangements, learnings from past experiences
TAG07 Proposal	Asset Management Principles for OHL	tbc	Investigate the "why" of asset management
TAG07	Live Work – Evaluate	tbc	Electrical engineering evaluation of work

Proposal	Safe Systems of Work		processes, clearances and safety issues
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5. Australian Panel Activities Report

i) General

Year 2019 Panel activities include:

- Annual Panel Meeting & “Asset Management” case studies from members
- 1 day seminar - Sydney
- Distribution of ToR, WG surveys, and draft TB for review
- Nomination of WG & CM members
- Support of WG convened by APB2 members
- Interaction with AORC
- Continuing engagement with distribution utilities for increased involvement
- Continuing engagement with research facilities for involvement opportunities
- Encourage participation & interaction with NGN
- APB2 database maintenance
- Initiate “preliminary paper” on Asset Management philosophy and policy with the intent to prepare a ToR and establish a new WG headed by an APB2 member.

ii) Panel meeting: Sydney 2019

- 2x day for panel meeting & local case study presentations
- 1x day technical tour.

iii) Future Activities: Australian Panel - 2020

- Panel meeting, Qld
- Proposed engagement with Asset Management Council & OHL Asset Managers

iv) Activities: SCB2 & International Symposiums

- SCB2 - 2019 November – New Delhi, India
- B2 Symposium – 2019 April – Hakodate, Japan
- B2 Symposium – 2019 mid-year - Denmark
- SCB2 - 2020 August, Paris
- SCB2 - 2021 November – Norway or Slovenia
- SCB2 - 2022 August, Paris

6. ANC Members on Working Groups

Refer appendix.

7. Membership of the Australian Panel

Name	Group Role	Company	Type
John MCCORMACK	owner	ElectraNet	Transmission
Frank Yeo	Secretary (NGN)	APD	Transmission
Robert Alcaro	representative	Transgrid	Transmission
Ken Barber	Specialist / B1 representative		Consultant
Asif BHANGOR	specialist	Ausnet	Consultant
Ashok Bhat	representative	AECOM	Consultant
Gary Brennan	specialist	consultant	Transmission/ Distribution
Linden Bronleigh	representative	Western Power	Transmission/ Distribution
Steve BROOKS	representative	Ergon Energy	Transmission/ Distribution

Alan DELAC	representative	Powerlink	Transmission
Peter DULHUNTY	representative	Dulhunty Works	Supplier
Elias Elkhoury	representative	UGL	Contractor
Glenn FORD	representative	Ausgrid	Transmission/ Distribution
Tony GILLESPIE	representative	Gillespie Power Consultancy	Consultant
Robert LAKE	representative	PSC	Consultant
Michael LEE	specialist	Groundline	Consultant
Simon LEITCH	representative	Transpower	Transmission
Francis LIRIOS	representative	AusNet Services	Transmission
Sanu MAHARJAN	specialist	TransGrid	Transmission
David MATE	representative	Endeavour Energy	Transmission/ Distribution
Brent MCKILLOP	representative	TasNetworks	Transmission/ Distribution
Graeme Paterson	representative	Downer	Contractor
Alex Price	NGN	Energex	Transmission/ Distribution
Steve REDHEAD	representative	Aurecon	Consultant
Conor Reynolds	representative	Worley Parsons (PB)	Consultant
Jack ROUGHAN	representative	Fluidlimit	Consultant
Sarah SUN	representative	Macleans	Supplier
Ahsan SIDDIQUE	specialist	Jacobs	Consultant
Nathan Spencer	specialist	URI Engineering	Consultant
Andrew Taylor	representative	NT Power & Water	Transmission/ Distribution
Morgan Williams	representative	Entura	Consultant
Michael Wilson	specialist	Transpower NZ	Transmission
Philip DULHUNTY	specialist	Dulhunty Poles Pty Ltd	
Henry HAWES	specialist		

8. Other Business

1. APB2 Convenors/sponsored members

WG	Active Convenor/ Sponsored member Nominee	Comment
WGB2.40 Electrical Clearances	Robert Lake	TB final draft under preparation: no further sponsorship required.
WGB2.64 Live Work	Alex Price	WG target completion 2020; continued sponsorship recommended.



WGB2.67 Wood Poles	Nathan SPencer	WG target completion 2021; continued sponsorship recommended.
ToR under review Risk Mgt of OHL	Asif Bhangor (Nominee)	Planned start 2020. ToR initiated by APB2; potentially need an AP convenor
WGB2.73 OHL & fires	Peter Dulhunty (Nominee)	Start 2019. ToR initiated by APB2; potentially need an AP convenor. Sponsorship will be requested.
TAG07 Proposal: Asset Management	Francis Lirios	Proposal to be prepared by APB2; potentially need an AP convenor Sponsorship will be requested.

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



Appendix A: AUB2 WG Representation; SCB2 publications, proposals

WG	Title	Status	Publication	AUB2 Rep
JWG13 C3/B1/B2	Environmental issues of high voltage transmission lines for rural and urban areas	Complete	With Publishers	Tim de Grauw
B2.23	Geotechnical and structural design of foundations for HV & UHV Lines	Final draft due 2019		Graeme Paterson
B2.24	Qualification of HV and UHV OHL Line Supports under static and dynamic loads	TB issued for review		Elias Elkhoury, Robert Lake, Henry Hawes Asif Bhangor (reviewer)
B2.40	Calculations of the electrical distances between live parts and obstacles for OHL	Final draft due 2019		Robert Lake (convenor) John McCormack
WG45	WG B2.45 Bushfire characteristics and potential impacts on OHL Performance	Complete	TB 745 (issued 2019)	Francis Lirios (WG) Michael Lee (WG) Peter Dulhunty (WG)
WG50	WG B2.50 Safe handling of fittings and conductors	TB issued for review		Peter Dulhunty (convenor)
WG55	WG B2.55 Conductors for the Uprating of Existing Overhead Lines	Complete	TB 763 (issued 2019)	Glenn Ford
WG56	WG B2.56 Ground Potential Rise at AC OHL Structures during Faults	Complete	TB 694 (issued 2019)	Charles Crew
WG57	Survey of operational Composite Insulator Experience and Application Guide for Composite Insulators	target complete?		Steve Redhead



WG	Title	Status	Publication	AUB2 Rep
WG58	Vibration Modelling of HTLS conductors - Self damping characterization	target complete 2018/19		Jack Roughan
WG59	Forecasting Dynamic Line Ratings	target complete 2018/19		Michael Lee
WG60	Affordable Overhead Transmission Lines for Sub-Saharan Countries	target complete?		Michael Lee
WG61	Transmission Line Structures with Fibre Reinforced Polymer (FRP) Composites	Final draft reviewed		Francis Lirios
WG62	Design of Compact HVDC Overhead Lines	Final draft reviewed		Asif Bhangor
WG63	Compact AC Transmission Lines	Final draft reviewed		not represented
WG64	Inspection & Testing of Equipment and Training for Live-Line Work on OHL	Active		Alexandra Price (WG) Simon Leitch / John Mc
WG65	Detection, Prevention and Repair of Sub-surface Corrosion in OHL Supports, Anchors and Foundations	Active		Elias Elkhoury
WG66	Safe handling and installation guide for high temperature low sag conductors	Active		Michael Wilson, Transpower



WG	Title	Status	Publication	AUB2 Rep
WG67	Assessment and testing of wood and alternative material type poles	Active		Nathan Spencer (convenor), Glen Ford, Peter Dulhunty (WG)
WG68	Sustainability of Conductor & Fittings	Active		Andrew Taylor
WG69	Coatings for Power Networks	Active		Francis Lirios
WG 70	Aerial Warning Markers	Active		Jack Roughan, Sarah Sun
WG 71	Inter-phase spacers	Active		Indhran Pillay (tbc)
WG 72	Condition Monitoring of OHL In Uninhabited Areas	Active		Robert Lake, Stephen Brooks
WG 73	The role of OHL electrical assets with respect to the initiation and prevention of bushfires	Active		Peter Dulhunty (convenor) David Mate, Grant Bailey, Francis Lirios,
WG 74	UAV for maintenance of OH distribution lines	Active		Francis Lirios, Ergon rep (tbc)
WG 75	Guide for application of insulated conductors on overhead MV & LV distribution lines	Active		Linden Bronleigh



	Proposed WG	Status	TAG	AUB2 Rep
	Lightning Performance of OHL	CAG review	TAG 04 Electrical	
	Audible Noise of OHL	CAG review	TAG 04 Electrical	Jitesh Raniga
	Foundations for Difficult Soils	CAG review	TAG 05 Structures	Frank Yao Graeme Paterson
	HTLS for new lines	CAG review	TAG 05 Structures	
	Ice on OHL	CAG review	TAG 05/06 Structure/Mechanical	Brett McKillop
	Risk of OHL	CAG review	TAG 07 Asset Mgt	Asif Bhangor (proposed convenor)
	Construction methodology	Under Development	TAG 05 Structures	
	Asset Management Principles	Under Development	TAG 07 Asset Mgt	Francis Lirios (proposed convenor)
	Performance of elastomer fittings - life expectancy	Under Development	TAG 06 Mechanical	
	Damping for long spans	Under Development	TAG 06 Mechanical	
	Inspection & repair of OHL structures	Under Development	TAG 05 Structures	
	Live Work: Review of Safe Systems		TAG 07 Asset Mgt	



AU 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.

Specific Activities of the Study Committee

2. SC Activities in 2019 Include

- 7 Working Group (WG) Meetings:
- B3 Annual **Study Committee Meeting**, in Chengdu China
- B3 **Poster Session**, 35 posters displayed : 484 visitors
- AP. B3 Substation Conference – Hobart Nov 2019
- Chairing IEEE Power and Energy Society in Victoria
- Contribution to IEEE standards

3. New and Existing Working Groups

New Working Groups and Members

- WG B3.52 Neutral Grounding Method Selection and Fault Handling for Substations in the Distribution Grid
- Bill Carman as Correspondent Member
- WG.B3.53 (new): Guidelines for fire risk assessment and mitigation in substations
- Michael Verrier, Terry Lee as Members and Derek Perkins as Correspondent Member
- Created a Mirror Panel for WG.B3.53 in AP comprising: Michael Verrier
- WG.B3.54 Earthing System Testing Methods
- Stephen Palmer WG Convener
- WG B3.55 Design guidelines for substations connecting battery energy storage solutions (BESS)
- Crina Costan: as Correspondent Member
- WG B3.56 Application of 3D Technologies in Substation Engineering Works
- Todd Margitich: Member



- WG.B3.46: Guidelines for Safe Work Methods in Substations
- Perry Tonking as Correspondent Member and Kerry Williams as Member

Australian Contributions to WG.B3

Carman	Bill	Corresponding	M	WG B3.52	B3	Australia
CHEANG	Andrew	Full Member	M	WG B3.38	B3	Australia
Cole	Peter	Corresponding	M	WG B3.48	B3	Australia
Costan	Crina	Corresponding	F	WG.B3.55	B3	Australia
KRIEG	Terry	Corresponding	M	WG B3.43	B3	Australia
KRIEG	Terry	Corresponding	M	WG B3.46	B3	Australia
KRIEG	Terry	Corresponding	M	WG B3.47	B3	Australia
KRIEG	Terry	Corresponding	M	WG B3.49	B3	Australia
Laubi	Andreas	Corresponding	M	WG B3.50	B3	Australia
Lee	Terry	Full Member	M	WG.B53	B3	Australia
LI	Yi	Corresponding	M	WG B3.47	B3	Australia
LOPEZ-ROLDAN	Jose	Full Member	M	WG B3.24	B3	Australia
Margitich	Todd	Full Member	M	WG.B3.56		Australia
MCCORMACK	John	Corresponding	M	WG B3.39	B3	Australia
Palmer	Stephen	Secretary	M	WG B3.35	B3	Australia
Palmer	Stephen	Convener	M	WG B3.35	B3	Australia
Perkins	Derek	Corresponding	M	WG.B3.53	B3	Australia
QUACH	Minh	Corresponding	M	WG B3.39	B3	Australia
RAYAPROLU	Ram	Corresponding	M	WG B3.39	B3	Australia
Ridgley	Matthew	Corresponding	M	WG B3.42	B3	Australia
Tonking	Peregrine	Corresponding	M	WG B3.46	B3	Australia
Verrier	Michael	Corresponding	M	WG B3.48	B3	Australia
Verrier	Michael	Member	M	WG.B3.53	B3	Australia
Williams	Kerry	Member	M	WG.B3.553	B3	Australia

4. Australian Panel Activities Report

Year 2019 Panel Activities Include:

- One day annual meeting held in Hobart
- Active participation in the SC B3 initiatives
- Distribution of ToR, WG surveys, and draft TB for review
- Nomination of WG & CM members
- Support of WG convened by APB3 members
- Contributions and members to IEEE panels
- Continuing engagement with distribution utilities for increased involvement



- Encourage participation & interaction with NGN
- Inclusion of new members from Utilities, Suppliers, Contractors, Office of the Technical Regulator South Australia
- Attended the Chengdu symposium
- Two day substation conference in Hobart

Future Activities: Australian Panel – 2020

The goal for next year is to interact more with the other Australian CIGRE panels

Organise a battery storage design workshop at the end of the AP. B3 meeting in Perth in July 2020

Future Activities: SCB2 & International Symposiums

- 2021 Symposium in Bucharest, Romania – with A2
- 2023 – New Delhi, India or Cairns, Australia?

Other Future events:

- IEC Conference on UHV AC/DC Trends – Hakodate, Japan April 23-26, 2019
- Conference on Condition Monitoring – Bucharest, Romania Sept 7-13, 2019

5. Membership of the Australian Panel

There are 30 members

We have one NGN member – AP. B3 Secretary

Our members come from the following fields:

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



	Name	Company
1.	Alan Crombie	UGL
2.	Alan Goodridge	Peracon
3.	Andy McMahon	Transpower
4.	Andreas Laubi	Jacobs
5.	George Bergholcs	ElectraNet
6.	Colin Crisafulli	Endeavour
7.	Doug Ray	Vector
8.	Mark Hibbert	Aurecon
9.	Michael Verrier	TasNetworks
10.	Ping S Wang	GE Grid
11.	Simon Hickey	Energy Queensland
12.	Stephen Palmer	Safearth
13.	Peregrine Tonking	Horizon Power
14.	Terry Krieg	Powernetwork Consulting
15.	Chris Gonzalez	Siemens
16.	Wu Hang	Aecom
17.	Jeremy Kearney	Entura
18.	Mark Pritchard	SA Power Networks
19.	Evan Lamplough	Transgrid
20.	Dasgupta Raj	NT Water & Power
21.	Malcolm Busby	WSP
22.	Anurag Gupta	GHD
23.	Mark Burns	Office of Technical Regulator
24.	Marco Surace	Western Power
25.	John Szmalko	Jacobs
26.	Joseph Pinheiro	Powerlink
27.	Hao Tian	ABB
28.	Chris Grinter	AusNet
29.	Crina-Miana Costan	TS Consulting
30.	Robert Scott	NGN - TasNetworks

Convener: Crina-Miana Costan Principal Engineer at Tudor Solutions Pty Ltd

Email: costan.crina@electranet.com.au;
crina.m.costan@gmail.com;

Phone: 0407970295

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:

- HVDC: economics of HVDC, applications, planning aspects, design, performance, control, protection, and testing of converter stations.
- Power electronics for AC transmission and distribution systems and power quality improvements: economics, applications, planning, design, performance, control, protection, construction and testing. This includes Flexible AC Transmission (FACTS) devices such as SVCs and STATCOMs.
- Advancements in power electronics: development of new converter technologies including controllers and use of new devices, application of these technologies in HVDC, power electronics for AC systems and power quality improvement.

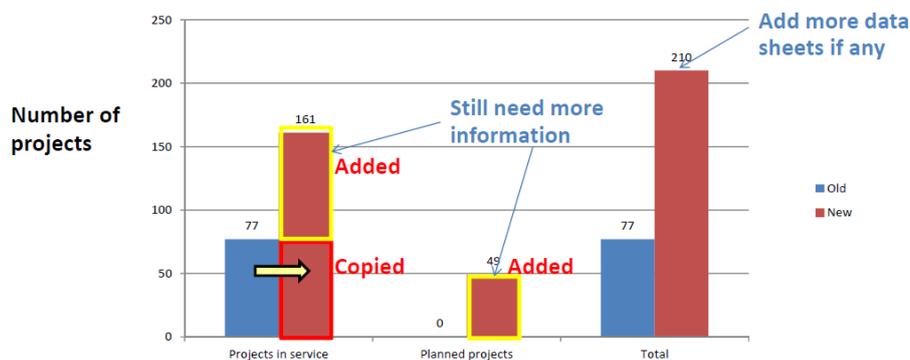
Specific B4 Study Committee activities over the last 12 months have included:

- SC B4 Colloquium – Johannesburg, South Africa
 - Combined with the 9th CIGRE Southern Africa Regional Conference.
 - Working Groups – 28 and 29 September 2019.
 - B4 Study Committee Meeting – 30 September 2019.
 - Tutorials – 1 October 2019 – Two tutorials presented by SC B4:
 - FACTS Planning, Technology Selection and Specification
 - Technology Selection and Specification of HVDC
 - Colloquium – 2 October to 3 October 2019
 - Three parallel streams – two covering the Southern Africa Regional Conference and one for SC B4.
 - 28 Papers presented for SC B4 covering the following topics:
 - Network Stability
 - Renewable Energy
 - LVDC and MVDC distribution and microgrids, Distributed FACTS devices, Synthetic inertia, HVDC Insulation
 - HVDC Reliability, Refurbishment and upgrades of HVDC and FACTS installations
 - HVDC and FACTS Equipment and Technology
 - Australian member chaired the session on Renewable Energy.
- 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 Paris next year (2020).
- Performance of SVC/STATCOM - The collation of data and analysis of performance of FACTS devices, particularly SVCs and STATCOMs is underway. Preliminary results were presented

in Johannesburg during the SC B4 colloquium. The results for the years 2017-2018 are currently being collated for publication in Paris next year (2020).

- Green Books
 - Green book on FACTS – The Study Committee is finalising a text-book on Flexible AC Transmission Devices (FACTS). The work is mostly complete, with the Green Book expected to be available by Paris 2020.
 - Green Book on Electricity Supply of the Future – SC B4 completed a chapter on HVDC and FACTS. The Green Book, which comprises of submissions from all study committees is expected to be published prior to Paris 2020.
- HVDC Compendium – The Study Committee is coordinating the collation of an online compendium of all HVDC systems installed around the world, with key characteristics shown for each.
 - The compendium is being updated and revised and is expected to be available on e-cigre by April 2020.
 - Figure 1 shows the addition of more projects in service and planned projects in the new compendium, increasing the number of projects from 77 (in the old compendium) to 210.

Figure 1 - Comparison of Content - Old vs New Compendium



3. Preferential Subjects

The preferential subjects for the 2020 Paris Technical Session for the B4 Study Committee have been agreed and accepted as:

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

- Planning and implementation of new projects including, need, justification, FACTS devices for renewables, environmental and economic assessment;
- Application of new technologies in FACTS and other PE equipment;
- Refurbishment and upgrade of existing FACTS and other PE systems; and
- Service and operating experience.

4. Proposed New Working Groups

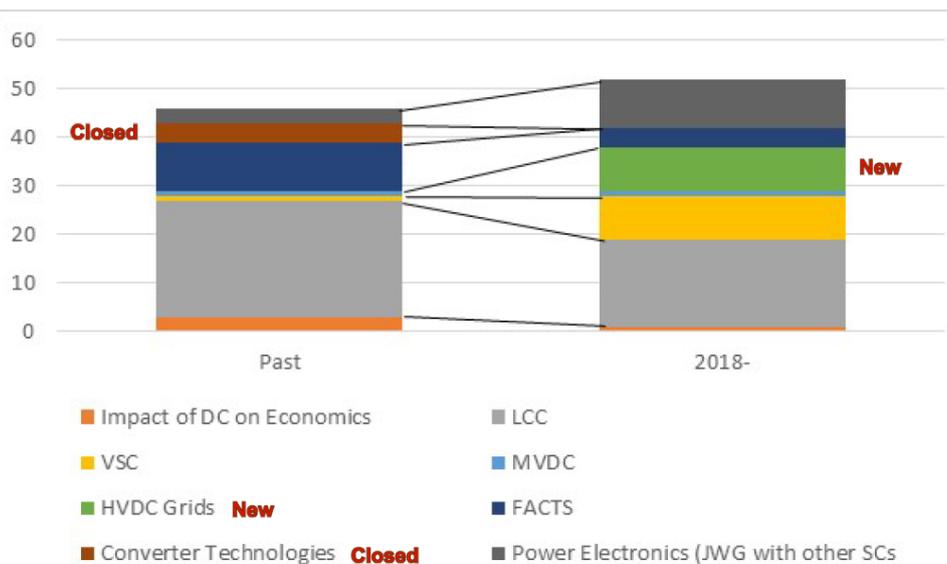
In Johannesburg (October 2019), the Study Committee Chairman presented some information on the strategic direction of SC B4, and in particular the general trends on topics for working groups.

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.

The evolution of SC B4 working group topics can be seen in Figure 2.

Figure 2 - Evolution of SC B4 Working Group Topics From 2009 to 2019



A number of new working groups were created or have been proposed during 2019:

- HVDC equipment with partially open-source software
 - A working group that seeks to address the issue of being able to model DC systems with converters from multiple manufacturers with closed, proprietary control and protection system software.
 - It will investigate whether some software associated with the control and protection systems can be open-source while the internal control and protection elements of the converters remain proprietary and closed.
- Fault current limiting technologies for DC grids
 - In HVDC grids, there is a need to isolate DC faults very fast before it affects the DC voltage in other parts of the grid. Devices to achieve this are under development but would benefit if the DC fault current can be limited.

- This WG will review and assess the DC fault current limiting technologies and devices, both available and possible, and to provide guidelines on how to select the technology and device for the specific application.
- Commissioning of FACTS
 - During the development of the FACTS controller commissioning chapter of the FACTS Green Book, it was determined that this would be a suitable topic for a working group. A new WG is therefore proposed to review the information collated so far and to develop guidelines for the commissioning of FACTS controllers.
- AC fault response options for VSC HVDC converters
 - TF B4.77 was created in 2016 to investigate the possibility of VSC converters acting as Virtual Synchronous Machines (VSM). A paper on the outcomes of this TF was published in the Cigre CSE Journal.
 - A key recommendation of this TF was the need to further investigate the operation of grids dominated by power electronic infeed, including the use of parallel grid forming converters.

The outgoing APB4 convenor (Les Brand) has proposed a working group to develop guidelines for the operation and maintenance of HVDC (and possibly FACTS) systems. This has received support within the Study Committee, and there is an action for a Terms of Reference (TOR) to be developed and issued for Study Committee approval.

A new task force has been created (AG04.TF6) “Performance Improvement” to review how HVDC and FACTS performance data is and can be shared and used.

5. Specific Activities of the Australian Panel

Key activities of the AU B4 panel during 2019 include:

- Significant contribution by Australian and New Zealand members to the Green Book on FACTS:
 - Babak Badrzadeh
 - Peeter Muttik
 - Rizah Memisevic
 - Andrew Van Eyk
- Contributing author to Green Book on Electricity Supply of the Future, HVDC chapter - Les Brand.
- Member, SC B4 AG-01 “Advisory Group” - Les Brand.
- VSC HVDC Common Terms Document – Outgoing AU B4 convenor (Les Brand) assigned the task to develop a “Common Terms and Description” document for VSC HVDC technologies, that can be referenced as background material for all future VSC working group Technical Brochures.
- Participation on International Working Groups and Task Forces:
 - Task Force TF B4.77 – “AC Fault response options for VSC HVDC Converters” - Simon Bartlett.
 - JWG C6/B4.37 – “Medium Voltage DC distribution systems” - Les Brand and Georgios Konstantinou.
 - B4 .82 – “Guidelines for Use of Real-Code in EMT Models for HVDC, FACTS and Inverter based generators in Power Systems Analysis” - Nathan Crook.
 - B4.78 – “Cyber Asset Management for HVDC/FACTS Systems” - Mark Shilliday.
- Outgoing SC AU convenor (Les Brand) has been assigned the Special Reporter role for the Paris 2020 technical session.

6. Meeting Report: Australian Panel

The AU B4 2019 Panel Meeting was held at Queenstown, New Zealand from 12 to 14 November 2019. The meeting was hosted by Transpower.

13 out of 19 members attended the meeting.

The meeting including one and a half days for the AU B4 meeting in Queenstown plus a half day site visit to Benmore HVDC converter station (located about 3 hours away).

Figure 3 - The AU B4 Team at the Pole 3 Control Centre - Benmore, New Zealand



Figure 4 - At the Electrode Station Site Outside of Benmore



During the AU B4 meeting, the new incoming Convenor for SC B4 was announced as Mr John Wright-Smith of American Superconductor.

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

In the Paris 2020 session, AU B4 will be submitting 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 will take a vote during the Paris 2020 Study Committee meeting.

8. 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

9. Membership of the Australian Panel

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

Convener: Les Brand
Email: les.brand@amplitudepower.com
Phone: 0488 020 948

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:

- 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 IEC61850.

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

2. Specific Activities of the Study Committee

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

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

The following preferential subjects were the basis of the 2019 SC B5 Colloquium in Tromsø Norway

1. Leveraging PMU data for better Protection, Automation and Control Systems
2. Time in Protection Applications – Time sources and distribution Methods
3. Future technologies for inter-substation communication and Migrating Digital Teleprotection Channels to Packet-Based Networks

25 B5 Working Groups are active and 1 Green Book was restarted.

The Secretary advised that a new SC B5 website is now active and available to the public. The URL is <https://projetb5.cigre.org/>

3. Preferential Subjects

Preferential Subjects for 2020 Paris France

1. Communication networks in PACS: Experience and challenges
2. Human aspects of Protection and Automation

Preferential Subjects for 2021 SC B5 Colloquium in India

1. Interoperability for IEDs of different
2. Fast Transient based protection
3. Mitigation Strategies and Methodologies to Manage the Impact of Low-Inertia and Low Fault Level Networks on PAC

4. Proposed New Working Groups & Green Books

During the 2019 SC B5 meeting three new working groups were proposed:

1. PACS Communication requirements for inter-substation and wide area applications
2. Experiences and future trends related to functional integration
3. Modelling of Protection Systems for Power System Planning

During 2019 the following Australian corresponding members were accepted for the following recently created working groups:

B5.69	Experience feedback and Recommendation for implementation of process bus in PACS	Frankie Lu (C) Kevin Hinkley
B5.70	Methods of Evaluating and Comparing Reliability of PACS Architectures/ Guide for reliability calculation and specification for PACS functions and architecture	Stewart Collins (C)

Before the 2019 SC B5 Colloquium in Tromsø the SC B5 chair asked Peter Bishop to restart and be the new convenor of the **IEC61850 Green Book (Restart) Task Force**. Peter chaired the first green book task force meeting in Tromsø. At this stage most planned future meetings will be by web meeting or during colloquium/Paris or during SEAPAC 2021.

5. Specific Activities of the Australian Panel

The AU B5 panel organised 2019 **South East Asia Protection & Automation Conference (SEAPAC)** was held in Sydney on 19-20 March. SEAPAC brought together the leading expertise in the protection and automation fields across Australia, New Zealand and the South East Asia region to participate at paper presentations and network at the technical exhibition.

- 139 delegates attended
- 36 presentations were delivered
- A diverse range of topics were covered from renewable generation challenges and application experience, IEC61850 scheme and digital substation experience, time synchronisation issues and teleprotection changes

The **2019 Australian B5 panel meeting was hosted by Snowy Hydro** in Khancoban/Corryong on the New South Wales/Victoria border on 14 & 15 May 2019. 19 members attended (4 were substitutes for the normal representative members), along with 3 guests.

The following presentations were given.

Mark Doherty	SA Power Networks	SA Power Networks MPLS protection scheme verification and implementation
Terry Foxcroft	Snowy Hydro	Australia generation mix update
Khang Dang	Western Power	Western Power's automatic fault record work
Marek Sokolowski & Damien Scott	Ausnet	Update on Ausnet's Rapid Earth Fault Current Limiter implementation
Brett Hampson	SEL	Summary of findings from transformer point on wave energisation tests

All Special Reporters' Questions for 2019 SC B5 Colloquium in Tromsø Norway were reviewed. Seven contributions were prepared with assistance from Transgrid, SA Power Networks and Transpower representatives.

At the meeting there was a presentation from the Next Generation Network representative, Damien Scott, and discussions on achieving greater Next Generation Network involvement with the panel. Also how there could be more interaction with university students.

After the panel meeting there was a technical tour of the existing Snowy Hydro power stations. The tour included a working view of the primary components of a generation scheme, their interaction with the associated protection systems and an appreciation of the design/maintenance considerations. It was

great to see systems function as generators were shut down, started up and synchronised to the grid. Terry Foxcroft did great work organising the panel meeting and tour.

The Cigre Knowledge Management System (KMS) has been used for blog/protection discussions on various protection issues relevant in Australia/New Zealand.

The next Australian panel meeting is planned to be hosted by Western Power in Perth in July 2020.

Rod Hughes suggested that **Green Books & Technical Brochures could be structured and stored online** rather than paper or pdf documents that are not updated and do not ideally deal with common information and are not easily searchable. Rod drafted a PowerPoint presentation for SC B5 to consider. During the SC B5 meeting in Tromsø the SC B5 secretary presented the PowerPoint to the SC members. Many members liked the existing technical brochure system and others could not imagine how and who would update online brochures. There was no clear plan by the SC to presently progress change.

Two paper abstracts by AU B5 panel members were **accepted** for the **CIGRE 2020 Paris Session**.

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

During the SC B5 meeting in Tromsø, Peter Bishop (on behalf of CIGRE Australia) gave a presentation on the **CIGRE Australia 2023 Cairns Symposium proposal** and invited SC B5 to take part. A discussion and vote occurred on whether to attend. The invitation was declined. There was a view by SC B5 members that they preferred a colloquium involving only SC B5 and would not be willing to fully support a symposium in addition.

7. ANC Members on Working Groups or Green Book

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

WG	Title	Australian Member
B5.41	Investig & Improvem't Possibilities for Metering Systems for Billing	Darron Tabone
B5.47	Network Protection Performance Audits	Peter Bishop
B5.48	Protection for developing network with limited fault current capability of generation	Rajnish Sood
B5.50	IEC 61850-based Substation Automation Systems – Expectation of Stakeholders and User Interaction	Ian Young
B5.51	Methods & Application of Remotely Accessed Information for SAS Maintenance and Operation	Taren Hobson
B5.52	Analysis and comparison of fault location systems in Substation Automation Systems	Darren Spoor (Full M)
B5.54	Protection and Automation Issues of Islanded Systems during System Restoration/Black Start	Terry Foxcroft
B5.56	Optimization of Protection Automation and Control Systems	Tuan Vu
B5.57	New challenges for frequency protection	Mitchell Eadie Chris Wembridge
B5.58	Faster protection and network automation systems: implications and requirements	Gavin de Hosson

WG	Title	Australian Member
B5.59	Requirements for Near-Process Intelligent Electronic Devices	Kevin Hinkley
B5.62	Life Cycle Testing of Synchrophasor Based Systems used for Protection, Monitoring and Control	Ritesh Bharat
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
B5.66	Cyber Security Requirements for PACS and the resilience of PAC architectures	David Taddeo
B5.67 JWG D2	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods	Benjamin Haines
B5.69	Experience feedback and Recommendation for implementation of process bus in PACS	Frankie Lu (C) Kevin Hinkley
B5.70	Methods of Evaluating and Comparing Reliability of PACS Architectures/ Guide for reliability calculation and specification for PACS functions and architecture	Stewart Collins (C)
Green Book	IEC 61850 Principles and Applications to Electric Power Systems	Peter Bishop (Convenor)

8. Membership of the Australian Panel

Name	Organisation	Type
D Harper	AECOM NZ	Consultant
J Brown	BECA NZ	Consultant
R Hughes	Rod Hughes Consulting	Consultant
P Blanchfield	Jacobs Australia now independent	Consultant
D Collins	Tesla Consultants NZ	Consultant
G.Munting	Entura	Consultant
S Kerr	PSC	Consultants
R Johnston	Essential Energy	Distribution
M Stanbury	Ausgrid	Distribution
R Coggan	Energy Queensland	Distribution
M Doherty	SA Power Networks	Distribution
M Browne	Endeavour Energy	Distribution
R Anegondy	Evoenergy	Distribution
R Simpkin	United Energy	Distribution

Name	Organisation	Type
T Foxcroft	Snowy Hydro	Generation
M Pallotta	ElectraNet	Transmission
B Capstaff	Powerlink Queensland	Transmission
M Sokolowski	AusNet Services	Transmission
S Bhola	TasNetworks	Transmission
G Saluja	TransGrid	Transmission
P Bishop	Transpower NZ	Transmission
K Dhang	Western Power Corporation	Transmission
A Kalem	Victoria University	University
Madhusudan S	ABB	Vendor
I Young	Schneider Electric	Vendor
L Torelli	CSE-Uniserve	Vendor
B Hampson	SEL NZ	Vendor
F Lu	Siemens	Vendor
F Pambrun	Grid Solutions	Vendor

Darren Scott from Ausnet is also on the panel as a NGN representative.

Also discussing membership with Power & Water Corporation NT and BHP.

The highlighted organisations have not attended the last 3 AP meetings

Convener: Peter Bishop
Email: peter.bishop@transpower.co.nz
Phone: +6421408503

AU C1 System Development and Economics

1. Study Committee Scope

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

2. Specific Activities of the Study Committee

Planning for rapid development, uncertain generation and desired reliability (newly and rapidly developing countries, system performance, contingency planning, mass penetration of renewables, a greenfield approach)

Investment drivers, decision processes and tools (investment drivers, planning criteria, grid codes and the role of new technology, new investment decision processes, new tools and methods for increasing uncertainty)

Asset management practices including risk assessment now and in the future (risk management, broad trends and practices, new solutions for changing power system designs).

3. Preferential Subjects

The following preferential subjects were selected by the Study Committee for the future Paris Session and/or other Study Committee events:

- PS1- Planning for a future sustainable grid
- PS2 - Building a sustainable future and integrating renewable energy resources
- PS3 - Technology solutions for a future sustainable power system

4. Proposed New Working Groups

C1.44 Follow-up from C1.35 (Global Electricity Network). Scope to be defined but could include:

- Fine-tuning and consolidation of assumptions, with particular regard to grid topology, routing and terminal points, possibly involving the directly impacted countries;
- Analysing the limits of the "copper plate" assumption within each node, and relevant improvements;
- Modelling the interconnections one by one and/or in properly identified clusters, in order to assess the individual viability and priority;
- Investigating the political, social, public acceptance barriers as well as the financing/ business models, trading/wheeling agreements as pre-requisite for realisation.

Convenor: Gerald Sanchis Support from: Saudi Arabia.

Review evolving existing and new expansion planning tools to include the value of distributed generation and customer flexibility

- Evolution of existing tools? Different ways to use existing tools and change current practices.
- Practices in scenarios development techniques.
- New tools required for the future. How do the tools adapt to the uncertainty? How will they use probabilistic tools?
- Need for new capabilities and tools (to build on C1.39 and C1.27).
- Consideration for different resource integration. Renewable integration for wind and PV as different resources. Customer participation. Potential for cooperation with SC C6.

Convenor: Charlotte Higgins Support from: Jeff Palermo.

Methods to extract the value from high penetration of EVs, customer storage and demand response

- Impact and methods to evaluate massive EV impact.
- Impact of mobile charging and how to get maximum benefit.
- Demand response.
- Value proppitiation - Frequency, voltage regulation aggregated.

- Methods to evaluate potential postponement of investment.
- Impact on capacity market; and on competition of batteries vs. EVs. Potential for cooperation with SC C5.

Convenor: To be nominated ASAP by Ning Zhang Support from: To be nominated ASAP by Bruno Cova

Requirements for asset analytic systems.

Convenor: Yury Tsimberg

5. Specific Activities of the Australian Panel

The key activities of the Australian Panel during 2019 included actively participating in ongoing C1 working groups including convening working group C1.38 and contributing to the C1 Green Book on Asset Management.

6. Meeting Report: Australian Panel

The AU C1 panel meeting will take place over 25-26 November 2019. The agenda includes reviewing papers for the 2020 Paris Session. A site visit to the HVDC terminal at Haywards substation is planned.

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

There are no invitations issued in 2019.

8. ANC Members on Working Groups

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

C1.38	Valuation as a comprehensive approach to asset management in view of emerging developments	Graeme Ancell (Convenor)
C1.39	Optimal power system planning under growing uncertainty	Christain Schafer
JWG C6/C1.33	"Multi-energy system interactions in distribution grids"	Kerim Mekki
WG C1.41	"Closing the Gap in Understanding between Stakeholders and Electrical Energy Specialists"	Phil Southwell (Convenor) Narelle Fortescue and Jonathan Dennis

9. Membership of the Australian Panel

Name	Organisation	Type
Graeme Ancell	Ancell Consulting	Convenor
Mark Hibbert	Aurecon	Consultant
Stephen Hodgkinson	ETSE Consulting	Consultant
Enrique Montiel	Powerlink	Transmission
Brad Parker	ElectraNet	Transmission
Herath Samarakoon	TasNetworks	Transmission
Christian Schaefer	AEMO	MSO and Transmission
Phil Southwell		
Kanchana Amarasekara	GHD	Consultant
Cristiano Marantas	Vector, NZ	Distributor
Asif Bhangor	Jacobs	Consultant

Name	Organisation	Type
David Volwes	University of Adelaide	Academia
Yateendra Mishra	QUT	Academia
Lekshmi Jaya Mohan	Western Power	Transmission and distribution

Convener: Graeme Ansell

Email: graeme.ansell@ansellconsulting.nz

Phone: +64 21382036.

AU C2 System Operations and Control

1. Study Committee Scope

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

2. Specific Activities of the Study Committee

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

TD1 – Real-time System Operation and Control

TD2 – System Operational Planning and Performance Analysis

TD3 – Control Centre Infrastructure and Human Resources for System Operation

A reference paper - 'Power System Restoration – World Practices & Future Trends' – was published in the June 2019 edition of the CIGRE Science and Engineering Journal.

3. Preferential Subjects

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

1. Capabilities required for future system operation
2. System operation interfaces: improving observability and controllability
3. System operation challenges with increasing use of Distributed energy resources (joint with C6)

4. Proposed New Working Groups

Study Committee C2 is seeking input of ideas for the development of Terms of Reference for a new JWG on cyber security in power system operation.

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;
- Submission of three paper synopses for the 2020 Paris Session, which have all been accepted ; and
- Sharing of local learnings through completion of surveys to support the work of working groups – particularly sharing Australian perspectives on power system operational resilience.

6. Meeting Report: Australian Panel

The AU C2 panel met in Melbourne on 12 November 2019. The Convenor provided an update on the activities of SC C2 and CIGRE internationally. The key insights gained from the Aalborg Symposium were shared and discussed with the panel. 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

An invitation has been extended to Study Committee C2 to meet in Cairns in 2023 in conjunction with the planned Symposium. No final decision has yet been made.

8. ANC Members on Working Groups

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

WG	Title	Australian Member
C2.24	Mitigating the risk of fire starts and the consequences of fires near overhead lines for System Operations'	Frank Crisci (Convenor)
C2.25	Operating Strategies and Preparedness for system Operational Resilience	Mark Miller Dean Sharifi Greg Hesse
C2.26	Power system restoration accounting for a rapidly changing power system and generation mix	Babak Badrzadeh (Convenor)
C2.39	Operator Training in Electricity grids at Different Control Levels and for Different Participants / Actors in the New Environment	Danial Lavis
C2.40	TSO-DSO Co-operation – Control Centre Tools Requirements	Matthew Rigano
C2/C5.05	Development and Changes in the Business of System Operators	Mark Miller Greg Hesse
C2/B4.38	Capabilities and requirements definition for Power Electronics based technologies for secure and efficient system operation and control	Richard Sherry and Sorrel Grogan

9. Membership of the Australian Panel

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



Convener: Greg Hesse
Email: ghesse@powerlink.com.au
Phone: 0418 783 840



AU C3 System Environmental Performance

1. Study Committee Scope

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

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

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

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

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

2. Specific Activities of the Study Committee

SC C3 currently has 1 working group and 13 active working groups:.

RG C3.01 EMF and Human Health (New Advisory group)	Michel Plante (CA)
WG C3.09A Corridor management	Aleš Kregar (SL)
WG C3.12 Methodologies for Greenhouse gas inventory and reporting for T&D utilities (Renewed TOR)	Mercedes Vázquez (ES)
WG C3.14 Impact of environmental liability on transmission and distribution activities	Vincent Du Four (BE)
WG C3.15 Best environmental and socioeconomic practices for improving public acceptance of high voltage substations	Marijke Wassens (NL)
WG C3.16 Interactions between electrical infrastructure and wildlife	Cécile Saint-Simon (FR)
WG C3.17 Interaction between wildlife and emerging renewable energy sources and submarine cables	Katherine Palmquist (USA)
WG C3.18 Eco-friendly approaches in transmission and distribution	Anne-Sophie Desaleux (FR)
WG C3.19 Responsible management of the Electric and magnetic Fields Issue	James Hart (AU)
WG C3-20 Sustainable Development Goals in the Power Sector	Christian Capello (AT)
JWG C3/B1/B2.13 Environmental issues of high voltage transmission lines for rural and urban areas (JWG with SC B1 and B2). –Closed this year-	Hector Pearson (UK)
WG C3.21 Including stakeholders in the investment planning process (Renewed TOR of former JWGC1/C3.31)	Susana Batel (PT)
WG C3.22 Vegetation management in substations	Mortier Johan (BE)
WG C3.23 Eco-design methods for TSO/DSO under environmental transition	Busato Guillaume



SC C3 met in Denmark in 2019 in conjunction with the Danish National Committee symposium. The symposium topics included:

- Offshore wind power network connection technologies and equipment: submarine and underground cables; HVAC and HVDC connections; wind farm power quality, transient and harmonic stability.
- Operation and system stability of weak networks with wind penetration, both DC and AC infeeds.
- (Offshore) HVDC technical and economic system perspectives, including multi-terminal DC networks, DC/AC hybrid transmission.
- Submarine cable technology and lifecycle.
- Upgrades and restructuring of onshore networks with mixed usage of HVAC, HVDC, overhead lines, underground and submarine cables.
- Changes and advances to split between roles and functionalities of distribution and transmission networks. Advances in exchange of data and services between DSO and TSO.
- Eco-design and environmental concerns of offshore and onshore transmission solutions, including asset management and public acceptance.

3. Preferential Subjects

The approved preferential subjects for 2020 include:

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

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

PS 2: Environmental impact of energy transition

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

PS 3: Relation of wildlife and electric infrastructure

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

One Australia paper for the 2020 Paris session has been accepted.

4. Proposed New Working Groups

Working groups which have commenced in 2019 include:

WG C3.21 Including stakeholders in the investment planning process (Renewed TOR of former JWGC1/C3.31)	Susana Batel (PT)
WG C3.22 Vegetation management in substations	Mortier Johan (BE)
WG C3.23 Eco-design methods for TSO/DSO under environmental transition	Busato Guillaume

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

- Environmental aspects of SF6.
- Life cycle assessment.
- Environmental effects of decommissioning.



Other ideas suggested, which may become future working groups, include sustainable supply chain, environmental aspects of storage, and adaptation to climate change.

5. Specific Activities of the Australian Panel

During 2018 AP C3 delivered two webinars based on the work of C3.19 Responsible management of the EMF issue.

A joint EESA/CIGRE Australia webinar was delivered in May 2019.

A CIGRE International webinar was delivered in November 2019. The webinar is available on eCigre.

<https://e-cigre.org/publication/WBN012-responsible-management-of-the-emf-issue>

AP C3 met in Sydney on 8 November 2018. Topics discussed included:

- Disposal of treated timber poles
- Fluid filled cable management strategies
- Biosecurity
- PFOS/PFAS contamination/fire fighting foam
- Sustainability
- KPIs
- Roundup and suitable alternatives
- Asbestos in meters/paint
- Training frameworks
- Significant incidents
- Growth retardants
- Waste management plans
- ISO14001
- Planning processes/GIS
- Resources, employees, structures, recent cut backs

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

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

The symposium theme is yet to be fully developed, but will focus on renewables and the challenges of integration and the impact of renewable generation on the Grid. It will include a number of committees including SC C3.

7. ANC Members on Working Groups

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

WG	Title	Australian Member
WG C3.18	Eco-friendly approaches in Transmission and Distribution	Andrew Johnson
WG C3.19	Responsible management of the Electric and Magnetic Field Issue	James Hart (convenor)
WG C3.17	Interaction between wildlife and emerging RES and submarine cables	Michael Roberts
WG C3.20	Sustainable development goals in the electric power sector	Michael Roberts

8. Membership of the Australian Panel



Name	Organisation	Type
James Hart	Ausgrid	Distribution/Transmission
Michael Roberts	Endeavour Energy	Distribution
Brett Haywood	Essential Energy	Distribution
Andrew Johnson	ElectraNet	Transmission
Ed Parker	TasNetworks	Distribution/Transmission
David Donehue	TransGrid	Transmission
Debra Kenned	Powerlink	Transmission
Sonya Bryce	Energy Queensland	Distribution/Transmission
Andy Shaw	Western Power	Distribution/Transmission

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

AU C4 System Technical Performance

1. Study Committee Scope

SC C4 deals with methods and tools for the analysis of power systems, with particular reference to dynamic and transient conditions and the interactions between the power system and its apparatus/subsystems (including external causes of stress). Specific issues related to the design and manufacturing of components are not in the scope of SC C4, nor are those specifically related to planning, operation and control, apart from those cases in which a component, apparatus or subsystem behaviour depends on, or significantly interacts with, the performance of the nearby network. However, as many design studies depend on the tools used and developed within the scope of SC C4, it is important to note that C4 encourages and regularly supports joint activities with other study committees.

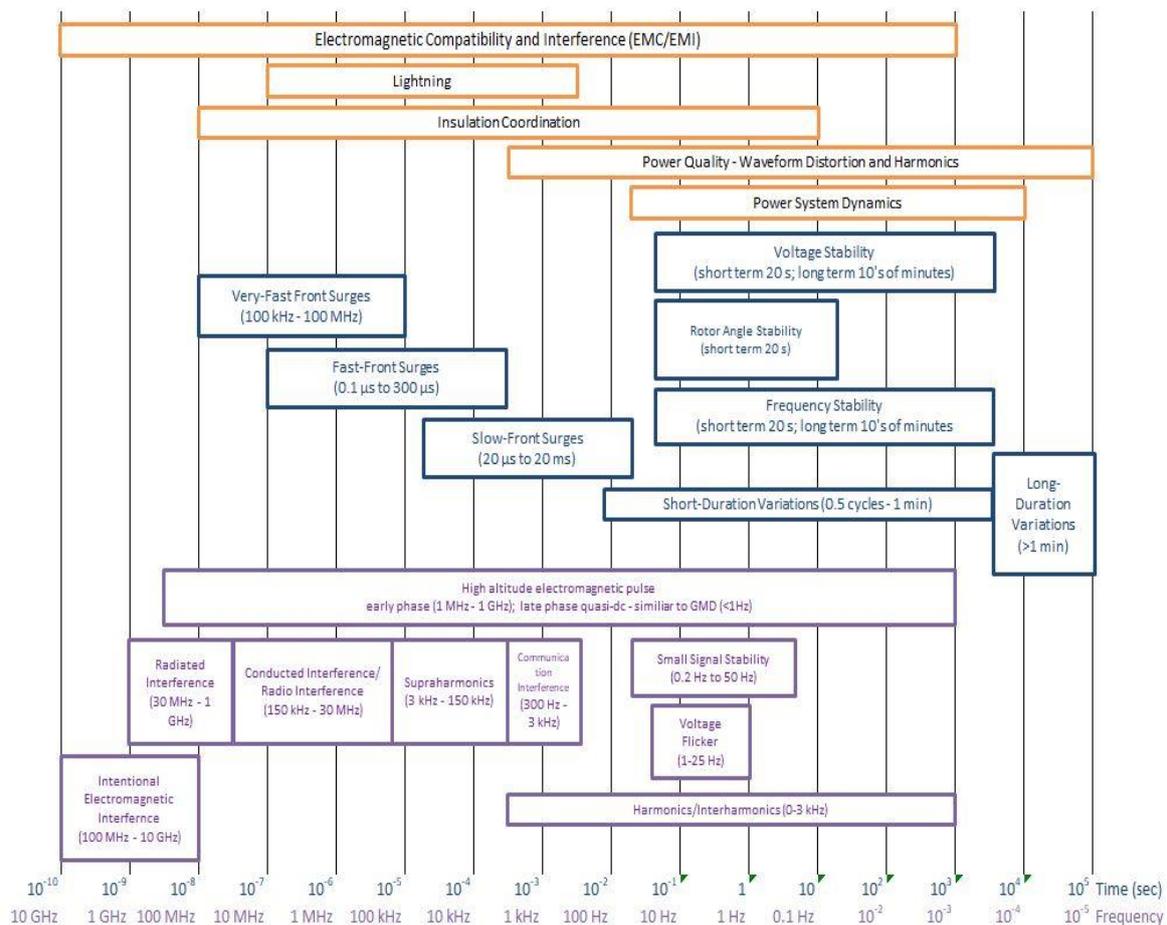


Figure 1: Time frame of various phenomena of interest in power system studies.

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

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

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

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

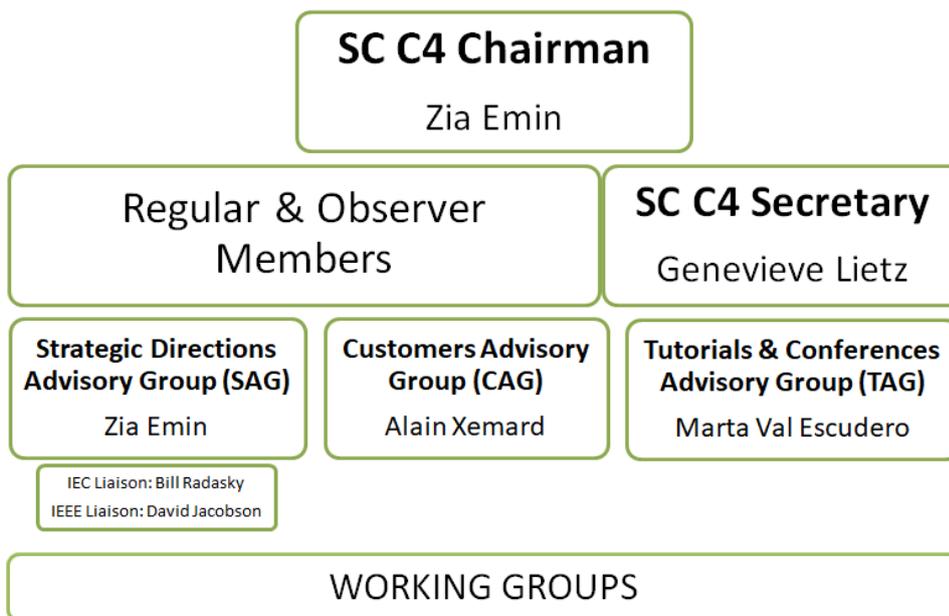
2. Study Committee Structure

The organisational structure of SC C4 is as shown in Figure 2. At the 2019 SC meeting in Aalborg (Denmark), the composition of the SC was confirmed as follows:

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

The membership of SC C4 presently encompasses 42 countries.

Figure 2: SC C4 structure



From AU C4, Andrew Halley and Sarath Perera are both members of SAG. Andrew is also a Regular Member of the SC, being one of twenty four (24) national representatives.

3. Specific Activities of the Study Committee

3.1 Active Working Groups

SC C4 currently has thirty five (35) active working groups (WG). The breakdown by sub-topic is:

- Power quality, 5
- Electromagnetic compatibility and interference (EMC/EMI), 5
- Insulation co-ordination, 7
- Lightning, 7
- Power systems dynamics and numerical analysis, 11

WG #	Title	Convener	Schedule
WG C4.23	Guide to procedures for estimating the lightning performance of transmission lines.	C. Engelbrecht (Netherlands)	2012 - 2015
WG C4.28	Extrapolation of measured values of power frequency magnetic fields in the vicinity of power links.	P. E. Munhoz Rojas (Brazil)	2016 - 2018
WG C4.31/CIRED	EMC between communication circuits and power systems.	D. Thomas (UK)	2012 - 2016
WG C4.36	Winter lightning – Parameters and engineering consequences for wind turbines.	M. Ishii (Japan)	2014 - 2017
WG C4.37	Electromagnetic computation methods for lightning surge studies with emphasis on the FDTD method.	Y. Baba (Japan)	2014 - 2018
WG C4.39	Effectiveness of line surge arresters for lightning protection of overhead transmission lines.	K. Tsuge (Japan)	2015 - 2017
JWG C4.40/CIRED	Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14.	M. Halpin (USA)	2015 - 2018
JWG C4/B5.41	Challenges with series compensation application in power systems when overcompensating lines.	L. Haarla (Finland)	2015 - 2017
JWG C4.42/CIRED	Continuous assessment of low-order harmonic emissions from customer installations.	I. Papič (Slovenia)	2015 - 2018
WG C4.43	Lightning problems and lightning risk management for nuclear power plants.	T. Shindo (Japan)	2017 - 2020
WG C4.44	EMC for large photovoltaic systems.	E. Salinas (Sweden)	2017 - 2019
WG C4.45	Measuring techniques and characteristics of fast and very fast transient overvoltages in substations and converter stations.	S. Xie (China)	2017 - 2021
WG C4.46	Evaluation of temporary overvoltages in power systems due to low order harmonic resonances.	F. F. da Silva (Denmark)	2017 - 2019
WG C4.47	Power system resilience.	M. van Harte (South Africa)	2017 - 2020
WG C4.48	Overvoltage withstand characteristics of power system equipment 35-1200 kV.	I. Dudurych (Ireland)	2017 - 2020
WG C4.49	Multi-frequency stability of converter-based modern power systems.	Ł. Kocewiak (Denmark)	2018 - 2021
WG C4.50	Evaluation of transient performance of grounding systems in substations and its impact on primary and secondary systems.	B. Zhang (China)	2018 - 2021
WG C4.51	Connection of railway traction systems to power networks.	D. Vujatovic (UK)	2018 - 2021
WG C4.54	Protection of high voltage power network control electronics from the High-altitude Electromagnetic Pulse (HEMP).	W.A. Radasky (USA)	2019 - 2022
WG C4.55	EMC related very-fast transients in gas-insulated substations - EMC interferences, measured characteristics, modelling and simulations.	A. Ametani (Japan)	2019 - 2022

WG #	Title	Convener	Schedule
WG C4.56	Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter connected generation.	B. Badrzadeh (Australia)	2019 - 2022
WG C4.57	Guidelines for the estimation of overhead distribution line lightning performance and its application to lightning protection design scope.	K. Michishita (Japan)	2019 - 2022
WG C4.59	Real-time lightning protection of the electricity supply systems of the future.	C. Tong (China)	2019 - 2022
JWG C4/B4.52	Guidelines for sub-synchronous oscillation studies in power electronics dominated power systems.	C. Karawita (Canada)	2019 - 2021
JWG A2/C4.52	High-frequency transformer and reactor models for network studies.	B. Gustavsen (Norway)	2014 - 2018
JWG A1/C4.52	Wind generators and frequency-active power control of power systems.	N. Miller (USA)	2015 - 2018
JWG A1/C4.66	Guide on the assessment, specification and design of synchronous condensers for power systems with predominance of low or zero inertia generators.	D. K. Chaturvedi (India)	2019 - 2021
JWG B1/C4.69	Recommendations for the insulation coordination on AC cable systems.	T. du Plessis (South Africa)	2018 - 2021
JWG B4/B1/C4.73	Surge and extended overvoltage testing of HVDC Cable Systems.	M. Saltzer (Sweden)	2016 - 2017
JWG B5/C4.61	Impact of Low Inertia Network on Protection and Control	R. Zhang (UK)	2017 - 2020
JWG C1/C4.36	Review of Large City & Metropolitan Area power system development trends taking into account new generation, grid and information technologies.	V. Jesus (Brazil) S. Utts (Russia)	2017 - 2019
JWG C2/C4.41	Impact of high penetration of inverter-based generation on system inertia of networks	M. Rampokanyo (South Africa)	2018 - 2020
JWG C4/A3.53	Application Effects of Low-Residual-Voltage Surge Arresters in Suppressing Overvoltages in UHV AC Systems	J. He (China)	2019 - 2021
JWG C4/C2.58/IEEE	Evaluation of Voltage Stability Assessment Methodologies in Transmission Systems	U. Annakkage (Canada)	2019 - 2021
JWG B2/C4.76	Lightning & grounding considerations for overhead line rebuilding and refurbishing projects, AC and DC.	William A. Chisholm (Canada)	2019 - 2022

3.2 Proposed Working Groups

There are no proposals for new WGs which are currently awaiting review by the SC.

3.3 Green Books

SC C4 is providing input to the following CIGRE reference material:

- *Electricity Supply Systems of the Future*. C4 has provided a complete chapter on system technical performance issues which can be reasonably foreseen in the future. Members from AU C4 have prepared the chapter section on power quality and have also contributed to the power system dynamics section. Publication of the Green Book is due in August 2020.
- *FACTS Devices*, The publication is being led by SC B4. AU C4 members have prepared the chapter which outlines commissioning test requirements and associated network considerations. Publication of the final document is expected toward the end of 2019, with the document now in the final stages of production.

3.4 CIGRE Science and Engineering Journal and Electra Articles

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

- CSE Journal Feature Article: “***The use of battery energy storage systems for system integrity protection schemes in the South Australian power system***”, Document reference: CSE-014, June 2019.
- Reference paper by WG C4.47 on Power System Resilience, “***Defining power system resilience***”, Document reference: Electra RP-306-1.
- Numerous other SC C4 related papers were published in the CSE Journal during 2019.

All documentation is available via the e-CIGRE website.

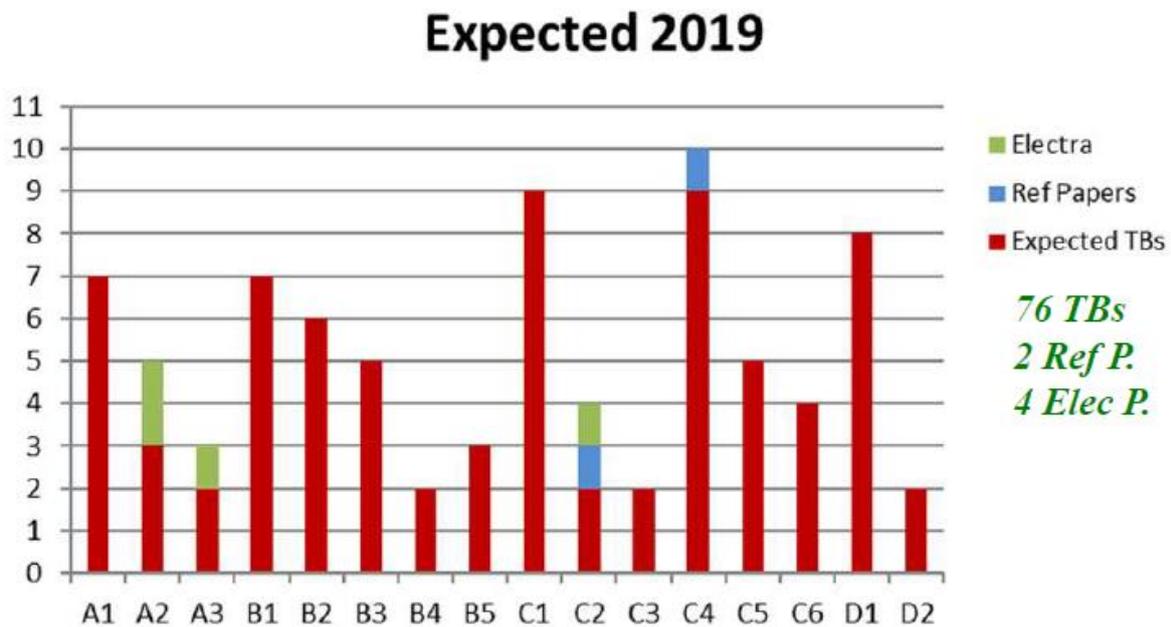
3.5 Published Technical Brochures

The following Technical Brochures (TB) have been published by SC C4 since November 2018.

- TB 742: A proposed framework for coordinated power system stability control, WG C2/C4.37.
- TB 745: Issues related to spark discharges, WG C4.25.
- TB 766: Network modelling for harmonic studies, WG C4/B4.38.
- TB 780: Understanding of geomagnetic storms environment for high voltage power grids, WG C4.32.
- TB 781: Impact of soil-parameter frequency dependence on the response of grounding electrodes and on the lightning performance of electrical systems, WG C4.33

A number of other TB's are currently being reviewed by the SC or are due for completion in the near future.

Figure 3: Expected number of TB publications in the 2019 calendar year.



3.6 Webinars

During 2019, SC C4 has offered the following webinars to CIGRE members:

- **“Benchmarking of Power Quality Performance in Transmission Systems”**, by Davor Vujatovic, Convener of WG C4.27. January 16, 2019.
- **“Modelling of inverter-based generation for power system dynamic studies”**, by Koji Yamashita, Co-Covener of CIGRE JWG C4/C6.35/CIRED. Apr 4, 2019.
- **“A proposed framework for coordinated power system stability control”**, by Yongjie Fang, convener of JWG C2/C4.37. Sep 5, 2019.

3.7 International Events

In addition to the Paris General Session which is held every second year, the following upcoming international events are being directly supported by SC C4.

- International Colloquium, **“Lightning and Power Systems”**, March 2021, Suzhou, China.
 - The *C4 SC meeting for 2021* will be held in conjunction with this event.
- CIGRE Symposium, **“Challenges of system performance in the energy transition framework”**, June 2021, Ljubljana (Slovenia).
- International Colloquium **“Active distribution network planning, operation and control”**, October 2021, Kyoto, Japan.

4. Paris Session 2020

4.1 Preferential subjects

All preferential subjects for the **2020 General Session** are available online at:

<https://www.cigre.org/GB/events/cigre-session-2020>

The preferential subjects for SC C4 at the **2020 Paris Session** are as follows:

PS 1: Improving power system technical performance through the use of advanced methods, models and tools:

- The analysis of widespread dynamic security issues including intentional electromagnetic interference, weather and geomagnetically induced currents.
- The assessment of frequency stability, system strength, or power quality using Big Data analytics.
- Development of emerging metrics for quantifying power system reliability, resiliency and flexibility.

PS 2: Modelling of the future grid based on lessons learned from system events including:

- Experience gained from smart grid projects.
- High penetration levels of inverter-based devices.
- Deployment of energy storage systems.

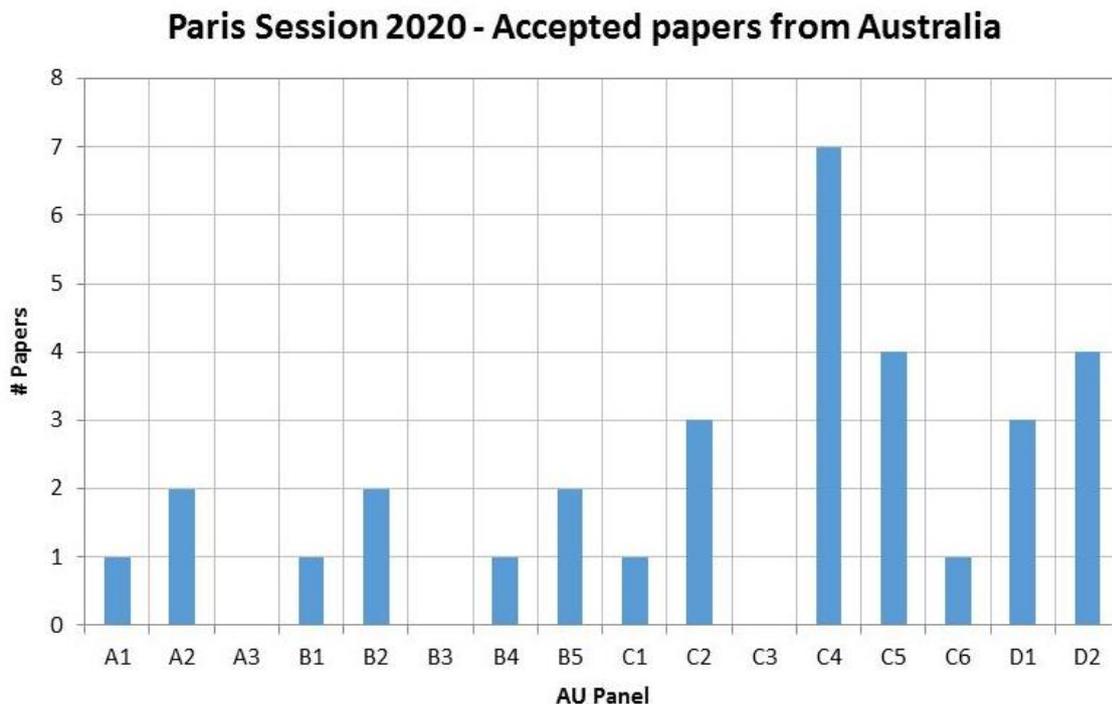
PS3: Methods, models and techniques for evaluating lightning, power quality and insulation coordination to enhance the performance of the evolving grid:

- UHV AC and/or DC systems,
- Renewable generation, inverter-oriented power systems and traction loads,
- Harmful interactions between power system components.

4.2 Accepted Papers from AU C4

There have been seven papers accepted from AU C4 for the 2020 Paris session. Six synopsis were submitted directly (and subsequently accepted), with a seventh paper redirected from SC C2 during the synopsis review process. This is a notable increase from 2018 when five papers were accepted and published through AU C4.

Figure 4: Australian papers accepted for Paris Session 2020



The seven papers that have been accepted are as follows:

Lead author	Paper #	Title
Neil Browne	520	Trends in power quality disturbance compatibility in Australia.
Nalin Pahalawatta	515	Power system analysis tools for supporting renewable generation connections.
Winodh Jayewardene	514	Holistic approach to modelling and tuning of a wind farm in conjunction with a synchronous condenser in a low system strength grid.
Greg Hesse	491	Monitoring and modelling of geomagnetically induced currents across the Australian National Electricity Market (NEM).
Babak Badrzadeh	499	Synchronous condenser solutions to replace synchronous generators for providing system strength in a large-scale power system – the South Australian experience.
Babak Badrzadeh	495	A large-scale electromagnetic transient model validation based on measured system disturbances.
Tony Morton	502	Generator fault current injection: Are system operators asking for the right thing?

4.3 Technical Workshop

In response to a general request from the C4 SC Chairman to consider what presentations and/or tutorials could be offered in Paris, a proposal from AU C4 was submitted and subsequently accepted by the CIGRE Technical Council. A technical workshop will be offered on Friday 28 August titled:

“System strength – Concepts and associated technical issues for networks having a high penetration of power electronic interfaced generating systems”

The general topics that will be presented by a panel of international experts coordinated by members of AU C4 are as follows:

- Explanation of what is meant by ‘system strength’ and its relationship with system inertia.
- Description of local vs system-wide system strength issues.
- Descriptions about how a ‘lack of system strength’ can manifest as an issue for the power system.
- Tools and techniques for analysing low system strength conditions (including screening methods and detailed simulation studies).
- Practical examples of assessing and managing local system strength issues including examples of both control system tuning and installation of auxiliary equipment (including synchronous condensers) as mitigation measures.
- Management of system strength in a real time operational environment.
- Current and prospective system strength solutions.

For further information on this event, please contact the coordinators, Andrew Halley and Babak Badrzadeh.

5. Other Specific Activities of the Australian Panel

The Australian Panel has continued to be active in 2019 with ongoing involvement in a number of WG, the Danish Symposium and contributions to various local initiatives. The following summaries highlight the major achievements of the panel.

5.1 Contributions to WG

The following CIGRE Australia members are contributing to active C4 WG.

WG Ref	Title	AU.C4 Reps	Involvement	Status	TB Ref
C4/C2.58/ IEEE	Evaluation of voltage stability assessment methodologies in transmission systems.	Ehsan Farahani	Corresponding member	In progress.	Pending.
C4.56	Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter connected generation	Babak Badrzadeh Sachin Goyal Mark Davies Sorrell Grogan Jingwei Lu	<u>Convenor</u> Member Corresponding members	In progress.	Pending.
C4/B4.52	Guidelines for sub-synchronous oscillation studies in power electronics dominated power systems	Babak Badrzadeh David Vowles Sachin Goyal	Member Corresponding members	In progress.	Pending.
C4.51	Connection of railway traction systems to power networks	Igor Perin Phil Coughlan	Members	In progress.	Pending
C2/C4.41	Impact of high penetration of inverter based generation on system inertia of networks.	Nilesh Modi Michael Negnevitsky Gregor Verbic	Members	In progress.	Pending
		Cheryl Noronha Craig Blizzard	Corresponding members		
C4.47	Power system resilience	Julian Eggleston Terry Lampard Mancarella Pierluigi	Members	In progress.	Pending

WG Ref	Title	AU.C4 Reps	Involvement	Status	TB Ref
C4.42/CIREC	Continuous assessment of low-order harmonic emissions from customer installations.	Tim Browne Sarath Perera Vic Gosbell	Corresponding Members	In progress.	Pending.
C4.40/CIREC	Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14.	Alex BAITCH Sarath PERERA Vic Gosbell	Members	In progress.	Pending.
C4.39	Effectiveness of line surge arresters for lightning protection of overhead transmission lines	Thomas Daly	Corresponding Member	In progress.	Pending.
C4.32	Understanding of the geomagnetic storm environment for high voltage power grids.	Andrew Halley Robert Adams	Members	Complete 2019.	<u>Technical Brochure TB 780</u>
C4.28	Extrapolation of measured values of power frequency magnetic fields in the vicinity of power links.	Ben Li Garry Melik	Member Corresponding Member	In progress.	Pending.

5.2 Contributions to other significant industry activities

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

Reference	AU representative	Contribution
<u>CIGRE Green Book</u> <i>"Electricity Supply Systems of the Future"</i> .	Sarath Perera Vic Gosbell	Lead authors to Chapter Section <i>"Power Quality"</i> .
	Andrew Halley	Contributing author to Chapter Section <i>"Power System Dynamics"</i> .
<u>Danish Symposium 2019</u>	Babak Badrzadeh	Technical session #10 chair: <i>"SSR, control interactions and instabilities"</i> .
	Andrew Halley	Technical session #19 chair: <i>"System technical aspects of wind generation"</i> .

Reference	AU representative	Contribution
<u>CIGRE Science and Engineering Journal</u> SC C4 feature article: <i>"The use of battery energy storage systems for system integrity protection schemes in South Australian power system"</i>	Nilesh Modi Babak Badrzadeh Sorrell Grogan Cheryl Noronha	Article produced by the Australian Energy Market Operator (AEMO) with support of ElectraNet. Submitted through AU C4. Published June 2019, CSE-014
<u>IEC Advisory Committee on Transmission and Distribution</u>	Alex Baitch	Member
<u>Standards Australia</u> EL-034 Power Quality EL-043 High voltage installations	Peeter Muttik Alex Baitch	Peeter is Chairman of EL-034 and a member of several of its sub-committees. Alex is Chairman of EL-043 and member of EL-034 and several subcommittees. He is an active member of several of its IEC mirror committees (TC8, SC8A, SC8B and SC77 and TC99).

5.3 AU C4 Panel Meeting and Technical Seminar – Brisbane, Energy Queensland

The Australian Panel of C4 held its annual meeting and technical seminar on Thursday 22 and Friday 23 August at the Brisbane office of Energy Queensland (EQ).

For the closed meeting on Thursday, there were a total of twenty four (24) attendees which included a small number of invited guests from EQ. The panel was fortunate to have an opening address delivered by Peter Price (Executive General Manager of Strategy, Asset, Performance and Security) who offered personal thoughts on the direction of the industry as well as the relevance and importance of CIGRE as an ongoing source of technical expertise. He encouraged discussions that were of direct relevance to industry and the development of solutions that could be readily applied in practice.

The first half of the meeting delivered a summary of SC C4 and CIGRE Australia activities with the intent that the information would be disseminated within each member organisation and/or peer group. The agenda included recognition that AU C4 panel member Professor Michael Negnevitsky was awarded the Outstanding Academic Achievement Award at the 2018 CIGRE Australia AGM.

The afternoon session provided an opportunity for each member to deliver an update on C4 related activities in which they are involved, including WG reports. As always, this generated interesting and insightful discussions and continued to demonstrate the vast knowledge reserves that are available within the AU C4 membership base.

The closed panel session concluded with agreement that the 2020 meeting would be held in South Australia in July or early August, but in any case prior to the Paris Session.

On Friday 23 August, AU C4 held an open technical seminar at the EQ offices which featured the following presentations:

- Terry Killen (Executive Manager, CIGRE Australia): Update on CIGRE Australia activities.
- Garry Melik: EMF issues associated with air core reactors.
- Vic Gosbell: Harmonic compliance assessment - why is it such a difficult issue!

- Andrew Halley: Management of system strength and inertia in Tasmania.
- Alex Baitch: Issues with ferroresonance.
- Michael Negnevitsky: Enhancing flexibility, reliability, and resilience of isolated power systems via low-load and variable speed diesel integration.
- Energy Queensland (Peter Kilby, Alan Louis):
 - Managing the 230V transition and PQ performance.
 - PQ challenges with distribution supply to remote areas having high penetrations of renewable generation.

All presentations were very well received by the audience (of approximately 30), with several generating significant discussion. The presentations on the power quality challenges being faced by EQ across its extensive distribution network were particularly interesting. Its efforts to install, manage and act on the feedback coming from a significant number of power quality measurement devices was noteworthy, as were discussions on the massive uptake of embedded photovoltaic (PV) generation.

The day concluded with an open forum on the following two topics:

- Future of power quality and system stability in networks having a high penetration of large renewable generation.
- The role of CIGRE AU C4 in transforming electricity systems and the NEM.

The key themes that resonated through the ensuing discussions were as follows:

- Analysis of the power system is becoming more complex and is requiring the development of new skill sets and analysis tools. While not ideal, a great deal of learning is occurring “on the job” simply to keep pace with the rate of change that now exists. How to develop, recruit and retain specialist skills were discussed as challenges for many organisations. The need to adapt under and post graduate courses to suit evolving industry needs was also mentioned.
- The amount of analysis required to connect new generation equipment has snowballed. Uncertainties surrounding model accuracy and the validity of simulation outcomes have contributed to an increase in perceived risk (for both generators and networks). This has potentially led to situations where unnecessary equipment has been installed purely as a risk mitigation measure (examples cited included installation of harmonic filters).
- It was noted that we need to better understand and manage these new risks so as to avoid unnecessary costs being (eventually) transferred back to customers (the end-users of electricity).
- While new generation technologies bring with them certain challenges, there are also opportunities to use fast acting power electronics to help control and manage various aspects of the power system, including in the power quality area, e.g. active filtering using power converters. Again, this requires increased understanding of the technical issues which are impacting on the power system, as well as the potential solutions that new technologies can offer.
- Improved visibility of the power system will become extremely important especially considering the growth of distributed energy resources (DER). The increasing importance of phasor measurement units (PMU), power quality meters and access to distribution level measurements from smart meters were all seen as important elements. It was noted that Network Service Providers not having ‘free and ready’ access to smart meter data was an increasing issue.

- The general consensus was that CIGRE has an opportunity to differentiate itself from other organisations by remaining technology agnostic (avoiding the coal versus renewable debates), politically unbiased and a source of superior technical expertise. There was a general feeling however that electrical engineers need to be better communicators and improve the way in which we disseminate information and knowledge to external groups including the general public.
- Mechanisms to raise the profile of CIGRE's capabilities were discussed. The perception is that there has been little if any advertisement of CIGRE (or other similar organisations like IEEE) outside of the immediate industry for a very long time. An idea was raised as to whether CIGRE panels could propose (electricity) rule changes and participate in industry consultations (such as those managed by the Australian Energy Market Commission (AEMC) and AEMO). Recommending changes to existing Australian Standards was also raised as a potential activity. An issue to be managed in these scenarios is any perceived conflict of interest where panel members are also potentially representing their own organisations in the same forums.

The technical seminar ended positively with attendees indicating that they had enjoyed the day and the quality of the material presented.

The AU C4 panel would like to recognise the support provided from Energy Queensland over the two days including access to excellent meeting facilities and providing quality catering services. We are appreciative of the support and look forward to ongoing liaisons with EQ representatives.

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

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

7. Membership of the Australian Panel

The AU C4 Panel consists of twenty four (24) members as of November 2019. The panel is currently seeking a Next Generation Network (NGN) representative to replace Tom Daly who headed overseas midway through the year to gain valuable international experience.

Name	Organisation	Type
Alex Baitch	BES (Aust) Pty Ltd	Consulting
Babak Badrzadeh	Australian Energy Market Operator (AEMO)	System Operator
Errol Bebbington	PSC Australia	Consulting
Steve Fraser	SA Power Networks	Network Service Provider
Don Geddey	TransGrid	Network Service Provider
Vic Gosbell	University of Wollongong	Academia
Andrew Halley	Tasmanian Networks Pty Ltd	Network Service Provider
Chandana Herath	Essential Energy	Network Service Provider
Miron Janjic	BECA	Consulting / Service Provider
Viji Krishnaratnam	Energex Ltd	Network Service Provider
Ben Li	Ausnet Services	Network Service Provider

Name	Organisation	Type
Garry Melik	Magshield Products International	Consulting
Rizah Memisevic	Powerlink Queensland	Network Service Provider
Peeter Muttik	GE Grid Australia Pty Ltd	Equipment Supplier
Michael Negnevitsky	University of Tasmania School of Engineering	Academia
Huuson Nguyen	Western Power	Network Service Provider
Sarath Perera	University of Wollongong	Academia
Devinda Perera	ElectraNet	Network Service Provider
Albert Pors	Endeavour Energy	Network Service Provider
Brett Roberts	AUSGRID	Network Service Provider
David Roby	ABB Australia Pty Limited	Equipment Supplier
Aditya Upadhye	Grid Wise Energy	Consulting
David Vowles	University of Adelaide	Academia
Neville Watson	University Of Canterbury	Academia
NGN representative	Currently vacant	

8. Panel contact details

For further information or questions, please contact:

Convener: Andrew Halley

Email: andrew.halley@tasnetworks.com.au

Phone: 0419 120 115

AU-C4 KMS Home Page:

<https://cigre.org/display/AUC4/AU+C4+System+Technical+Performance+Home>

AU C5 Markets and Regulation

1. Study Committee Scope

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

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

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

- share experiences;
- learn from real life experiences of usual or extreme market circumstances and how markets responded during system disturbances; and
- examine the performance of various market designs and regulations.

Work has commenced to prepare the 2020 workshop in conjunction with C2.

2. Specific Activities of the Study Committee

The Study Committee is continuing its focus on market developments, both at the macro and the micro level. A focus on distribution networks and the edge of the grid has again been included in the preferential subjects for 2020. The Study Committee is also contributing to the Technical Council Green book on the Grid of the Future.

The SC published Technical Brochures on Systemic Risk in Electricity Markets, Wholesale Price Caps and Barriers to achieving full value for storage

Study Committee C5 continues to support Study Committee C1 in a joint working group with the IEC (ACTAD TT-4, examining the tasks to progress Global Electricity Interconnection. This work is related to WG C1-35, which is examining this issue for CIGRE. SC C5 is providing a markets perspective to this work.

The Study Committee conducted the market component of the Large Disturbance workshop in cooperation with SC C2. Amongst other topics, the workshop examined environmental and technical causes for the SA blackout in 2016 and the policy and rule changes that followed. The workshop was attended by over 400 delegates and was highly regarded.

3. Preferential Subjects

The preferential subjects agreed for 2020 are:

PS1: The changing nature of markets and ancillary requirements

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

PS2: Changing role of regulators and standards

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

PS3: Market designs for coordination of generation and network investments

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

Four synopsis for papers from AU C5 have been accepted and drafting of the full papers is underway. Papers are to cover:

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

4. Proposed New Working Groups

There are no new working groups proposed (that I am aware of):

5. Specific Activities of the Australian Panel

The Australian Panel held its meeting in Sydney on Friday 7th of June 2019, hosted by EY. Fifteen panel members attended the meeting.

The chair and secretary of C5 and convenor of AU C5 held a web meeting with the chair and secretary of C2 and the chair and secretary of SC C2 to plan the combined Market and System Disturbance workshop for Paris 2020. Events in Argentina, Australia, Germany, Indonesia, UK, Japan and the US are candidates. The meeting agreed to work to filter these events to a manageable number with covering both C2 and C5 issues.

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

An invitation has been extended to SC C5 to meet in Australia in 2023, in conjunction with the C6 meeting and CIDER.

7. ANC Members on Working Groups

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

Working Group	Title	AU/NZ Leader*/ Representative
JWG C2.05/C5	Development and Changes in Business of System Operations	Greg Hesse(C2)
WG C5.22	Management of Systemic Market Risk in Electricity Markets – Convener: David Bowker. TB published 2019	Greg Thorpe* Tim Baker Andrew Jones Alex Cruickshank
WG C5.23	Wholesale Market Price Caps. TB published 2019	Ben Vanderwaal* Julian Eggleston Victor Francisco Alex Cruickshank
WG C5.24	Exploring the Market-based value of Smart Grid developments	Alex Cruickshank
WG C5.25	Regulation & Market design perspectives raised by new storage technologies. Reported 2019	Gari Bickers Ben Vanderwaal
WG C5-26	Auction markets and other procurement methods for demand	Gregor Verbic Victor Francisco
WG C5-27	Market Design for short term flexibility	Gregor Verbic* Greg Thorpe John Cooper Tim Baker
WG C5-28	Energy Market Price Formation	Greg Thorpe
WG C5- 30	Blockchain applications	David Bowker *
WG C5-31	Cost impacts of flexible Demand Response	Alex Cruickshank
WG C5-32	Carbon Pricing in Electricity Market	

8. Membership of the Australian Panel

Name	Organisation	Type
Greg Thorpe	Convener/Oakley Greenwood	Consultant
Victor Francisco	SecretaryPSC Consulting	Consultant
Tim Baker	Tim Baker Consulting	Consultant
Gari Bickers	Transpower	TNSP
Bess Clark	Tasnetworks	TNSP
Julian Eggleston	AEMC	Other
Stephen Hinchliffe	GHD Consulting	Consultant
John Cooper	Hydro Tasmania	Generator/Retailer
Kevin Kehl	Powerlink	TNSP
Rainer Korte	ElectraNet	TNSP
Jonathon Dennis	NGN/Powerlink	TNSP

Name	Organisation	Type
Ian Rose/Ben Vanderwaal	Ernst&Young	Consultant
David Swift	David Swift Consulting/AEMO	Consultant/Operator
Gregor Verbic	University of Sydney	Lecturer

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

AU C6 Active Distribution Systems and Distributed Energy Resources

1. Study Committee Scope

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

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

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

2. Specific Activities of the Study Committee

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

The main areas of attention are:

- Enabling technologies for renewable and distributed energy resource integration and application:
active network management, microgrids, virtual power plants, distribution management systems, DER monitoring and control, aggregation systems and platforms.
- Innovative solutions for DER and distribution technology deployment:
smart inverters and power electronic interfaces and interconnection device applications, MV/LV DC supply systems, distribution system modernization.
- Storage technologies:
deployment of various storage technologies such as electrochemical battery energy storage systems, flywheels, flow batteries, hydropower, hydrogen, multi-energy solutions (with thermal storage), power2X applications (power to heat, power to gas, etc), electric vehicles.
- New approaches to configure distribution systems for enhanced reliability and resilience:
islandable grid connected microgrids, power exchange between microgrids.
- Consumer integration and empowerment:
demand side integration and participation, demand response, load management, smart load, new customer sectors such as electric vehicles, smart home and smart meter applications with impact on distribution systems.
- Smart cities:
integrated distribution system technologies, power control and information and communication technology deployment for flexibility, integration of multi-energy systems.
- Rural electrification:
islanded power systems and individual customer off-grid systems and solutions.

3. Preferential Subjects

The proposed preferential subjects for the 2020 Paris Session are:

PS1: Advanced distribution system design incorporating DER

- Configuring demand response and intelligent loads for customer empowerment
- Exploiting local energy storage possibilities and managing uncertainties
- Enabling multi-energy systems using intelligent inverters and controls

PS2: Enabling technologies and solutions for distribution systems

- DER management and aggregation platforms
- Individual and multiple microgrid and virtual power plant design and control
- Rural electrification and off-grid distribution systems

PS3: System operation challenges with increasing distributed energy resources

- Enhancing flexibility, reliability and resilience
- Providing grid services through aggregators
- Aggregator interaction

Preferential Subject PS3 is to be co-chaired by both C2 and C6.

4. Proposed New Working Groups

In 2019 two new C6 working groups had their kick-off meetings. These were:

- C6.36 Distributed Energy Resource Models for Impact Assessment
- C6.40 Electric Vehicles as Distributed Energy Resource (DER) Systems

The following two topics were discussed at the SC C6 meeting held in Chengdu, China, in September 2019 and terms of reference documents will be prepared by the proponents:

- technology and application of the low voltage smart distribution equipment based on internet of things (IoT);
- guide for engineering procurement and testing of distribution battery energy systems.

The following topics were also discussed at SC C6 meeting in Chengdu and it was generally considered that further work will be required to determine the scope of any proposed WG. It is expected that these areas will be further discussed at the SC C6 meeting to be held in Paris in 2020:

- electrical railway distribution systems;
- LV DC distribution networks.

5. CIDER 2019

Australian Panel C6 hosted its third Conference on Integration of Distributed Energy Resources (CIDER) in Melbourne on 20-21 August 2019. This was held at the Pullman Melbourne on the Park, with 88 delegates attending. The conference included:

- two keynote presentations, Violette Mouchaileh of AEMO and Lachlan Blackhall of ANU;
- 26 presenters in a single-stream format, covering a number of issues including active distribution systems, voltage in LV networks, storage, harmonics, DER orchestration, testing, inverters and system performance, STATCOMs and synchronous condensers;
- an NGN panel, on *Managing the Impact of DER on Grid Stability*;
- a second panel on *Power Quality Response Modes*;
- stand-up networking dinner.

The conference received extremely good feedback from attendees, both in a survey sent to all participants immediately after the event and comments directly from delegates during the conference.

This was the third CIDER run by Australian panel C6, the previous two conferences being in Brisbane in 2015 and Sydney in 2017. The next CIDER will be held in 2021, in a city still to be selected.

6. Meeting Report: Australian Panel

Australian Panel C6 held its annual meeting in Melbourne on 19 August 2019, hosted by the University of Melbourne. This was a one-day meeting held immediately before CIDER 2019.

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. There were 17 panel members in attendance plus a number of guests. General administrative items and wider CIGRE news were covered in the morning, with members' presentations and discussion in the afternoon.

7. Specific Activities of the Australian Panel

Two Australian papers have been accepted for C6 for the 2020 Paris Session.

Australia has assisted the international SC C6 in 2019 with reviews of draft technical brochures and other documents. This role was expanded and formalised at the SC C6 meeting in September 2019 in Chengdu and this will be an area of greater contribution going forward.

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

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

9. ANC Members on Working Groups

The following are current AU representatives on Working Groups.

WG	Title	Australian Member
C6/C2.34	Flexibility Provision from Distributed Energy Resources	Pierluigi Mancarella (convenor)
C6/C2.34	Flexibility Provision from Distributed Energy Resources	Michael Negnevitsky
C6/C2.34	Flexibility Provision from Distributed Energy Resources	Gloria Zhang
C6.35	DER Aggregation Platforms for the Provision of Flexibility Services	Jenny Gannon
C6.35	DER Aggregation Platforms for the Provision of Flexibility Services	Archie Chapman
C6.36	Distributed Energy Resource Models for Impact Assessment	Jenny Riesz
C6.36	Distributed Energy Resource Models for Impact Assessment	Shariq Riaz
C1/C6.37/ CIRED	Optimal Transmission and Distribution Investment Decisions under Increasing Energy Scenario Uncertainty	Alex Baitch
C6/B4.37	Medium Voltage DC Distribution Systems	Georgios Konstantinou
C6.38	Rural Electrification	Jacqui Mills (secretary)
C6.38	Rural Electrification	Glen Summers
C6.39	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

10. Membership of the Australian Panel

Name	Organisation	Type
Ken Ash	Energ-G Management Group	Consultant
Alex Baitch	BES	Consultant
Ray Brown	RBPE	Consultant
David Butler	Hydro Tasmania	Generation
Hedy Dalvand	United Energy	Distribution
Sean Elphick	University of Wollongong	University
Shervin Fani	Western Power	Distribution
John Fletcher	University of NSW	University
Jenny Gannon	Energy Queensland	Distribution
Victor Ho	SA Power Networks	Distribution
Laura Jones	TasNetworks	Distribution
Olav Krause	University of Queensland	University
Gerard Ledwych	Queensland University of Technology	University
Pierluigi Mancarella	University of Melbourne	University
Michael Negnevitsky	University of Tasmania	University
Chirayu Oza	AGL	Retailer
Albert Pors	Endeavour Energy	Distribution
Jenny Riesz	AEMO	Operator
Thomas Smolka	Reinhausen	Manufacturer
David Stephens	Horizon Power	Distribution
Pradip Verma	Pacific Power Association	Distribution
Sanika Willard	CutlerMerz	Consultant
Mike Wishart	EcoJoule Energy	Manufacturer
Matthew Zillmann	Energy Queensland	NGN Rep.

Convener: Ray Brown

Email: ray@rbpe.com.au

AU D1 Materials and Emerging Test Techniques

1. Study Committee Scope

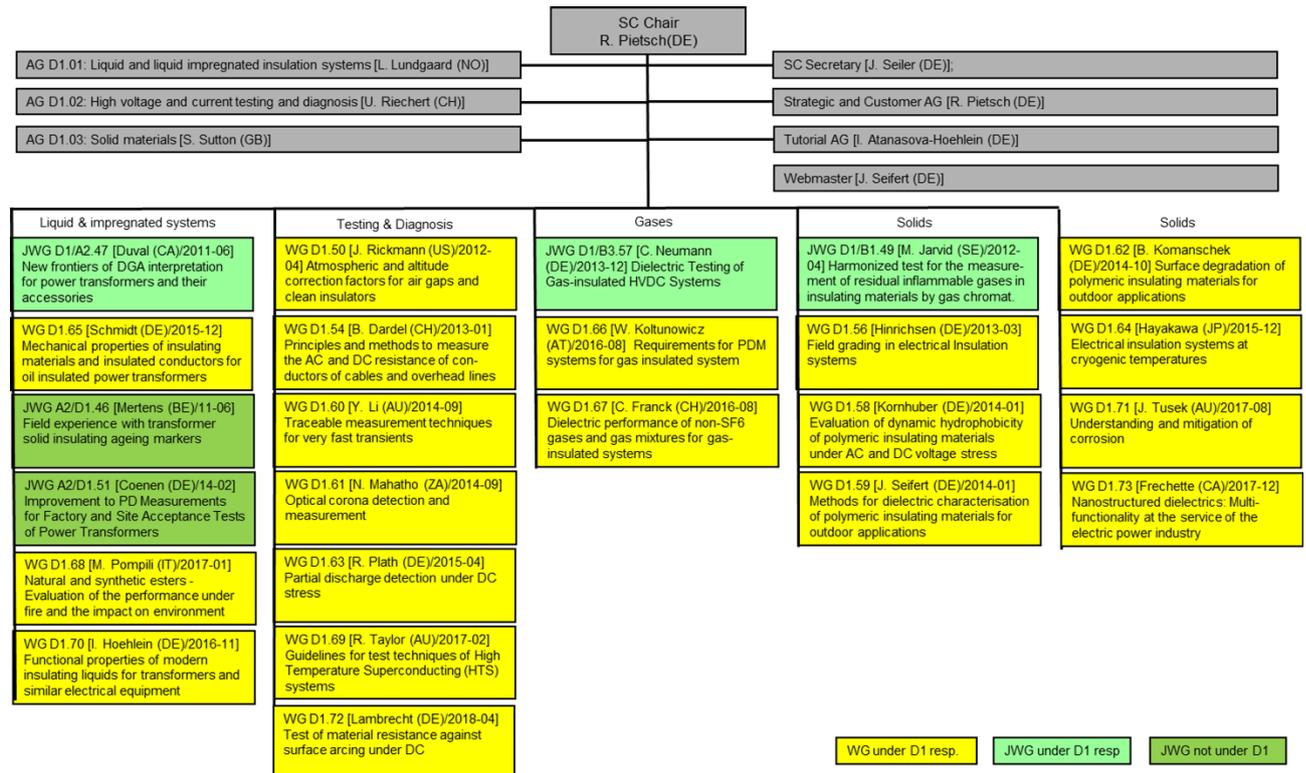
The D1 study committee deals with testing techniques and material developments that support HV plant. It is one of the two horizontal committees that also provide services to other SCs. Typically, D1 partners with a SC to provide engineering and scientific input into their understanding of plant asset management.

This includes:

1. Providing information on new materials to advance the properties of, or facilitate application of, appropriate materials or component substitutions, e.g. SF6 gas replacement options
2. Investigating and identifying degradation mechanisms
3. Identifying new asset management tools
4. Providing insight into the impact of new test techniques on plant
5. Assisting with standardisation of tests and information
6. Providing any technical assistance to any equipment committee that needs a partner with materials or testing expertise.
7. Maintaining liaisons with IEC technical committees
8. Determining preferential subjects for events

2. Specific Activities of the Study Committee

At the time of writing this report, SC D1 had not yet met and thus the report does not contain the usual updates that follow this meeting. The SC has 27 working groups active: 22 D1 WGs, 3 JWG D1/X and 2 JWG X/D1. These are detailed in the figure below.



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

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

Activity overview,

- At the time of writing no new WG have been approved.
- 4 Technical Brochures have been published in 2019
 - TB 783 – A2/D1 - DGA Monitoring Systems
 - TB 779 – Field Experience With Transformer Solid Insulation Ageing Markers
 - TB 771 - Advances In DGA Interpretation
 - TB 765 - Understanding And Mitigating Corrosion

It is noteworthy that the long-awaited TB 771 was been published. Within which is a comprehensive guide to the use and interpretation of the various Duval diagrams for the interpretation of DGA results.

3. Preferential Subjects

Preferential subjects for D1 for the joint Colloquium A2, B2 and D1 in New Delhi 18-22 Nov 2019.

PS 1: Long Term Performance of Insulation Systems (AC and DC)

- AC and DC Gas Insulated lines – new Insulating materials
- HVDC GIS – type of technologies
- UHV Composite insulators, insulating rods, Nano composites

PS 2: Test techniques for UHV including HVDC

- Test circuits and test voltages for HVDC equipment
- Composite voltage testing for HVDC equipment.
- Correlation studies among PD measuring techniques
- Impulse voltage shapes, wet tests, atmospheric correction

PS 3: Advanced Diagnostic Techniques

- Material ageing assessment and defect detection in UHV composite insulators, Materials of Offshore and subsea application.
- On-line / off-line monitoring of power equipment.
- Ageing studies on new insulating materials.
- New sensors for advanced diagnostics.

Preferential subjects for 48th Paris Session 23-28 August 2020

D1 - MATERIALS AND EMERGING TEST TECHNIQUES

PS 1 : Testing, Monitoring And Diagnostics

- Experience and insight from monitoring systems.
- Reliability of test equipment and systems for testing, monitoring, and diagnostics.
- Data handling, analytics, and advanced condition assessment.

PS 2 : Functional Properties And Degradation Of Insulation Materials

- New stresses, e.g. power electronics, load cycling, higher temperatures, and compact applications.
- Materials with lower environmental footprint, during production, operation, and disposal.

- Characterisation methods for validating functional properties.

PS 3 : Insulation Systems Of Advanced Components

- Materials under high stresses, e.g. field stress, flux, electric current, and frequency.
- Experience and requirements for new test procedures and standards.
- Development of new materials, e.g. 3D printing; lamination; casting; and additive or subtractive manufacturing.

4. Proposed New Working Groups

These are the new WG proposed for D1 although new proposals are expected during the meeting in New Delhi.

1. Draft TOR G N° D1/B4/...YY, PD measurements for insulation systems stressed by HV power electronics
2. TOR set to be approved by SC D1 for follow up to WG D1.71, to target Corrosion Management. JWG with B1 is proposed and likely to be formed in early 2020, proposed Convenor J.Tusek.
3. Draft TOR General Oil Test (GOT) of insulating liquid for electrical equipment – aims to review elements that lead to variability in DGA from sample collection through to processing with the aim of reducing differences in outcomes from different providers.

5. Specific Activities of the Australian Panel

In 2019 there were no activities of the D1 Panel associated with promotion outside of awareness initiatives within member's organisations.

6. Meeting Report: Australian Panel

The Australian Panel of D1 met in Newcastle on 22 October, at the offices of Verico AIS. This was the last meeting of AP D1 to be convened by Joe Tusek from Verico AIS, whose term expires at the 2019 ANC AGM. The new convenor will be Dr Yi Li from the National Measurement Institute. The meeting was difficult to organise around people's work schedules and final numbers were down a little on previous years with eight in attendance out of membership of fourteen.

Member changes: Robert Li of TransGrid was replaced by Sam Murali. Mohinder Pannu of Wilson Transformer retired, Wilson have yet to name a replacement.

In summary the meeting this year was not able to be informed as in previous years by a previous SC D1 meeting, thus it comprised mostly only local content. Below is a summary of discussions

- Review of 2018 ANC reports
- Review of brochures released in 2018 and 2019 in D1, A2 and B1 that were considered of interest to D1 members.
- Specific discussions were held about developments in
 - SF6 alternative gases, including vacuum technology available at 145kV.
 - Vacuum breaker monitoring is a concern when access is very limited and Penning equipment is not able to be easily used.
 - Identification of instances of multiple few cycle, high-current transients (no protection operation), which are thought to be weakening winding winding restraint and leading to increased failures.
 - Characteristics of hydrophobicity after cleaning of polymeric insulators.
 - Frequency Response Analysis of transformer windings – new developments and feedback from A2 WG on FRA.
 - Synchronous condenser introduction into SA network and condition assessment requirements.
 - GIS CB timing testing using always earthed connection points.
 - SWER Line Monitoring system development in UNSW.
 - Research results at UQ were made highlighting, fibre optic moisture probes, impact of renewables and condition monitoring cables in mixed networks.
 - Silver corrosion in tap changer contacts is an ongoing concern.

- Design of transformer lid that results in water ingress and a failure of a power transformer.

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

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

8. ANC Members on Working Groups

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

WG	Title	Australian Member
D1.59	Methods for dielectric characterisation of polymeric insulating materials for outdoor applications	Chandima Ekanayake and Dr Toan Phung (corresponding members)
D1.60	Traceable measurement techniques for very fast transients	Dr Yi Li (Convenor)
D1.50	Atmospheric and altitude correction factors for air gaps and clean insulators	Dr Yi Li
D1.69	Guidelines for test techniques of High Temperature Superconducting (HTS) systems	Richard Taylor (Convenor)
A2.53	Objective interpretation methodology for the mechanical condition assessment of transformer windings using Frequency Response Analysis (FRA)	Joe Tusek (corresp.)

9. Membership of the Australian Panel

Name	Organisation	Type
Joe Tusek	Verico	Consultant
Prasanna Wickramasuriya	Energy Queensland	Distribution
Wenyu Guo	Omicron	Manufacturer
Mark Cotton	AusNet Services	Transmission
TBA	Wilson Transformers	Manufacturer
Karl Haubner	Doble	Manufacturer
Phil Ramsay	Plus ES	Distribution
Andrew Wilkinson	ElectraNet	Transmission
Sam Murali	TransGrid	Transmission
Dharmendra Shah	Powerlink	Transmission
Prof Tapan Saha	University of Queensland	University
Dr Yi Li	National Measurement Institute	Other
A. Prof Toan Phung	University of NSW	University
Prof Trevor Blackburn	University of NSW	University



Convener: Joe Tusek

Email: joe.tusek@verico.com.au

Phone: 0418669250

AU D2 Information Systems and Telecommunication

1. Study Committee Scope

SC D2's mission is to facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of information systems and telecommunication for power systems.

2. Specific Activities of the Study Committee

In the area of information systems, SC D2 focus continues to be in the following areas:

- a) Dealing with technology and equipment obsolescence, including integration with new technologies
- b) Cybersecurity – best practices, mitigations and increasing overall organisational maturity
- c) Migration from legacy TDM (time domain multiplexing) telecommunications technology to packet switched networks such as MPLS
- d) Taking advantage of new opportunities in technologies such as Block Chain, IoT

The SC D2 Strategic Plan is as follows:

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

The D2 Colloquium was held in Helsinki between 11 and 14 June 2019.

The D2 Panel meeting was held in TasNetworks, Hobart between 24 and 26 July 2019.

3. 2019 D2 Colloquium, Helsinki (11 – 14 June 2019)

Preferential subjects (PS) by the Study Committee for the 2019 D2 Colloquium were as follows:

- a) PS 1: Information and communication technology (ICT) supporting energy transition
 - i. Big data, data analytics using artificial intelligence (AI) for securing the electric power utilities operations;
 - ii. Cloud computing;
 - iii. Machine learning.

- b) PS 2: Cyber security
 - i. Threats management in electric power utilities (EPU);
 - ii. Security assessments tools;
 - iii. Cyber security maintenance in power system operation;
 - iv. Electric power utilities credential management with blockchain technology;
 - v. Big data used for detecting cyber anomalies in electric power utility informational and operational technology (IT/OT).

- c) PS 3: New internet of things (IoT) application to support electric power utilities
 - i. 5G for utility networks;
 - ii. New internet of things applications to support electric power utilities;
 - iii. Cybersecurity issues in internet of things.

A total of 40 papers were presented and discussed:

- a) PS1 – 15 papers
- b) PS2 – 16 papers
- c) PS3 – 9 papers

Three tutorial were presented:

- a) Advanced Utility Data Management and Analytics for Improved Situational Awareness of EPU Operations, by Gasper Lakota (SI)
- b) Design, Deployment and Maintenance of Optical Cables associated to Overhead HV Transmission Lines, by Sacha Kwik (ES) and Krister de Vries (SE)
- c) Cyber Security Management – a key player in the EPU resilience strategy by Giovanna Dondossola (IT) and Roberta Terruggia (IT)

4. Working Group Status

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

WG	Title	Convener	Supervising AG	SC D2 TD	2019		2020		2021		2022	
					S1	S2	S1	S2	S1	S2	S1	S2
WG D2.43	Enabling Software Defined Networking for EPU telecom applications	V. TAN	AGD2.03	TD1								
WG D2.44	Usage of public or private wireless communication infrastructures for monitoring and maintenance of grid assets and facilities	P. MULVEY	AGD2.03	TD2								
WG D2.45	Impact of governance regulations and constraints on EPU sensitive data distribution and location of data storage	H. KLIMA	AGD2.01	TD3								
WG D2.46	Cybersecurity future threats and impact on EPU organizations and operations	D.K. HOLSTEIN	AGD2.02	TD4								
JWG B5/D2.67	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods	R. DE VRIES	AGD2.03	TD1								
JWG D2/C6.47	Advanced consumer side energy resource management systems	A.A. NEBERA	AGD2.01	TD2								
JWG D2/C2.48	Enhanced information and data exchange to enable future transmission and distribution interoperability	G. TAYLOR	AGD2.01	TD2								
JWG B2/D2.72	Condition Monitoring and Remote Sensing of Overhead Lines	Ying CHEN Akshat KULKARNI	AGD2.01	TD3								

Figure 1 - SC D2 working group status

Australia has the following participation in the above working groups:

1. D2.40 – Victor Tan (VTan Consulting) as Member
2. D2.43 – Victor Tan as Convener, Greg Helps (ElectraNet) and Louise Watts (SA Power Networks) as Members
3. D2.44 – Victor Tan as Member
4. JWG B5/D2.67 – Benjamin Haines as Member (Ausgrid)
5. D2.46 – Victor Tan, Andrew Bain, Manoj Kumar (Commtel) as Members

The following technical brochures have been published:

1. TB 762 “Remote Service Security Requirement Objectives”
2. TB 746 “Design, Deployment, and Maintenance of Optical Cables associated to Overhead HV Transmission Lines”
3. TB 782 “Utilization of Data from Smart Meter System”

5. Specific Activities of the Australian Panel

The Australia D2 Panel held its annual meeting in Hobart between 24 and 26 July 2019, hosted by TasNetworks and co-sponsored by VTan Consulting.

24 attendees attended the panel meeting, of which 20 were Panel Members and 4 guest speakers.

6. Membership of the Australian Panel

Name	Organisation	Type Vendor Tx Utility Dx Utility Consultant Academic
Aaron Gates	Western Power	T
Mark Mullins	Tesla Consultants	C
Andy Hemming	Transpower	T
Aruna Yahampath	Endeavour Energy	D
Branko Andric	Horizon Power	D
David Paramandan	CommTel	V
David Taddeo	GHD Pty Ltd	V
James Cole	ActewAGL	T, D
John Grace	Genesis Energy	D
Josh Cunningham	TasNetworks	T
Mark Jones	TransGrid	T
Mark Remmer	Powerlink	T
Paul McKeen	Energex	D
Rohan Fernandez	ElectraNet	T
Ross Gaspard	PSC New Zealand	C
Sam Devadason	Powercor	D
Sumith Withanage	Power and Water Corporation	T, D
Thoai Ton	Ausnet	T
Tony Myatt	SA Power Networks	D
Victor Tan	VTan Consulting	C

Convener: Victor Tan

Email: victor@vtanconsulting.com

Phone: 08 7079 0301

Working Group A2.58 Site Installation and Pre-commissioning of Power Transformers and Reactors

1. Working Group Scope

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

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

Link to Terms of Reference

https://www.cigre.org/userfiles/files/News/2018/TOR_WG_A2_58_Installation_and_Pre_Commissioning_of_Transformers_and_Shunt_Reactors.pdf

2. Working Group Activities

2017

1st Meeting 6-7 April Sydney hosted by GE

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

2018

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

4th Meeting 25-26 August Paris hosted as part of CIGRE 47th Paris Session

2019

The 5th meeting was held in Boston USA, on 12th & 13th April 2019.

Nine WG regular members attended. The SC Chairman was an invited guest. The meeting discussed progress of the four task forces; “Site Installation”; “Site Testing;” “Trial Operation” and “Moisture”.

Matt Gibson (corresponding member from AU A2) has completed a draft report on the results from our Survey for an upcoming Electra article.

TF 1 Site installation:

- o A substantial draft has been documented that is based on an OEM's installation procedures and the draft was reviewed on KMS.
- o A flow chart to be used to illustrate the process steps.
- o The demarcation on what is included in the scope of site installation is the extent of the transformer/shunt reactor components is shown on the general arrangement /outline drawings.
- o The interface between site installation details with adjacent equipment, lead terminations, GIS, cable boxes, etc. is invariably handled by others but may impact the site installation of the transformers/shunt reactors.
- o Need to ensure the utility perspective on site installation is included.

TF 2 Pre-commissioning and Site Acceptance Tests:

- o The draft was uploaded to KMS on 11 April 2019.
- o Need to add a listing of site acceptance tests (SATs), while rating importance, why to perform, and when to perform.
- o Need to add typical listing of SAT equipment and show potential pitfalls for each test.
- o The “Visual and Functional Tests” section needs more detail.

TF 3 Trial operation/operation during warranty period:

- o Proposed to have three sections: (1) End of Warranty Period, (2) First Energization Post Installation, and (3) Trial Operation Prior to Handover of Supplier.
- o Trial Period – what checks need to be performed during warranty period? May include making oil checks, IR inspections, and noise measurements. Suggest recommended time intervals in order to confirm specifications and expectations.
- o Next step is to review Survey results associated with TF3.

TF 4 Moisture:

- o Discussion on dew point measurements, at factory and at site, and the need to keep it simple, practical, and not a science project.
- o WG experience has shown that dew point measurement process works well and is accurate enough.
- o Dew point measurements require accurate insulation system temperature measurements.
- o Good practice on site dew point measurements is to perform the measurements before sun up when the tank starts to heat up.
- o DFR and power factor tests can also offer a means to confirm dryness of insulation systems but would need to be performed after fluid fill.
- o The TB should include recommended supplementary site dry out techniques.
- o WG reviewed the changes proposed within the draft revision of IEEE C57.93.
- o Brief discussion on field dry out in TB 445 (Maintenance Guide). The TB should include recommended dry out procedures if the measured moisture content exceeds maximum allowable levels.
- o Action item to get latest version of the draft revision of IEEE C57.93 and upload to KMS.
- o TB 445, TB 741, and TB 349 need review to compare dry out and moisture measurements

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

Six WG regular members attended. The SC chairman and Bert Wouters were invited guests.

TF 1 Site Installation:

- o WG reviewed the comments for the latest version of the TF 1 draft
- o Need to compare TB 445 and IEEE C57 .93. Review of IEEMA transformer manual
- o Add fluid/oil handling recommendations
- o Add reference to IEC standard on liquid/Oil requirements and preparations and remove table
- o Consider placing oil fill procedures in Appendix to show at example, place overview and summary in main body of document
- o Add reference to IEC 60475 for oil sampling techniques
- o Cross check with IEEE C57.93 to identify any gaps

TF 2 Pre-commissioning and Site Acceptance Tests:

- o WG reviewed latest TF 2 draft.
- o Make clear that site installation includes final assembly which includes the installation of bushings, radiators, and conservator tank following the transformer transportation; and site assembly includes active part assembly.
- o Tabulation of SAT should emphasize those tests that need (a) benchmarking and (b) temperature dependent

TF 3 Trial operation/operation during warranty period:

- o WG reviewed Table 3 (Typical Maintenance Intervals) of TB 445 - Guide for Transformer Maintenance
- o Two members shared what their utilities do during trial period prior to expiration of warranty coverage

TF 4 Moisture:

- o Reviewed C/GRE TB 741 (WG 01.52) - Moisture measurement and assessment in transformer insulation - Evaluation of chemical methods and moisture capacitive sensors, recommended to consider adding recommended techniques for moisture determination (see chapter 4 of TB 741)
- o TB needs to indicate what is being used for moisture equilibrium in paper, pros and cons?
- o Reference CIGRE TB 349 - Moisture Equilibrium and Moisture Migration within Transformer Insulation Systems, use moisture equilibrium diagrams in Chapter 6.2
- o US members contributed recommended actions to take to keep transformers dry during their installation, dry out procedures, and procedure to measure dew point
- o Case examples needed to collect the moisture content measurements for new transformers at (a) delivery, (b) completion of installation and (c) completion of dry out. In addition, provide the vacuum/oil fill records for the same transformer.

7th Meeting is to be held 20 November New Delhi India and hosted as part of CIGRE SC A2/B1/D1 Colloquium.

The terms of reference for this WG has very high relevance to the Australian Power Industry. This is especially heightened by the significant increase in the importation of power transformers following the closure of two of the three major power transformer factories that were in Australia. There will be concern about their correct installation, and what is prudent checking of operational performance during trial operation. Loss of experience and expertise in the industry exacerbates these concerns. The WG Survey provides an idea of the relative location of transformer supplier to the installation, and who performs installation. The survey also shows who is performing the acceptance tests and what tests are being done after commissioning. The involvement of third parties and service companies in installation and acceptance test activities confirms the need for a Technical Brochure that espouses industry guidelines.

3. Working Group Program

At least one, possibly two WG meetings are planned in 2020 that are intended to be used to consolidate and then review the draft technical brochure. The 8th meeting will be hosted by CEPS in Elektrarenska, Prague, Czech Republic in late January or early February 2020. The AG 2-6 will hold a Green Book meeting immediately after the WG meeting.

If another WG meeting is required in 2020, then the 9th meeting will be held in May or June 2020.

It is planned at this stage that a draft Technical Brochure document, ready for comment, will be completed in time for the SC A2 meeting held during the 2020 Paris Session. The document can be finalized, along with a tutorial and Electra article by the 2021 Study Committee meeting.

Convener: Ross Willoughby

Email: ross.willoughby@ge.com

Phone: +61 417 712 879



Working Group B2.64 Inspection and Testing of Equipment and Training for Live-Line Work on Overhead Lines

1. Working Group Scope

Live-line maintenance of power lines is widely used worldwide at low, medium and high voltage levels. This way of work requires special tools to guarantee the maximal safety of the workers. All the equipment used for different tasks executed by live-line methods must undergo various inspections before use. These inspections could be type tests at the factory, acceptance tests before the first use, on-site tests before every use and periodic tests after a pre-defined period of time.

Nowadays there are many different international standards and national regulations regarding the inspection of different live-line working equipment. Unfortunately there is no common framework to define the different kinds of tests and their frequency, so the condition, the way of certification and expiration of inspections can be very different depending on the country, even in some cases within the company where they are used.

Another important aspect regarding the different live-line working activities is related to the education of workers. Basic and refresher training might be very different in each country, as well as the examination/certification requirements. Similar theoretical and practical topics of education and the same requirements of knowledge would assist with the possibility of cross-country working. Consistent education can guarantee the same level of knowledge and the safety of the work at any time – and also make the possibility of independent and international audits and certifications. Refreshment courses after a specified period of time are especially important to recognize faults and improve skills of workers to guarantee an up-to-date knowledge base and to ensure the safety of live-line maintenance at all voltage levels.

This WG extends the JWG B2/B3.27 work and further increase the awareness of live-line working requirements for equipment certification and personnel training.

Specifically the WG tasks include:

- Review the existing live-line working equipment and tools inspections, procedures and applications, including tabulating any regulatory or standards referenced.
- Review existing technical and safety standards, regulations and assess their relevance to live-line working.
- Develop detailed guidelines for testing and inspection (both electrical and mechanical) and define and evaluate the proposed test procedures for live-line tools and equipment.
- Analyse the benefits of the different live-line working techniques and technologies.
- Summarise experiences of education for live-line maintenance and training at different voltage levels (training rules, materials, training centre requirements, certification etc.).
- Based on established relationships and analysis of the necessary components, develop methods and indicators which can identify requirements for live-line working certification and different level of training (from linepersons to managers).
- Provide a methodology and concept for building a live-line maintenance training centre.

The working group has 20 main contributors from 13 different countries. Members come from a variety of backgrounds including university professors and students, testing laboratories, training facilities, live-line tool manufacturers, current and former live-line workers from utilities and private companies, and consultants.

2. Working Group Activities

The working group formed in early 2016 with an original target completion of the end of 2018. The WG has held seven meetings. The final WG meeting was held in Hungary in March 2019 where the draft technical brochure content was completed.

3. Working Group Program

The working group will finalise the draft technical brochure by the end of 2019. The tutorial will be developed and the TB reviewed by SC B2 in the first quarter of 2020. The Electra article will be



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completed by the end of June 2020 with a view to publishing the technical brochure, tutorial and Electra article in July/August 2020.

Australian Regular Member: Alexandra Price

Email: alexandra.price@energyq.com.au

Phone: 0428 674 873



Working Group B2.67 “Assessment and Testing of Wood and Alternative Material Type Poles”

Working Group Scope

1. To determine the present status of wood pole experience and extent of failures in utilities worldwide. This is to identify whether the points mentioned in the background are common to all utilities or are only regional issues, and to supplement the list of potential issues with other predominant issues that utilities have to deal with. This shall also reference the type of failure and whether related to the pole and/or foundation, guying, as well any loading changes over the service life of the pole.
2. To identify different types of timbers that are being used as powerline wood pole and to determine if there is any relation between timber types and the pole operational failure (pole top fire) or maintenance failure (electrocution/ crossarm damage).
3. To identify and qualify the range of available methods for testing and inspecting wood poles at time of delivery and subsequently in the field, especially with regard to pole top rot, to help utilities to ensure their reliable performance and maintenance personnel safety. Limitations, if any, of a suitable test method due to the foundation type or pole configuration shall also be noted. There may be sufficient information to allow some limited risk assessment guidelines to be developed.
4. To identify and discuss the various methods used to strengthen or reinforce degraded poles, including their impact on the foundation arrangement.
5. To provide guidance on alternate preservatives/treatments and compare their potential environmental impacts.
6. To provide guidance on the type of alternate pole materials, e.g. steel, concrete, composite, that are available and the available experience of their use. This will include describing relevant testing procedures for consideration for these pole types, for their purchase and maintenance. This WG excludes any coverage of Fibre Reinforced Polymer (FRP) Composite poles which are specifically covered under WGB2.61. However, coordination with the activities of WGB2.61 is encouraged to cross reference the findings, and to ensure there is no overlap in scope.

Working Group Activities

First two meetings we held at the 2018 Paris Sessions and the 2019 New Delhi Colloquium.

The 3rd WG meeting is planned for Paris 2020, with additional teleconferences likely in 2020 to try and draft as much of the paper as possible before Paris.

At present, the paper is approximately 30% drafted with good progress made at Delhi by the 6 participants (3 in person 3 on teleconference).

Working Group Program

Approach: The group is to be cut down to participating members as it is too large and we need to focus our approach and communications. There are only a handful of people that actually contribute.

There was a 50-question survey sent out and extensively marketed, but we received less than 20 useful responses from utilities around the world. The results are informative, and indeed the lack of responses also tells a lot about the industry globally.

Achievements: Preliminary chapter allocations based on the Paris meeting have been agreed and some drafts submitted already, and incorporated at New Delhi.

The completion date goal is 2021.

Convener: Nathan Spencer

Email: nathan.spencer@revogroupau.com

Phone: +61 (0)439 511 836

Working Group C1.38 Valuation as a comprehensive approach to asset management in view of emerging development

1. Working Group Scope

The WG will carry out a survey of international practice in the justification of asset sustainment investments and the management of risk in asset investment decision-making.

The survey would include topics such as:

- How asset health and asset criticality are used in expenditure decision making;
- How asset risk management is applied by organizations and in their governance;
- The influence of regulatory regimes on asset investment decision making practices;
- Degree of integration between defining investments for CAPEX (Capital Expenditure) and O&M (Operations & Maintenance) expenditures decision making;
- Degree of integration in CAPEX decision making for different types of assets;
- Degree of integration of replacement/refurbishment capital expenditure (system sustainment) with new assets capital expenditure (system development);
- Use of prioritisation frameworks and criteria (e.g. reliability, safety, etc.);
- Extent of the use of monetization of risk, specifically in valuing consequence of failure, in investment decision making, including descriptions of how valuations are calculated for impacts on corporate key performance indicators such as reliability, safety, environment, asset value, regulatory compliance, customer service, “brand name” protection etc.;
- Risk assessment for high impact low probability events and economic justification for mitigations.

[Terms of reference.](#)

2. Working Group Activities

The working group was approved in April 2017. The survey and analysis of responses has been carried out. The final draft of the TB is being reviewed. The TB will be sent to SC C1 later this year or early next year for review.

The survey has shown that asset management practices in Australia are in advance of many countries in terms of transparency (publication of Asset Management Plans), valuation of risk and incorporation of risk in asset management process.

3. Working Group Program

Phase	Milestone	Date	Progress
Initiation	Commence working group	May 17	Complete
Survey	Design survey	May 18	Complete
	Carry out survey	July 18	Complete
	Analysis	March 19	Complete
Prepare Report	Draft report for comment by SC	October 19	Report under review.
	Technical Brochure, Electra article ready	March 20	

Convener: Graeme Ansell
Email: graeme.ancell@ancellconsulting.nz
Phone: +64 21 382 036

Working Group C1.41 Closing the Gap in understanding between stakeholders and electrical energy specialists

1. Working Group Scope

Scope:

This working group will examine the gap in understanding amongst the various stakeholders of the range of technical issues from a planning perspective related to the changing nature of the power system and how this has developed. It will review how stakeholders perceive this gap and what is being done across the world to improve the level of understanding, particularly of the non-technical stakeholders. It is intended that the working group members be technical and non-technical personnel, with the latter ideally having a speciality in communication and/or stakeholder engagement.

https://www.cigre.org/userfiles/files/News/2018/TOR-WG%20C1_41_Closing%20the%20gap%20in%20understanding%20between%20stakeholders%20and%20electrical%20energy%20specialists.pdf

2. Working Group Activities

Have had 3 meetings to date – 2 by teleconference and one in person

18 Dec 2018 – teleconference

30 May 2019 – teleconference

24 October 2019 – in person – Leamington Spa - UK

Achievements to date:

- Identified core issues
- Identified case studies
- Developed outline of the Technical Brochure

Highlight areas of particular relevance to the Australian Power Industry

Many of our members and utilities need to consult with a range of stakeholders on what are sometimes quite technical and difficult issues. The work of the WG should provide some insight into how these complex technical issues may be explained to the layperson so that meaningful consultation can take place.

3. Working Group Program

The WG will focus on the following stakeholder groups:

- Energy policy decision makers (including politicians)
- Regulators
- Business leaders
- Environmental leaders

- Customers

Electrical energy specialists including the following:

- Engineers
- Economists
- Scientists

Tasks

1. Confirm the given set of stakeholders and determine which are most

important to different industry sector participants/CIGRE members in different countries:

- a. Stakeholders they are obliged to communicate with;
 - b. Stakeholder they believe they should be in communication with.
2. Define the communication gap in terms of
- a. The communication channels:
 - i. Which channels currently exist between electrical energy specialists and stakeholders?
 - ii. In the opinions of CIGRE members and stakeholders, which of them work well and or less well?
 - iii. Which channels should be improved or created?
 - b. Content: what information is lacking, or is lacking in ways that can be understood and used?
 - i. In the opinion of CIGRE members in respect of what stakeholders appear to know.
 - ii. In the opinion of stakeholders in respect of what they would like to learn from electrical energy specialists
 - iii. Consider how to reach agreed technical specialist positions to ensure consistency.
3. Identify existing material or approaches in sectors other than the electrical energy sector that may provide models for useful forms or channels of communication.
4. If time and resources permit:
- a. Develop new material and/or information channels with the aim of helping understanding of the issues identified in task 3. This includes suitable:
 - i. Language
 - ii. Analogies or metaphors
 - iii. Infographics
 - iv. Improvements to existing glossaries of terms used in the industry.
5. . Test the identified and newly developed material with a limited set of stakeholders.

Deliverables:

- Interim report in Sept 2019 to check progress, refine scope and confirm final deliverables.
- Technical Brochure and Executive summary in Electra Electra report Tutorial⁵

Time Schedule: start: Nov 2018 **Final Report:** Nov 2020

Convener: Phil Southwell

Email: phil.southwell.cigre.c1@gmail.com

Phone: c/- CIGRE Australia (07) 3310 8838



Working Group C3.19 Responsible management of the EMF issue

1. Working Group Scope

EMF research remains active and EMF continues to be a major issue for some businesses both nationally and internationally. Since the WHO 2007 review, there have been over 1200 peer reviewed studies regarding EMF and possible health effects.

While the evidence falls short of establishing any adverse health effects, EMF can be significant influencing factor for new projects.

Industry has been actively managing the EMF issue since the early 80s. However, many key industry personnel have retired or are approaching retirement. This combined with the worldwide trend for downsizing and increased staff turnover has resulted in a reduction of knowledge and expertise around responsible EMF management.

In light of the continuation of EMF research, particularly from less developed countries, vocal and better connected advocates and a classification that looks likely to remain, industry is likely to face some challenges in the years ahead.

If not managed consistently, openly and responsibly the issue can have serious implications for businesses.

The purpose of this brochure is to provide accurate, consistent, industry-wide information for guidance to the electricity distribution and transmission industry to address the EMF issue.

Specifically the brochure will cover EMF basics, the science of EMF and health, compliance with guidelines and the notion of precaution and prudent avoidance. It will also provide practical advice on ways to reduce EMF, medical implants and EMF communication.

The working group currently has 20 members from 15 different countries. Members include professors, researchers, engineers, scientists, industry members and consultants.

2. Working Group Activities

The working group formed in early 2018 and has three face to face meetings to date.

The first WG meeting was held in Canada in conjunction with the meeting of RG C3.01 EMF and Health, a meeting of the Utilities Threshold International Consortium (UTIC) and a presentation from the International Commission on Non Ionising Radiation about their EMF guideline including their next revision.

RG C3.01 is an expert group comprising occupational and public health physicians supported by other scientists and engineers. Their role is to keep CIGRE regularly informed on the issue of power frequency electric and magnetic fields and health.

UTIC is a consortium of electricity companies and groups which contribute together to scientific research on thresholds for a physiological response which form the basis of EMF guidelines.

The WG C3.19 meeting focused specifically on developing a first draft brochure consistent with the views of WG C3.01 and for discussion in Paris where the whole working group would be in attendance.

The second meeting was held during the Paris Session and involved working through the draft brochure in detail. The third meeting was held in Denmark in 2019 in conjunction with the Danish National Committee symposium and focused on key areas of the document where opinions tended to differ.

A number of RG C3.01 meetings were held which also discussed the brochure. Although the convenor did not attend these meetings the outcomes of discussions were forwarded for consideration.

A significant portion of the work has been completed via email.

Key achievements to date include:

- Near final draft technical brochure.
- Detailed information on assessing compliance with the guidelines, particularly in relation to live line work and work in close proximity to heavily loaded cables (this is a significant improvement on information currently relied upon in Australia).



- Detailed information about the risk management of medical implants.
- Information on successful risk communication leveraging off International learnings.
- An information sheet for workers.
- An appendix which includes frequently asked questions and answers

3. Working Group Program

The working group target completion date is the end of 2020.

The final brochure and tutorial are on target to be approved ready for the Paris session in 2020. An Electra article will follow.

Convener: James Hart
Email: jhart@ausgrid.com.au
Phone: 0412070574



Working Group C4.56 ON Electromagnetic transient simulation models for large-scale system impact studies in power systems having a high penetration of inverter-based resources

1. Working Group Scope

Conventional power system simulation models, referred to as root mean square (RMS) model, lose accuracy as the ratio of synchronous to inverter-connected generation (including wind turbines, solar inverters, battery energy storage systems, and variable speed pumped storage units) continues to decline.

System operators in regions having a very high penetration of inverter connected generation are already observing limitations in the use of RMS-type models and have developed large-scale electromagnetic transients (EMT)-type models of their systems. This includes Australia and Texas where EMT-type models are used extensively for making operational decisions. Australia is one of the leading countries in this area with AEMO has recently completed their full-scale model of the NEM in an electromagnetic transient tool.

This working group is intended to serve as a platform for the dissemination of knowledge, lessons learned, recommended practices, intended applications, and underlying reasons for the use of EMT-type models for large-scale stability studies in power systems having a high penetration of inverter connected generation.

The working group currently has 37 members from 17 different countries. Members include professors, researchers, engineers working for system operators, network owners, generation developers, consultants and software vendors including three NGN and three female members.

2. Working Group Activities

The working group formed in late April 2019 and has two meetings to date.

The first full-day WG meeting was held in June 2019 in Denmark during the CIGRE Aalborg symposium. Six presentations were made in this meeting with follow up discussions to agree on inclusions/exclusions.

The second meeting was held as a two-day standalone meeting in Canada in October 2019 and 12 presentations were made.

Below reflects the current skeleton of the TB which sets out the activities to be carried out by members.

1.STATE-OF-THE-ART

1.1RELEVANT CIGRE ACTIVITIES

1.2RECENT INTERNATIONAL EXPERIENCES

- 1.2.1 Australian national electricity market
- 1.2.2 France
- 1.2.3 Texas
- 1.2.4 Quebec
- 1.2.5 TenneT, Germany
- 1.2.6 Others

2.THE ROLE OF DIFFERENT SIMULATION TOOLS IN POWER SYSTEMS HAVING A HIGH PENETRATION OF INVERTER CONNECTED GENERATION

2.1DIFFERENCES BETWEEN RMS AND EMT SIMULATION MODELS

- 2.1.1Representation of control systems of inverter connected generation
- 2.1.2Comparison of simulated responses
- 2.1.3Comparison against measured system disturbances

2.2 ON-LINE VS OFF-LINE EMT SIMULATION

2.3 THE ROLE OF SCREENING METHODS IN DETERMINING WHEN EMT STUDIES ARE REQUIRED

- 2.3.1 Time-domain methods
- 2.3.2 Frequency-domain methods



3. MODEL ADEQUACY

3.1 LARGE-SCALE INVERTER-CONNECTED GENERATORS

- 3.1.1 Primary components
- 3.1.2 Control systems
- 3.1.3 Protection systems

3.2 NETWORK11

- 3.2.1 Static network elements
- 3.2.2 HVDC and FACTS
- 3.2.3 Protection systems
- 3.2.4 Network frequency calculation

3.3 DISTRIBUTED ENERGY RESOURCES

- 3.3.1 Controllable inverter-connected DER
- 3.3.2 Non-controllable inverter-connected DER

3.4 LOADS

- 3.4.1 Direct connected loads
- 3.4.2 Inverter connected loads

3.5 APPLICATION OF GENERIC EMT MODELS

4. LARGE-SCALE EMT SIMULATION

4.1 NETWORK DEVELOPMENT13

- 4.1.1 Load flow
- 4.1.2 Dynamic model initialization

4.2 TECHNIQUES FOR SIMULATION SPEED IMPROVEMENT

- 4.2.1 Hybrid simulation
- 4.2.2 Dynamic phasor

4.3 NETWORK EQUIVALENCING13

- 4.3.1 Static voltage sources
- 4.3.2 Dynamic voltage sources
- 4.3.3 Frequency dependent network equivalent (FDNE)

4.4 HARDWARE AND SOFTWARE NEEDS

4.5 TIME-DOMAIN VS FREQUENCY-DOMAIN TECHNIQUES

5. ACCEPTANCE TESTING AND VALIDATION OF EMT MODELS

5.1 HARDWARE-IN-LOOP TESTING

5.2 PRE-COMMISSIONING MODEL ACCEPTANCE

5.3 POST-COMMISSIONING MODEL VALIDATION

6. CASE STUDIES

6.1 SYSTEM STRENGTH STUDIES

- 6.1.1 Determining whether or not a proposed inverter connected generator adversely impacts system strength
- 6.1.2 Determining system-wide unit commitment requirements
- 6.1.3 Developing operational constraints

6.2 ADVERSE CONTROL INTERACTIONS AND INSTABILITIES17

6.3 DESIGNING SYSTEM-WIDE CONTROL AND PROTECTION SCHEMES

6.4 SYSTEM SEPARATION

7. Working Group Program

The working group is due to complete the technical brochure by June 2022.

A key focus for 2019 was to define all chapters/sub-chapters and associated responsibilities, consolidate and present state-of-the-art in the area of EMT modelling, and determine gaps that need to be focused on by the time of next meeting in April 2020 in Melbourne, Australia.

Several practical case studies are already done and more will follow as conducted by members in the next few months.



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Convener: Babak Badrzadeh
Email: babak.badrzadeh@aemo.com.au
Phone: 0466504953



Working Group C3.30 The Role of Block Chain Technologies in Power Markets

1. Working Group Scope

Block chain technologies offer an exciting opportunity in decentralized trading systems. Their rise has coincided with power systems becoming more decentralized and a world in which consumers can collectively control quite large energy sources. They offer the opportunity for consumers to trade their power sources and their load effectively with the potential to reduce their energy costs.

This working group consists of two streams of work.

The first phase, **Exploration**, is an assessment of the potential value and uses of block chain technologies in energy markets and power systems. This will include an explanation of how they work and some simplified examples of possible applications. Specifically, this stage will:

- gather information on the characteristics of distributed ledger products.
- consider the range of potential applications in electricity both for financial and physical parameters
- consider the implications for the electricity industry: efficiency and scope for new approaches with vastly more transactions - vs - disruption and the risk of being bypassed

The second phase, **Assessment**, will be a review of a range of trials and examples of early adoption of projects that use block chain, to document their value and practicality. During the project, a set of assessment criteria will be developed and applied to the trials and examples. SC D2 will be represented in this WG with an observer.

Given the fast-moving nature of this topic, there will be a short review/update as the last step in the development of the Technical Brochure to ensure that the document is as up to date as possible. The possibility of shortening the approval and publication timelines will also be investigated along with the possibility of early electronic publishing.

2. Working Group Activities

The Terms of Reference for the WG were approved in December 2018. The first face to face meeting was held in Montreal and was very successful. There were 18 people in person and 6 on the teleconference. At the Montreal meeting a number of activities were undertaken.

- 1 Presentations were made on the current status of block chain implementations in several countries including Estonia, GCCIA, USA, Russia, India, Chile and Australia.



- 2 Fazel Mohammadi, University of Windsor, Canada gave a very useful summary of a paper titled **Blockchain Technology in the Energy Sector - A Systematic Review of Challenges and Opportunities**
- 3 The project selection methodology was discussed and the criteria for project selection was finalised
- 4 A test sample of projects had already been assessed using the Assessment Criteria to test the practicality of actually assessing a project in this way. A few minor changes were made but the assessment methodology was found to be quite workable.
- 5 The intention is to present the relative development of the use of blockchain in energy markets in different countries. A number of members of the working group come from countries where there are no applications of blockchain in their energy markets. They have been asked to select another country for their contribution.

3. Working Group Program

The working group is broadly on track except that the selection of projects for assessment is not yet complete. It is planned to have teleconferences as required and to have the completed analysis in time for the Paris meeting in 2020. It is also planned to have a draft of the first part of the Technical Brochure, which covers the exploration phase, in time for discussion in Paris.

The final report is due to be approved by December 2020.

Convener: David Bowker
Email: dgbowker@gmail.com
Phone: 0418136493

Working Group D2.43 Enabling Software-Defined Networking for Electric Power Utilities' Telecom Applications

1. Working Group Scope

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

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

2. Working Group Activities

WG meetings:

- a) 2017-01-12 (Teleconferencing): 14 attendees
- b) 2017-03-28 (Teleconferencing): 11 attendees
- c) 2017-07-28 (Teleconferencing): 7 attendees
- d) 2017-09-18 (Teleconferencing): 3 attendees
- e) 2018-08-25 (Paris): 6 attendees
- f) 2019-06-10 (Helsinki): 4 attendees

Progress has been slow this year. We're hoping to pick up the activity again in the new year.

So far we have 23 survey responses received. We would prefer more responses, particularly from the countries which have not responded. This would enable us to get a better sampling of the data.

Current survey responses came from the following countries:

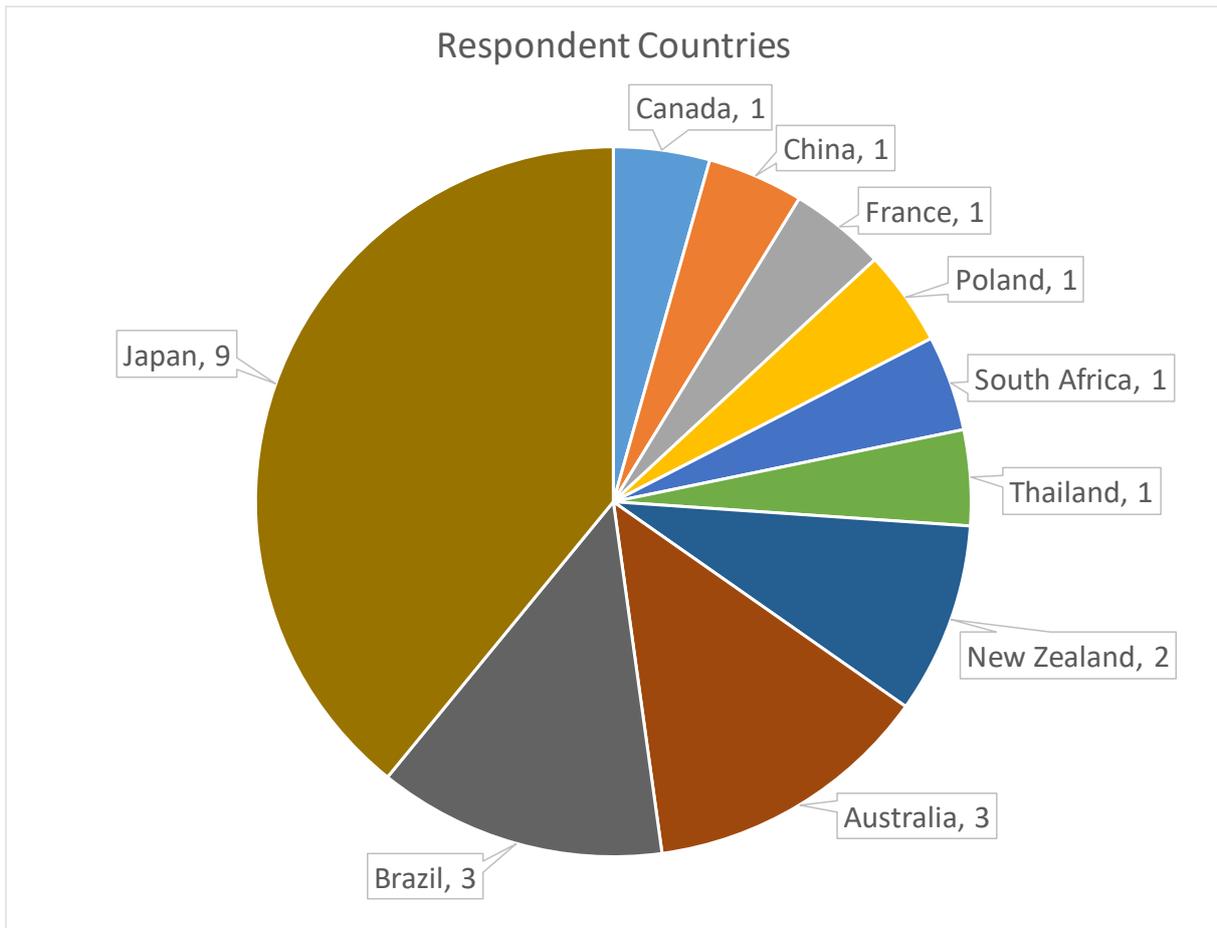


Figure 1 - Survey respondents

3. Working Group Program

The working group progress is on track for completion in 2020.

The following tables show the current progress:

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

Milestone	Planned	Actual Date
Initial Approval from Technical Committee		2016-12-13
Draft TB for SC review	AUG 2019	
Electra Article	JAN 2020	
Final draft	JAN 2020	
Technical Brochure published	MAR 2020	
Tutorial Presentation	AUG 2020	

The timeline is shown in Figure 2.

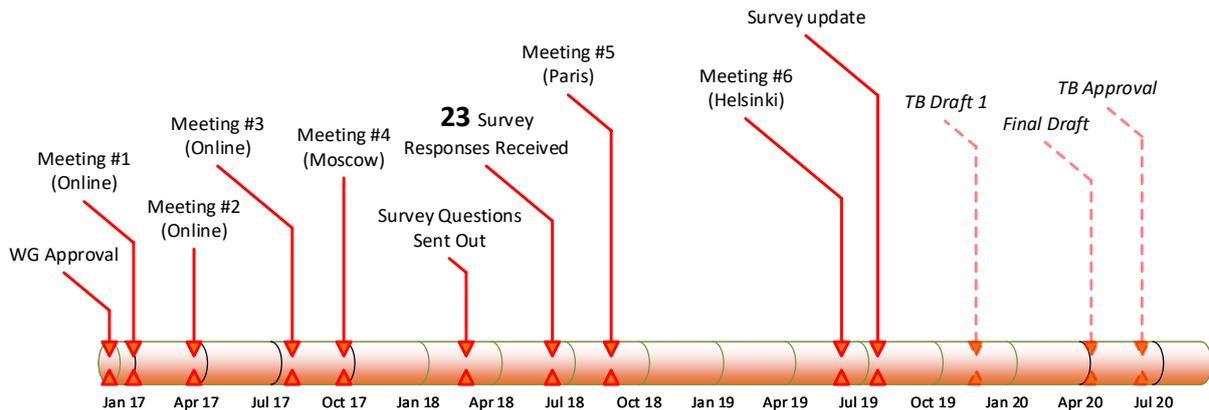


Figure 2 - Current Timeline

Convener: Victor Tan

Email: victor@vtanconsulting.com

Phone: +61422881273

CIGRE Workshop presented by AU A2 Transformers and Reactors

“Transformers – with a Focus on Tapchangers – An Interactive Workshop”

1. Details of the Workshop

The workshop was held in Sydney at the Hyatt Regency Hotel on Monday 3 April, 2019, and was attended by 69 delegates and 11 speakers. The workshop was held in conjunction with Techcon Asia Pacific, which was held later at the same venue on the 4 and 5 April. The workshop operated using 16:9 format powerpoint presentations. The workshop had four parts, two sessions in the morning and one after lunch where speakers presented technical papers. The fourth and final session following the afternoon break involved a panel discussion where speakers received questions initially from the facilitator, which led into spontaneous questions and interactive discussion from the delegates.

2. Workshop Program

The day commenced with twelve presentations by speakers from very broad range backgrounds; a transformer OEM, an Australian university, a tapchanger OEM, two tapchanger service providers, a test equipment supplier, and an international test laboratory. The presenters provided delegates with experience, guidance, advice and recommendations on how asset managers position themselves to address the maintenance, testing and risks with the tapchangers used in power transformers.

Ross Willoughby & Kerry Williams	Introductions & explanation of workshop proceedings.
Kevin Newman GE	OLTC types and application to different transformer design. Onerous applications
Michael O'Brien GE	Voltage regulation, FAT Testing and service considerations
Dr Dan Martin University of QLD	ANZ failure statistical evaluation results
Dr Thomas Smolka MR Australia	OLTC technology development over the last decades and what is to come in the future
Marc Foata MR Germany	DGA for OLTCs, Tapchanger failure modes listed and respective assessment criteria (based on work of Cigre WG A2.49)
David Peck Fundamentals Group	Reverse power flow and limitations by OLTC
Max Philipp Budin-Philipp	Maintenance requirements of tapchangers
Florian Predl & Wenyu Guo - Omicron Marc Foata - MR	OLTC testing (Wdg R and Dynamic Resistance), Vibro-acoustic
Marc Foata - MR Ross Willoughby - GE	Silver Sulphide formation on tapchanger silver contacts, both OLTC and DETC
Jelena Lukic – Institute Nikola Tesla	How can presence of silver sulphide be detected or suspected?
Jelena Lukic – Institute Nikola Tesla	Formation of corrosive sulphur and impacts on transformer components, sulphide detection and solutions to deal with corrosive sulphide

These presentations provided the delegates with the background knowledge and case examples for dealing with tapchanger issues. In the afternoon, the speakers formed a panel to take questions from the facilitator and then from delegates as the interaction developed.



Dan Martin – ANZ Failure Statistical Analysis



Thomas Smolka – OLTC Technology Development



Marc Foata – DGA for OLTCs



David Peck – Reverse Power Flow



Max Philipp – Maintenance of OLTCs



Wenyu Guo – OLTC Testing



Florian Predl – OLTC Testing



Jelena Lukic – Silver Sulphide on Tapchangers



Facilitator and Speakers in the Panel Discussion Session

3. Conclusion

The workshop provided delegates with the viewpoints of speakers from diverse backgrounds. Important take away messages included:

- The special considerations for the application of tapchangers in different transformer types were outlined. Onerous applications for tapchangers were explained
- How tapchangers work to control voltage regulation and the myths about CFVV. Overfluxing is an intrinsic operational consequence of tapchangers being used to increase the volts/turn
- Graphing winding resistance versus tap position is a very useful diagnostic tool for tapchangers
- De-energised tapchangers (DETC) do pose risks. Regular exercising prevents coking of a contact.
- Maintenance effort varies with tapchanger types and duty
- The interpretation of DGA signatures has improved. Effects on main oil DGA can be complex
- Informative findings from 2016 Aust power transformer failure survey. Failures evaluated using Weibull distribution. Findings show fires and explosions caused by bushings and tapchangers are in equal proportion, one sixth of ≤66kV failures caused by OLTCs, one third of >220kV caused by OLTC, one tenth of 110&132kV failures caused by OLTC, and failures begin to occur at 20 years

- Various tapchanger failure modes discussed. The development of DGA algorithms were outlined. Condition assessment of tapchangers was explained based on the guidelines of TB 761.
- Tapchangers that were designed for uni-directional power flow have limitations when used in networks with distributed energy resources. The limitations of these need to be quantified and managed. Solutions for overcoming the limitation were outlined.
- Maintenance requirements for tapchangers are a routine. Oil quality must be maintained. A series of photographs illustrated the consequences for lack of maintenance.
- Tapchanger testing techniques involve winding resistance, dynamic resistance measurements (DRM) and vibro-acoustic measurements (VAM). Principles, required data and examples of results were thoroughly explained. An excellent reference for future tapchanger testing was provided.
- Silver sulphide deposits on silver plated contacts of tapchangers has been found causal for expensive failure of transformers. The mechanism for its formation was explained and photographic case examples of its deposition were presented. Diagnostic techniques and the solutions to deal with sulphur corrosion were outlined

The added value with running a CIGRE event together with the TechCon conference again proved popular with delegates. Almost all delegates attending the seminar also attended Techcon over the following 2 days. Some delegates may have attended the CIGRE seminar because they were already travelling to Sydney for Techcon. The delegate attendance at Techcon also increases when run in conjunction with a CIGRE event.

The Techcon organisers acted as event coordinators for CIGRE and managed most of the logistical issues associated with arranging the seminar. Registration was also handled by the Techcon staff, allowing delegates to register for either or both conferences. Many of the costs, such as advertising, were also shared with Techcon.

The CIGRE workshop organisers were Kerry Williams and Ross Willoughby (Convener AU A2).

Overall the event was a success and CIGRE Australia received appreciative feedback from the delegates. The event also made some modest income for CIGRE Australia. The event continues the success of the 2018 event where 84 delegates attended.

The affiliation of the speaker presenters (with AU A2 members **accented**) involved in the workshop:

Kevin Newman (GE), Michael O'Brien (GE), **Dan Martin (University QLD)**, **Thomas Smolka (MR Australia)**, Marc Foata (MR Germany), David Peck (Fundamentals Group), Max Philipp (Budin-Philipp), Florian Predl (Omicron Austria), **Wenyu Guo (Omicron Australia)**, **Ross Willoughby (GE)**, Jelena Lukic (Institute Nikola Tesla Serbia). **Kerry Williams** facilitated the panel discussion.

The event was chaired by Kerry Williams (then CIGRE Australia Secretary) and Ross Willoughby (Convener AU A2).

Name: Ross Willoughby

Email: ross.willoughby@ge.com

Phone: 0417 712 879

CIGRE Conference organised by AU B3

“Substations 2019 Conference”

1. Details of the Workshop

The Australian - Substations and Electrical Installations – B3 Panel and CIGRE Australia hosted a conference on the 7th and 8th of November 2019.



There were three preferential subjects and received 17 papers.

1. 1. Building substations for a sustainable green grid:
 - Evolution of design, operations and maintenance skills with the connection of renewables to existing infrastructure
 - Environmental, safety and fire protection changes with the connection of renewables to existing infrastructure
 - Integration of renewables and storage technologies to existing substations – challenges and opportunities
2. Challenges and opportunities of substation digitalisation:
 - Transition from traditional substation design to digitalised substation
 - Substation digitalisation contribution to increased substation resilience
 - Digital information storage platforms and usage
3. Managing ageing substation assets in an era of digital substations:
 - Integration of new technologies (hardware and software) into existing substations
 - Making economic and risk based decisions supporting asset management
 - Experience with life extension methods in substations

The conference had over 100 delegates, 6 exhibitors.

The welcome note on behalf of TasNetworks – the major sponsor - by Bess Clark (GM TasNetworks) and Steve Davy (CEO Hydro Tasmania)

Key Note Address by Guy Barnett, Minister for Energy

We had 13 technical presentations, 3 tutorials and 1 workshop – battery storage.

At the end of Day 1 there was a Cocktail reception & networking function.



2. Workshop Program

DAY 1 – Thursday, 7 November 2019		Presenter	Company	
Conference Registration				0745 - 0830
Welcome & Introduction to Conference.				0830 - 0845
Welcome from Bess Clark, General Manager Project Marinus, TasNetworks				0845 - 0850
Welcome from Steve Davy, Chief Executive Officer, Hydro Tasmania				0850 - 0855
Introduction to Guest Speaker				0855 - 0900
Key Note Address: Hon. Guy Barnett - Minister for Primary Industries & Water, Minister for Resources, Minister for Energy				0900 - 0920
Futuristic Networks: Grid Collection Substations	Anurag Gupta	GHD		0920 - 0940
Integrating Synchronous Condensers into Renewable Generator and Grid Substations	Peter Berry	CPP		0940 - 1000
Connecting Renewable Generation Sources – Now a Network Issue	George Bergholcs	ElectraNet		1000 - 1020
Questions and Answers				1020 - 1030
Morning Tea				1030 - 1050
DERMS – The Future of DER Operation in Microgrids	Lee Ucich Perry Tonking	Horizon Power		1050 - 1110
Introduction to Seminars of Day 2				1110 - 1115
- Low Cost Substation Design Solutions (for Developing Countries)	Perry Tonking	CIGRE		
- Current Interruption in Atmospheric Air"	David Peelo	IEEE		
- Substation Earthing System Design Optimisation Through the Application of Quantified Risk Analysis (QRA)	Steve Palmer	Safearth		
- Workshop – High Power, Grid Forming Inverters enabling tomorrow's high renewables NEM	Stephen Sproul	ABB		
The possibilities of hydrogen technologies in direct network support applications	Mark Jackson	Mark G Jackson Consulting		1115 - 1135
Integration of a Large BESS to a Brownfield Substation	Dorin Costan	ElectraNet		1135 - 1155
Isolation techniques and guarding against the risks of back feeding	Faraz Mirzaagha	DNV GL		1155 - 1215
Questions and Answers				1215 - 1230
Lunch				1230 - 1300
Panel Discussion: Challenges Associated with the Connection of Renewables to Existing Substations	John Szmalko	Jacobs Engineering		1300 - 1400
Paradigm Shift in Power Transformer Asset Management by "Digitizing" & "Digitalizing" Temperature Measurements	Bhaba Das, Naser Hashemnia	ABB		1400 - 1420
Managing technical and non-technical challenges in the transition to a digitalised substation	Lara Kruk	Jacobs Engineering		1420 - 1440
Experiences with TransGrid's Journey to Substation Digitisation	Mark Jones	TransGrid		1440 - 1500
Earthing Systems and Substation Digitisation-issues, investigations and solutions	Stephen Palmer	Safearth		1500 - 1520
Modernising Substation Delivery through the use of BIM	John Fallow	Beca (NZ)		1520 - 1535
Questions and Answers				1535 - 1540
Afternoon Tea				1540 - 1550
Performance and Operational Experiences of High Voltage GIS with clean air insulation and digital features	Chris Gonzalez	Siemens		1550 - 1610
Point on Wave Switching of Power Transformers	Alan Crombie	UGL		1610 - 1630
End of Life Strategies for Substation Gantry Steelwork and Foundations	Evan Lamplough	TransGrid		1630 - 1650
Developments in the use of non-SF ₆ gases and gas mixtures for a more sustainable grid	Terry Krieg	Power Network Consulting		1650 - 1710
Questions and Answers				1710 - 1720
Close of Day 1				
Cocktail Reception & Networking Function – Trade display area, Wrest Point Casino				1730 - 2030

DAY 2 – Friday, 8 November 2019	Presenter	Company	
Welcome			0830 - 0835
Tutorial - Low Cost Substation Design Solutions (for developing countries) This tutorial presents the work of CIGRE WG B3.43 and the technical brochure 740 published in August 2018 and presents a contemporary approach to the design of high voltage substations. The work provides a good basis for the many considerations involved with design and is just as applicable for developed as it is for developing countries.	Perry Tonking	Convenor of WG B3.43 CIGRE	0835 - 0935
Questions and Answers			0935 - 0945
Morning Tea			0945 - 1000
Introduction			1000 - 1005
Tutorial - Current Interruption in Atmospheric Air David Peelo is an international expert on switching in high voltage networks with particular expertise in current interruption using air-break disconnectors. The tutorial explains the behaviour of free burning arcs in air as related to the interruption of transformer magnetizing, capacitive charging and loop currents with a view to achieving safe operating practices.	David Peelo		1005 - 1100
Questions and Answers			1100 - 1110
Tutorial - Substation Earthing System Design Optimisation Through the Application of Quantified Risk Analysis (QRA) This tutorial presents and explains the creation and application of CIGRE TB 749. It shows the staged use of QRA in a practical and robust earthing system design approach which can reliably produce a balance between cost, practicality and management of risk for the resultant earthing system.	Stephen Palmer Bill Carman	Safearth	1110 - 1210
Questions and Answers			1210 - 1220
Lunch			1220 - 1250
Introduction			1250 - 1255
Workshop – High Power, Grid Forming Inverters enabling tomorrow’s high renewables NEM This workshop will detail and discuss some of the key network services provided by the BESS, including issues such <ul style="list-style-type: none"> - BESS - Virtual generator - Stability and synthetic inertia services - Reliability and microgrid functionality - Power quality support (frequency and voltage) - Fault current provision - Integration of renewable energy sources: centralised and distributed - Non-convention control methods to increase hosting capacity - Future developments and applications as sizing, system strength and capability, and will include discussion of the learnings from design, installation and testing of BESS in substations. 	Stephen Sproul	ABB Australia	1255 - 1500
Questions and Answers			1500 - 1510
Thanks and Conference Close			1510 - 1515

CIGRE Australia acknowledge and thank the following sponsors who have helped stage this event:



3. Conclusion

The event was well received by the participants.

AP.B3 panel would like to continue organising these conferences. They provide a great way for knowledge sharing and networking.

The conference committee:

Michael Verrier - TasNetworks

Robert Scott – TasNetworks

Terry Krieg – PowerNetworks Consulting

Simon Hickey – Energy QLD

Alan Crombie – UGL

John Szmalko – Jacobs

Crina-Miana Costan - Tudor Solutions

With special thanks to Terry Killen and Debbie Haddock

Email: <<crina.m.costan@gmail.com>>

Phone: <<0407970295>>

CIGRE Conference organised by AU B5 Protection & Automation

“South East Asia Protection, Automation and Control Conference”

1. Details of the Conference

The 2019 South East Asia Protection, Automation & Control Conference (SEAPAC) was held at the Star Hotel in Sydney on 19-20 March. The SEAPAC conference is held every two years and brings together the leading expertise in the protection and automation fields across Australia, New Zealand and the South East Asia region to participate at paper presentations and network at the technical exhibition.

CIGRE B5 Protection & Automation Panel's principle objective is the 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

139 delegates attended the 2019 SEAPAC conference where 36 presentations were delivered over two days. Even though there were some late paper and presentation withdrawals, a diverse range of current and topics relevant to Australia/New Zealand were covered. These topics included renewable generation challenges and application experience, IEC61850 scheme and digital substation experience, time synchronisation issues and addressing tele-protection changes. The keynote speaker explained the changing grid and challenged the audience to address the resulting protection, automation and control issues. Question and answer time after each session provided the opportunity for the audience to ask questions. During the session intervals and evening cocktail event delegates visited the technical exhibition where they had direct interaction with a range of vendors and service providers. Conference exhibition support from organisations displaying latest technology, products and services is greatly appreciated. Thanks to AusGrid there was also an interesting technical site visit (on the day before the conference) to the Barangaroo IEC61850 33kV/400V 4MVA distribution substations, the 33kV district cooling plant and the central control systems.

Day 1 – 19 March 2019:

Gerard Reiter Transgrid	Keynote Address: “Network changes and challenges - Transgrid’s perspective in planning for them”
Nathan Kirby Western Power	Western Power’s Perenjori BESS - Functionality and Operational Experience
Ian Young Schneider Electric	Process Bus in Breaker and a Half Applications
Duncan Buchanan Transpower New Zealand Ltd	Transpower Application for Automatic Control of Reactive Equipment Using SCADA in the Upper North Island (UNIRPC)
Daniel Moulds Powerlink Queensland	Benefits of integrating automation functions into IEC 61850-based Substation SCADA/HMI platforms

Scott Cansdale TransGrid	First Digital Substation in TransGrid Australia A journey: Process Bus testing experience
Dan Martin TIC/UQ	Transformer Innovation Centre – Overview and Summary
Ian Young Schneider Electric	The benefits of using IEC61869 in Process Bus applications
Pejman Peidaee Victoria University	Development of Wide Area Monitoring and Protection System Based on IEC61850 Standard
Terry Foxcroft SnowyHydro	How important is a bolt?
Leonardo Torelli CSE- Uniserve	Do frequency changes affect protection element accuracy?
Ravi Anegondy ACTEW AGL Distribution	A new Approach to detecting Vegetation Faults: Voltage Sensitive Earth Fault Protection
Daniel Abetz Siemens Ltd	Recent Transitions in Bus Bar Protection for Closed Ring Networks
Simon Bartlett ARCMesh PTY. Ltd	Delivering affordable, reliable and sustainable electricity to Australia
Bhavish Kumar Transpower New Zealand Ltd	Developing a cost-effective distance-to-fault cable-zone fault indication scheme
Klaus Winter Swedish Neutral AB	The use of REFCL technology in Australia and other countries
Graeme Lloyd GE Grid Solutions	Process bus based Busbar Protection - A stepping stone towards Digital Substation
Stefan Schlichting OMICRON Electronics GmbH	Data Management and Analytics for Protection System Maintenance - A Specialized and Secure Solution Operating in the Technical Zone
Dr. Zeljko Schreiner IPS Intelligent Process Solutions GmbH	Integrated IED Asset Management, Risk Management and Maintenance Strategies - current situation and future hopes
	Cocktail Function/Dinner

Day 2 – 20 March 2019:

Peter Bishop	B5 Activities Update
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Maty Ghezelayagh TasNetworks Pty Ltd	Wind Farm Power Plants: How should be protected, controlled and integrated to grid
Gustavo Azevedo University of Queensland	Battery Energy Storage for Frequency Control in an Electricity Market with High Penetration of Renewable Energy
Nick Yates Flexity Pty Ltd	Advanced voltage control in substations and feeders affected by DER
Joseph Treacy Transgid	Protections for Large Scale Renewable Generation Connection
Winodh Jayewardene WSP	A New Paradigm for Power System Stability Protection with Asynchronous Generation
Jingwei Lu Australian Energy Market Operator	Fault current calculations in power systems dominated by power electronic interfaced asynchronous generation
Martin Van DermLinde NOJA Power	Australia's First Large Scale PMU Deployment in the Medium Voltage Distribution Network
Chirag Mistry GE Grid Solutions	Managing Sub-Synchronous Oscillation Interaction Risk with Waveform Measurement Units - A novel approach
Ian Young Schneider Electric	PTP Time Synchronisation
Graeme Lloyd GE Grid Solutions	Deployment and evaluation of IEEE1588 in a PRP network
Nilesh Joshi CommTel NS Pty Ltd	Application of MPLS-TP for Transporting Power System Protection Data
Colin Gray Schweitzer Engineering Laboratories, Inc	Solving the Inherent Problem of Transporting Serial Teleprotection Circuits Over MPLS
Graeme Lloyd GE Grid Solutions	Optimising high impedance busbar protection scheme design using a microprocessor-based relay
Fabrizio Girardi Mac-Taggart Siemens Ltd	SCADA's Role in Large-Scale PV Plants
David Gil Donate ZIV Applications	Teleprotection in the new WAN world
Andrew West SUBNET Solutions Inc	IED System Management Solution: A Universal Approach for all your Grid IoT Integration
Veselin Skendzic Schweitzer Engineering Laboratories, Inc.	Using Wavelength Division Multiplexing for Protection Applications





3. Conclusion

The 2019 SEAPAC conference was well attended and 36 presentations were communicated on a diverse range of current topics relating to protection, automation and control. The presentations and associated papers shared experiences of commissioned projects, information on projects being initiated, power system event learnings, and approaches to deal with existing & future changes/challenges. During the question and answer sessions there were some lively discussions. Thanks to the support from a range of sponsoring companies, delegates were able to meet, view and discuss the products and services on display in the exhibition space during intervals and cocktail dinner.

Survey feedback received provided mostly very good and excellent overall ratings for the SEAPAC 2019 event and a good range of comments on aspects that went well and ideas for improvement. The feedback will help the AU B5 panel shape the next SEAPAC conference.

The 2019 event was organised by an AU B5 committee of Kathryn Ward, Ian Young, Kevin Hinkley, Ben Haines Matthew Browne, Khang Dang, David Harper, Shane Kerr, Leonardo Torelli, Francois Pambrun, Terry Foxcroft.

The contribution by the following session chair people was also appreciated – Leonardo Torelli, Peter Cleaves, Gavin DeHosson, Behnam Taherian, Ian Young, Justin Brown, Kevin Friesen.

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

Name: Peter Bishop – AU B5 Convenor

Email: peter.bishop@transpower.co.nz

Phone: +6421408503

CIGRE Conference Presented by AU C6

Conference on Integration of Distributed Energy Resources 2019

1. Details of the Conference

Australian Panel C6 hosted its third Conference on Integration of Distributed Energy Resources (CIDER) in Melbourne on 20-21 August 2019. It was held at the Pullman Melbourne on the Park, with 88 delegates attending. The conference included:

- two keynote presentations;
- 26 presenters in a single-stream format;
- an NGN panel, on *Managing the Impact of DER on Grid Stability*;
- a second panel on *Power Quality Response Modes*;
- stand-up networking dinner.

This was the third CIDER run by Australian Panel C6, the previous two conferences being in Brisbane in 2015 and Sydney in 2017. The next CIDER will be held in 2021, in a city still to be selected.

2. Conference Program

Tuesday 20 August 2019

Violette Mouchaileh AEMO Keynote Speaker	The Role of Distributed Resources in Transforming the Energy System and Market
Laura Jones TasNetworks	Opportunities from DER? How do we create a future where DER benefits customers and the energy system?
Nathan Kirby Western Power	Western Power's Perenjori BESS - Functionality and Operational Experience
Olav Krause University of Qld	Understanding the Impact of Very High Penetrations of Rooftop PV on Power Transformer Tap Changer Operation: A Case Study
Peter Kilby Energy Queensland	Solving the Problem of Excessive Voltage Rises Caused by Rooftop Solar Using Voltage-regulating Distribution Transformers
Toby Roxburgh Electromotiv	Narara Ecovillage Case Study – Delivering 100% Solar Import and Export Capable, Zero Emissions Smartgrid
Hedy Dalvand United Energy	Dynamic Voltage Management System
Gerard Ledwich Qld University of Technology	Dynamics of Inverters with Synchronous Machines
Mehdi Ghazavi Dozein Melbourne University	Frequency Response Provision from Distributed PVs Considering the August 2018 Separation Events in Australia
Naomi Stringer University of NSW	Data-driven Insights into Distributed PV Behaviours - Balancing System Level and Distribution Needs
Shariq Riaz Melbourne University	Provision of Time Constrained Grid Services through Energy Constrained Distribution-Side Resources

Maryam Khallaghi OMICRON	Protection, Automation and Control with Distributed Energy Resources - Testing Issues
Ke Meng	Hardware-in-the-Loop Test for DERs: A Powerful Benchmarking Tool
Jacqui Mills (Moderator)	NGN Panel Session Managing the Impact of DER on Grid Stability
	Peter Kilby (Energy Queensland) Cheryl Noronha (AEMO) Sasan Zabihi (ABB) Glen Summers (AGL Energy) Olav Kraus (University of Queensland)
	Social Event / Drinks / Stand-up Networking Dinner

Wednesday 21 August 2019

Jason David University of Wollongong	Harmonic Emissions Studies of Large Renewable Energy Farms; Modelling and Data Management Learnings
Kevin Tu WSP	Harmonics Considerations when Connecting Power Electronics (PE) Interfaced Generation
Marius Jansen Optimised Network Equipment	Network and Generator Modelling for Harmonic Compliance
John Wright-Smith AMSC	Sizing STATCOMs for Step Voltage Change Criteria
Jason David University of Wollongong	Performance Testing of LV STATCOMs
Derrick Nofal ABB	Application of Modern Synchronous Condensers to Support Distributed Energy Resources
Lachlan Blackhall ANU Keynote Speaker	DER in a Decarbonised, Decentralised and Democratised Grid
Olav Krause University of Qld	Maximising Grid Utilisation through Constraint Based DER Orchestration
Michael Jurasovic TasNetworks	Quantifying the Effects of Electric Vehicles on the Tasmanian Low Voltage Network
Stephen Sproul ABB	Grid-forming Converters and Benefits to the Grid - ABB's Experience
Leonardo Callegaro University of NSW	From Inverter Standards to Understanding Inverter Behaviour for Small-scale Distributed Generation
Sanika Willard CutlerMerz	Power Quality Response Modes

Jenny Gannon (Moderator)	Panel Session Power Quality Response Modes
	David Stephens (Horizon Power) Sanika Willard (CutlerMerz) Hedy Dalvand (United Energy) Albert Pors (Endeavour Energy)
Han Wang University of Melbourne	Techno-economic and Business Case Assessment of University of Melbourne Virtual Power Plant
David Stephens Horizon Power	Carnarvon Microgrid Trial
Andrew McConnell Energy Queensland	Insights into the DER API Working Group in Australia



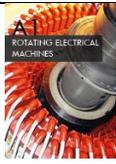
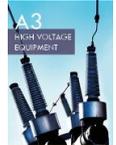
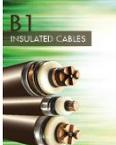
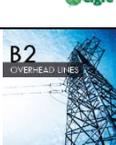
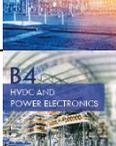
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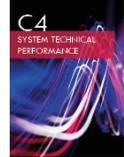
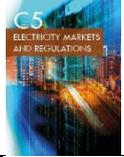
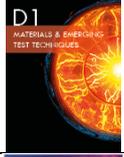
The conference received extremely good feedback from attendees, both in a survey sent to all participants immediately after the event and comments directly from delegates during the conference.

Name: Ken Ash, Jenny Gannon, Matt Zillmann, Terry Killen, Albert Pors, Sean Elphick, Laura Jones and Ray Brown

Email: ray@rbpe.com.au

Attachment 3 – Brochures published by CIGRE in 2019

Study Committee	TB Number	Title
	776	Factory quality assurance testing requirements for turbo-generator components - stator bars
	774	State of the art of stator winding supports in slot area and winding overhang of hydro generators
	772	Turbogenerator stator windings support system experience
	769	Dielectric dissipation factor measurements on new stator bars and coils
	761	Condition assessment of power transformers
	755	Transformer bushing reliability
	783	DGA monitoring systems
	779	Field experience with transformer solid insulation ageing markers
	771	Advances in DGA interpretation
	757	Guidelines and best practices for the commissioning and operation of controlled switching projects
	773	Fault location on land and submarine links (AC & DC)
	770	Trenchless technologies
	758	Test regimes for HV and EHV cable connectors
	756	Thermal monitoring of cable circuits and grid operators' use of dynamic rating systems
	784	Standard design of a common, dry type plug-in interface for GIS and power cables up to 145 kV
	767	Vegetation fire characteristics and the potential impacts on overhead line performance
	763	Conductors for the uprating of existing overhead lines
	777	Reliability analysis and design guidelines for LV DC auxiliary systems
	764	Expected impact on substation management from future grids
	754	AC side harmonics and appropriate harmonic limits for VSC HVDC
	766	Network modelling for harmonic studies

Study Committee	TB Number	Title
	768	Protection requirements on transient response of digital acquisition chain
	760	Test strategy for Protection, Automation and Control (PAC) functions in a fully digital substation based on IEC 61850 applications
	787	ISO series 55000 standards: Implementation and information guidelines for utilities
	786	Investment decisions in a changing and uncertain environment
	775	Global electricity network - Feasibility study
	778	Reliability standards and market rules related to maintaining reliability and market efficiency
	785	Electromagnetic computation methods for lightning surge studies with emphasis on the FDTD method
	781	Impact of soil-parameter frequency dependence on the response of grounding electrodes and on the lightning performance of electrical systems
	780	Understanding of geomagnetic storm environment for high voltage power grids
	759	Mitigating systemic market risk in electricity markets
	753	Wholesale market price caps
	752	Regulation and market design barriers preventing to capture all the value from fast and high-locations-freedom energy storage
	782	Utilization of data from smart meter system
	765	Understanding and mitigating corrosion
	762	Remote service security requirement objectives