

## Australian Technical Committee of CIGRE 2018 Report



This report on the Australian Technical Committee is 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 2017.

### Contents

Role of the Australian Technical Committee.....	2
ATC Membership.....	3
Australian Panels.....	3
Working Groups.....	4
CIGRE KMS.....	6
Study Committee Meetings in Australia.....	6
CIGRE 2018 Session.....	6
Seminars, Conferences and Training.....	7
Health of Technical Activities – ATC KPI.....	7

**David Bones**  
Chair of the Australian Technical Committee  
December 2018

## 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.

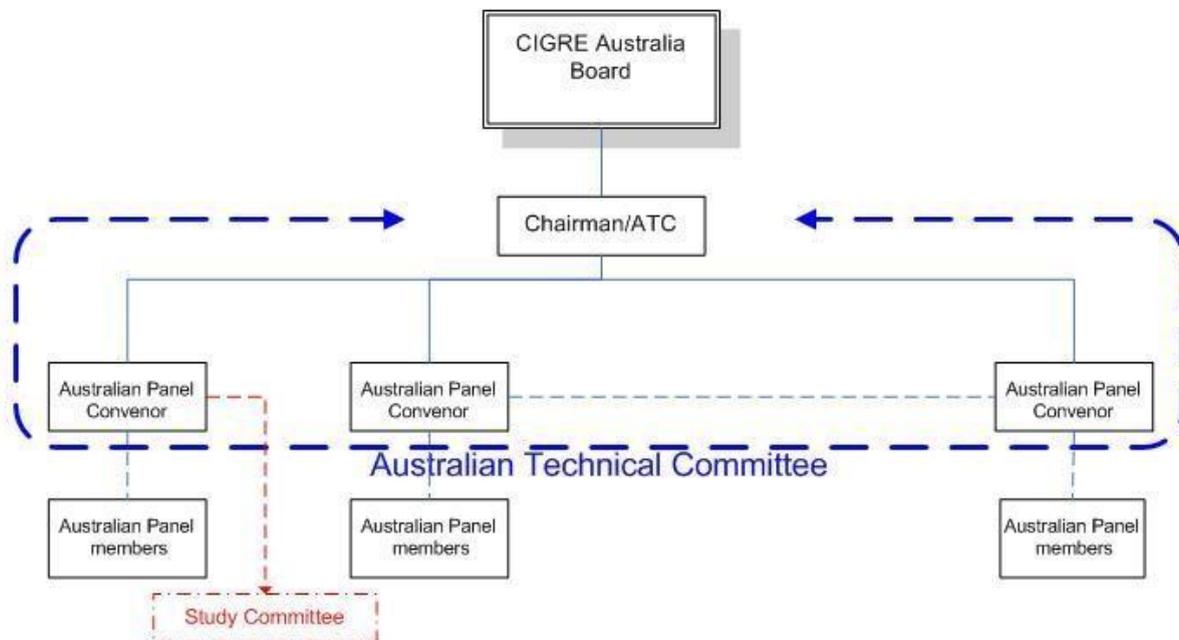
The Technical Committee provides a forum for the ATC members to:

- 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 ANC of CIGRE Board. The CIGRE Australia Executive Manager and Secretary provide administrative support to the committee and a linkage between the CIGRE Australia Board and the Australian Panels for all financial and administrative decisions.

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 membership of the order of 20 members although a number of the panels have larger membership due mainly to the structure of the electricity supply industry and the value of ANC CIGRE membership. The largest panel currently has 33 members and the smallest has 10 members.

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



The ATC conducts most of its activities during the year by quarterly teleconferences. The main face-to-face meeting was held on the day before the CIGRE Australia Annual General Meeting.

## ATC Membership

Australian Panel Conveners are normally appointed for a six-year term. It is normal practice for approximately one third of Australian Panel Conveners to retire at the Annual General Meeting in odd numbered years. In 2018 Alex Cruickshank was appointed to Chair the C5 Study Committee Electricity Markets and Regulation. To allow Alex to concentrate on this new role, Greg Thorpe was appointed to take over the role of Australian Panel convener.

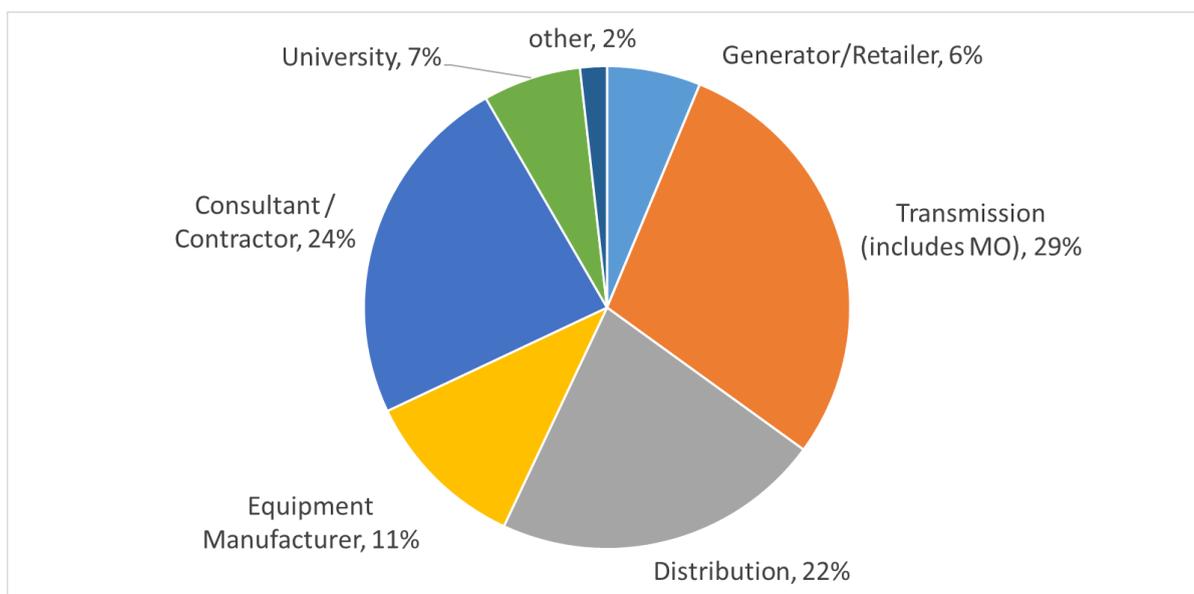
CIGRE Australia enjoys excellent access to the international technical activities of CIGRE through Alex's role as the SC C5 Chairman. In this role Alex is also a member of the CIGRE Technical Council. Alex's appointment means that CIGRE Australia has enjoyed an extended period of influence over the technical 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 Cruickshank).

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 2018 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 structure for CIGRE and its members. Local initiatives also form the basis for future international CIGRE work.

Membership of Australian Panels increased slightly across 2017. Sector representation is shown below.



Each Panel has a dedicated NGN liaison who 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 2018 ATC report.

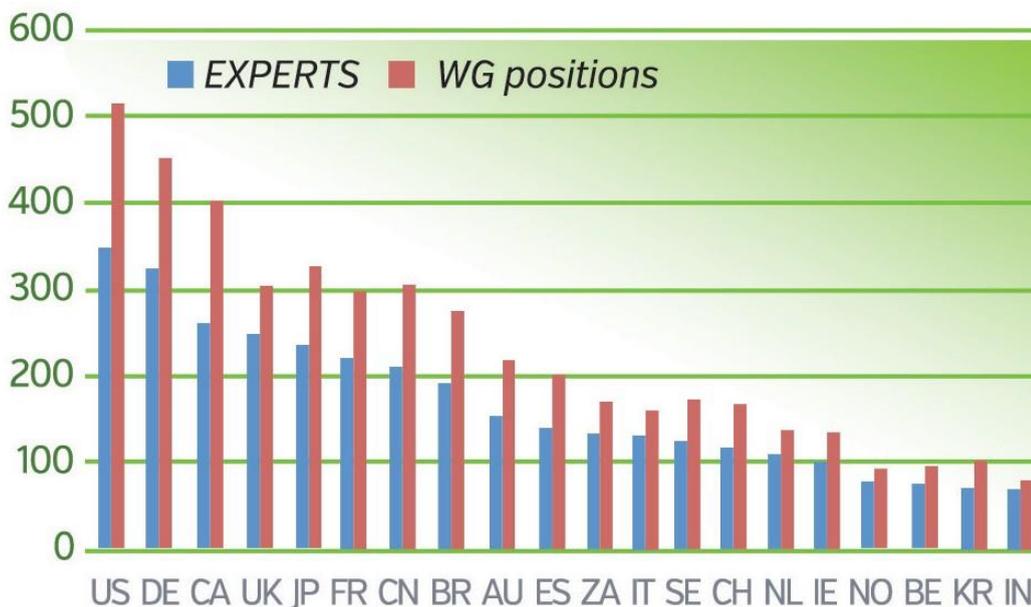
Panel Conveners also delivered a presentation at the ATC Seminar held of the day before the 2018 AGM. Those presentations focusses of key impressions from the Paris session and highlighted SC activities of particular relevance to Australia. Copies of the presentation are available from the CIGRE Australia 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 pre-determined periods of time. The primary outputs of Working Groups are technical reports that become industry reference documents detailing state of the art, industry best practice and the direction of the industry. The list of Working Group Brochures published by CIGRE in 2018 is included as attachment 3 to this report. All of these brochures are available for Cigre Australia members via the e-cigre (<https://e-cigre.org/>).

A survey of Australia Panel conveners completed in November 2018 identified that CIGRE had 239 active Working Groups. CIGRE Australia members are making a significant contribution to working groups with 149 active working group members identified by Australian Panel Conveners, which means that approximately 50% of all working groups have a CIGRE Australia member. Further details are provided in the annual reports prepared by each Australian Panel Convener regarding the involvement of panel members in international working groups.

In 2017 CIGRE completed a survey of working group activities<sup>1</sup>. The survey data revealed that CIGRE Australia continues to rank highly (9<sup>th</sup>) in the list of national committees contributing to working groups.

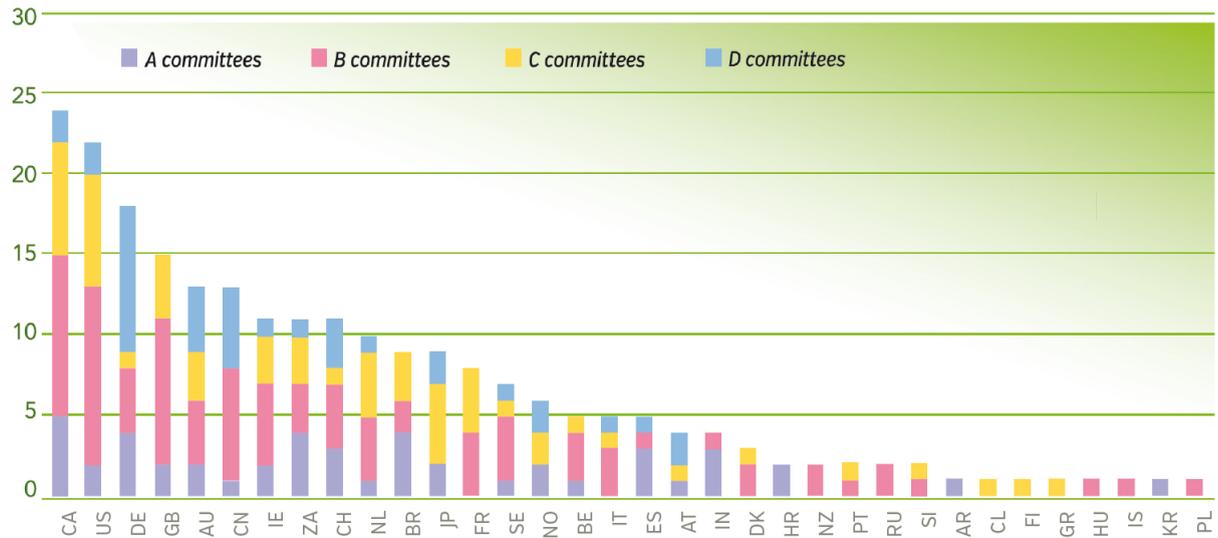


Australia's leadership position is greatly enhanced by CIGRE Australia representatives who convene international Working Groups on topics of significant regional and international interest. These members are considered leaders in their field with the task of addressing industry issues and defining international best practice.

In the 2017 survey data CIGRE Australia was ranked 5<sup>th</sup> among all national committees for leadership of international Working Groups.

<sup>1</sup> <https://www.cigre.org/GB/knowledge-programme/our-16-study-committees-and-domains-of-work> Scope of work 2018

### Working Group Conveners' origins



CIGRE Study Committees / 2018 SCOPE OF WORK & ACTIVITIES

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 funding travel for 10 working group meeting 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 2018.

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)
B3-43	Contemporary Solutions for Substations in Developing Countries	Peregrine Tonking (C)
B4-77	AC Fault response options for VSC HVDC Converters	Simon Bartlett (M)
C1-38	Valuation as a comprehensive approach to asset management in view of emerging developments	Graeme Ancell (C)
C3-19	Responsible management of the Electric and Magnetic Field Issue	James Hart (C)
C5-22	The Management of Systemic Market Risk in Electricity Markets	David Bowker (C)
D1-69	Guidelines for test techniques of High Temperature Superconducting (HTS) systems	Richard Taylor (C)

<b>WG/TF No</b>	<b>WG or TF Name</b>	<b>Convener/Member</b>
D1.71	Understanding and mitigating corrosion	Joe Tusek (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 2018 working group meetings. These reports follow the Australian Panel Annual Reports and are also listed in attachment 2 of this report.

During the 2018 the following working groups previously supported by CIGRE Australia completed their work with technical brochures submitted and awaiting publication:

- A2.49 – Condition assessment of power transformers convened by Peter Cole
- B3.43 – Contemporary Solutions for Substations in Developing Countries convened by Peregrine Tonking
- B4-63 – Testing and commissioning of VSC HVDC Schemes convened by Les Brand
- C4-40 – Revisions to IEC Technical Reports 61000-3-6, 61000-3-7, 61000-3-13, and 61000-3-14, Sarath Perera member

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/>

## **CIGRE KMS**

In 2016 CIGRE Central Office adopted the use of the confluence system as the preferred knowledge management system. Confluence has been used by the Australian Panels for many years to provide a collaborative online environment to assist with the management of Panel activities.

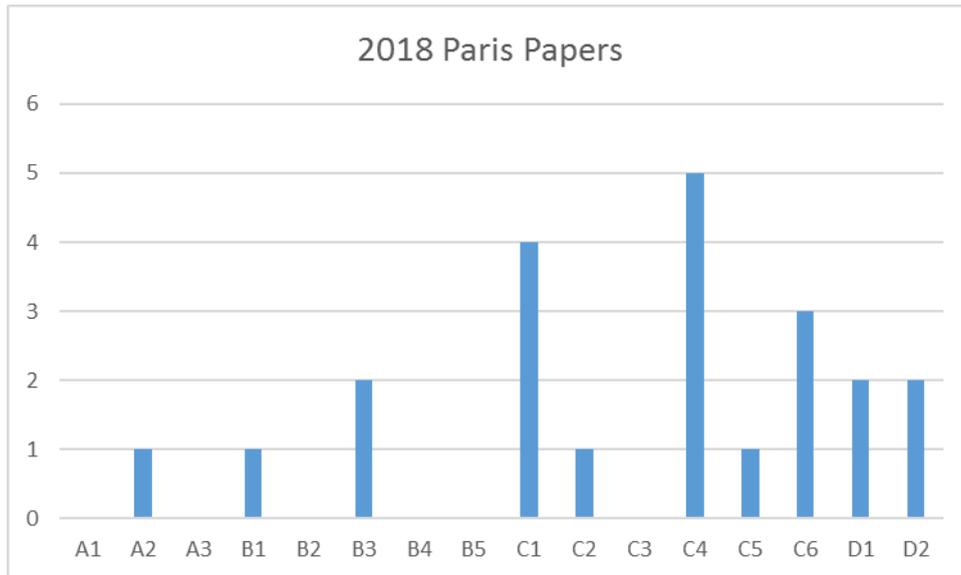
The use of the Confluence knowledge management system is now common across all study committees and working groups. Australian Panels and the ATC rely on the KMS system as the primary communication and collaboration tool. Any panel members who have not set up a KMS login should do so as it will enhance the value they gain from participation in CIGRE.

## **Study Committee Meetings in Australia**

CIGRE Australia did not host any Study Committee meetings in 2018.

## **CIGRE 2018 Session**

A record number of papers were submitted by CIGRE Australia for the 2018 Paris Session. 22 papers were submitted. The following figure shows the distribution of CIGRE Australia papers across the 16 Study Committees.



In addition to preparing papers and contributing to the technical discussion through delivery of interventions, a number of CIGRE Australia members performed important roles at the 2018 Paris Session. They include:

- Terry Krieg retiring SCB3 Chairman
- Alex Cruikshank becomes SCC5 Chairman and Chaired the market disturbance workshop
- Peter Wiehe secretary SCA1
- Wayne Pepper, James Hart, Andrew Halley, Greg Thorpe, Victor Tan are taking on roles of special reporter
- Graeme Ancell and Wayne Pepper organized the SC poster sessions
- Joe Tusek is a member of the SAG and CAG for SCD1
- John McCormack, Peter Dulhunty and Michael Lee are all members of TAG for SCB2
- Andrew Halley and Sarath Perera are members of AG1 of SCC4

In addition the opening address at the Paris session was provided by Audrey Zibelman, AEMO CEO and Australia provided 4 presenters at key workshops across the Paris session.

## Seminars, Conferences and Training

**Transformer Workshop** - A workshop was held in Sydney on 16 April 2018, and was attended by 84 delegates. The seminar was held in conjunction with Techcon Asia Pacific, which was held at the same venue on 17 and 18 April. The workshop had two parts, a morning session where speakers presented CIGRE tutorials or technical papers, followed after lunch by a panel session where speaker/experts received questions initially from the facilitator, which led into spontaneous questions and interactive discussion from the delegates. A report on the workshop is provided in attachment 2

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.

Further information on events is available on the CIGRE Australia website.

## Health of Technical Activities – ATC KPI

Across 2018 the ATC develop a set of measures that are collectively aimed at monitoring 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
Technical contribution	10 working groups pa, (projected outcome based on YTD committment)
	10 ITL WG articles pa, (projected outcome based on YTD committment)
	3 technical seminars pa, achieving positive feedback (preparation on track and positive feedback post event)
	Annual reports provided to members for each Panel and funded WG (templates in Aug, reports before AGM)
	55% WG have Australian member, 20 papers for paris session, 9 substantive roles during Paris session
Sustainable structure	All panels have active NGN liaison
	All panels have convenor and identified successor
	Panel membership reflects all industry sectors

A number of targets have been set and are used to assess whether the performance against each measure is acceptable.

Statistics gathered across the final quarter of 2018 indicate that the targets relating to the technical contribution were achieved during 2018. Some further work is required to meet all of the targets established to measure the sustainability of the structure of the panels. 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

A focus during 2019 will be to implement strategies to address the identified areas of concern

### 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 2018.

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 – 2018 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 B3 Chairman	Terry Krieg
SC C5 Chairman	Alex Cruickshank
Executive Manager CIGRE Australia	Terry Killen
Secretary CIGRE Australia	Kerry Williams

## Attachment 2 – Annual Reports by the ATC

### Australian Panel Annual Reports

CIGRE\_Annual\_Report\_AP\_A1\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_A2\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_B1\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_B2\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_B3\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_B4\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_B5\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_C1\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_C2\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_C3\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_C4\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_C5\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_C6\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_D1\_2018.pdf  
CIGRE\_Annual\_Report\_AP\_D2\_2018.pdf

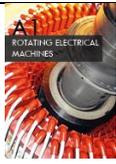
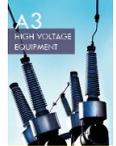
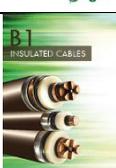
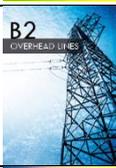
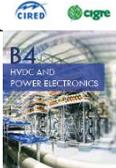
### Reports on Working Groups supported by ANC of CIGRE

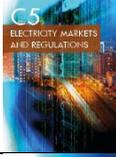
CIGRE\_Working\_Group\_Report\_WG\_A2-58\_2018.pdf  
A2.58 Survey final for release v0 18-7-18.pdf  
CIGRE+Poster+WG A2 58+2018+QR Code.pdf  
CIGRE\_Working\_Group\_Report\_WG\_B2-64\_2018.pdf  
CIGRE\_Working\_Group\_Report\_WG\_B2-67\_2018.pdf  
CIGRE\_Working\_Group\_Report\_TF\_B4-77\_2018.pdf  
CIGRE\_Working\_Group\_Report\_WG\_C1-38\_2018.pdf  
CIGRE\_Working\_Group\_Report\_WG\_C3-19\_2018.pdf  
CIGRE\_Working\_Group\_Report\_WG\_C5-22\_2018.pdf  
CIGRE\_Working\_Group\_Report\_WG\_D1-69\_2018.pdf  
CIGRE\_Working\_Group\_Report\_WG\_D1-71\_2018.pdf  
CIGRE\_Working\_Group\_Report\_WG\_D2-43\_2018.pdf

### 2018 Event Reports

CIGRE\_Event\_Report\_A2 2017.pdf

Attachment 3 – Brochures published by CIGRE in 2017

Study Committee	TB Number	Title
	743	Guide on new generator-grid interaction requirements
	729	Technological feasibility studies for super and ultra premium efficient motors
	724	Guide on use of premium efficiency IE3 (IEC 60034-30) motors & determining benefits of green house gas emission reduction
	735	Transformer post-mortem analysis
	725	Ageing high voltage substation equipment and possible mitigation techniques
	737	Non-intrusive methods for condition assessment of distribution and transmission switchgear
	716	System conditions for and probability of out-of-phase
	728	On-site Partial Discharge assessment of HV and EHV cable systems
	722	Recommendations for additional testing for submarine cables from 6 KV (UM=7.2 KV) up to 60 KV (UM = 72.5 KV)
	720	Fire issues for insulated cables in air
	744	Management guidelines for balancing in-house and outsourced overhead transmission line technical expertise
	731	The use of robotics in assessment and maintenance of overhead lines
	740	Contemporary design of low cost substations in developing countries
	734	Management of risk in substations
	723	SF6 Measurement guide
	749	Substation earthing system design optimisation through the application of quantified risk analysis
	717	Protocol for reporting operational performance of FACTS

Study Committee	TB Number	Title
	739	Protection and local control of HVDC-grids
	715	The future of reliability - Definition of reliability in light of new developments in various devices and services which offer customers and system operators new levels of flexibility
	750	Wide area monitoring systems – Support for control room applications
	742	A proposed framework for coordinated power system stability control
	733	System operation emphasizing DSO/TSO interaction and coordination
	732	Advanced utility data management and analytics for improved operation situational awareness of EPU operations
	748	Environmental issues of high voltage transmission lines in urban and rural areas
	745	Issues related to spark discharges
	736	Power system test cases for EMT-type simulation studies
	718	Benchmarking of power quality performance in transmission systems
	719	Power quality and EMC issues with future electricity networks
	727	Modelling of inverter-based generation for power system dynamic studies
	747	Costs of electric service, allocation methods, and residential rate trends
	726	Asset management for distribution networks with high penetration of distributed energy resources
	721	The impact of battery energy storage systems on distribution networks

Study Committee	TB Number	Title
	741	Moisture measurement and assessment in transformer insulation - Evaluation of chemical methods and moisture capacitive sensors
	738	Ageing of liquid impregnated cellulose for power transformers
	730	Dry air, N <sub>2</sub> , CO <sub>2</sub> , and N <sub>2</sub> /SF <sub>6</sub> mixtures for gas-insulated systems
	746	Design, deployment and maintenance of optical cables associated to overhead HV transmission lines

## **AP A1 Rotating Electrical Machines**

### **1. Study Committee Scope**

SC A1 focuses on the development of new technologies and the international exchange of information and knowledge in the field of rotating electrical machines, to add value to this information and knowledge by means of synthesizing state-of-the-art practices and developing guidelines and recommendations.

### **2. Specific Activities of the Study Committee**

The current areas of work of the A1 Study Committee and strategies to progress the work of Cigre are:

- The technological improvements in design, materials, insulation, cooling, bearing, availability, reliability, efficiency, monitoring and maintenance of the electrical rotating machines.
- Assessment of electrical rotating machines management, improvements in monitoring, diagnosis, and prognosis systems.

### **3. Preferential Subjects**

Three Preferential subjects were selected by the Study Committee for the 2018 Paris Session 47:

#### **PS1: “Generation mix of the future”**

- Total of 6 technical papers were submitted and presented at poster sessions at Paris Session 47
- Hybrid generation of gas turbine and battery energy storage
- Eddy current losses calculation in high speed PM synchronous generators.
- Design improvements and technological developments required for machines to withstand cycled operation due to fluctuating feed-in of renewable energy and variable load demand.
- Impacts and effects of increasing renewable power mix on existing legacy generators, generator auxiliaries and motors.
- Evolution and trends in designs of machines for renewable generation.

#### **PS2: “Asset Management of Electrical Machines”**

- Total of 10 technical papers were submitted and presented at poster sessions at Paris Session 47 (paper A1-206 was withdrawn).
- Further development of PD measurement techniques in electrical rotating machines and Isolated Phase Bus particularly in hydro generators.
- The use of generators as synchronous condensers to meet dynamic system requirements in the new generation mix.
- Experience with refurbishment, replacement, power up rating and efficiency improvement of aged generators.
- Novel techniques to overcome known operational and design problems
- Optimisation condition monitoring, diagnosis, prognosis and maintenance practices to improve reliability and extend operational life at convention plant and in new volatile grid conditions.

#### **PS3: “Developments of rotating electrical machines and operational experiences.”**

- Total of 10 technical papers were submitted and presented at poster session at Paris session 47
- New development of large indirect cooling turbo generators
- Reports of a number of operational experience and repairs of large generators
- Reactive power capability of large hydro generators and the European Grid code requirements with respect to voltage stability
- Latest design, specification, materials, manufacture, maintenance and performance and efficiency improvements in generator and motors.
- Operational experience in failures, root cause analysis, recovery options, cost and time reduction initiatives.

### **4. Proposed New Working Groups**

The following new Working Groups have been formed or about to start:

<b>WG</b>	<b>Title</b>	<b>Australian Member</b>
A1.63	Turbo Generator stator winding and lead connections – Field Experience, failure and design improvements	Tri Tran
A1.65	Guide to optimal management of coal generation in presence of significant inverter-based resources	TBD

## 5. Specific Activities of the Australian Panel

At the AP A1 annual meeting held in Hobart on 26<sup>th</sup> July 2018, the following presentation and discussions were taken place:

- Kangaroo Valley upgrade
- A failure at Valley Power and Murray 1 Power Station
- Stator rewind – an experience
- Repulse Power Station refurbishment
- Vales Point 6B PA Fan Motor Bearing Failure Incident May 2018
- “A lesson learnt from a 500MW generator failure”

The AP A1 panel is planning to hold a mid-year Skype meeting with members in February 2019. The purposes of the meeting are to keep members up to date with Cigre current activities, sharing operational experience and preparation for the 2019 annual meeting.

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

There is no invitation for SC A1 or WG A1 to meet in Australia in 2018 / 2019.

## 7. ANC Members on Working Groups

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

<b>WG</b>	<b>Title</b>	<b>Australian Member</b>
A1.33	Guide to the Proper Storage and Cleanliness of Turbogenerators and Components	Tri Tran
A1.37	Turbogenerator Stator Winding Support System Experience	Tri Tran
A1.39	Application of dielectric dissipation factor measurements on new stator coils and bars	Tri Tran/ Peter Wiehe
A1.42	Influence of Key Requirements to Optimize the Value of Hydro-generators	Kapila Nanayakkara/ Peter Wiehe
A1.44	Guidelines on Testing of Turbo and Hydro-Generators	Peter Wiehe
A1.48	Guidance on the Requirements for High Speed Balancing / Overspeed Testing of Turbine Generator Rotors Following Maintenance or Repair	Len Gunn
A1.49	Magnetic core dimensioning limits in Hydro-Generators	Peter Wiehe
A1.50	Factory Quality Assurance Testing Requirements for Turbo-generator Components	Tri Tran
A1.51	Monitoring, Reliability and Availability of Wind Generators	Tri Tran

<b>WG</b>	<b>Title</b>	<b>Australian Member</b>
A1.55	Survey of Split Core Stators	Peter Wiehe
A1.56	Survey on Lap and Wave Windings and their consequences on Maintenance and Performance	Peter Wiehe
A1.57	Visual Inspection of Stator Windings and Cores of Large Turbo-generators	Tri Tran
A1.59	Survey on Industry Practices and Effects associated with the Cutting out of Stator Coils in Hydro-generators	John Iles
A1.60	Guide to Economic Evaluation for Refurbishment or Replacement Decisions on Hydro-generators	Peter Wiehe/ Kapila Nanayakkara

## 8. Membership of the Australian Panel

<b>Name</b>	<b>Organisation</b>	<b>Type</b>
Tri Tran	AGL Energy	Utility
Peter Wiehe	Hydro Tasmania (Acutel Consulting)	Consultant/Utility
Johan Strydom	Synergy	Utility
Kapila Nanayakkara	Snowy Hydro	Utility
Ashok Ojha	Alinta – Loy Yang B PS	Utility
David Graham	Energy Australia – Yallourn PS	
Charles Tema	CS Energy	Utility
Hossein Rahimpour	AmpControl	Consultant
Len Gunn	Origin Energy	Utility
Phil Onions	Stanwell Corporation	Utility
Simon Nawrot	Delta Electricity	Utility
Damien Cooper	Snowy Hydro (Colongra)	Utility
Nik Walker	Alinta Energy	Utility
Viet Trinh	ElectraNet Pty. Ltd	Transmission

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

## AP A2 Transformers and Reactors

### 1. Study Committee Scope

The scope of SC A2 covers:

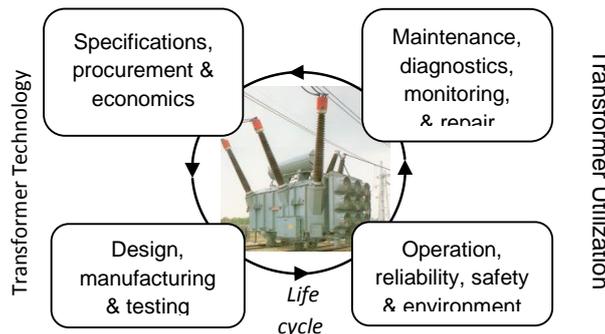
- All kinds of power transformers, including HVDC transformers converter and phase-shifting transformers;
- All kinds of reactors, including shunt reactors, series reactors, and HVDC smoothing reactors;
- All transformer components, including bushings, tapchangers, and other transformer accessories.

### 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
PC57.12.158 (New)	Guide for the Application of Tertiary and Stabilizing Windings in Power Transformers	Approved 2017
PC57.12.10 (Revision)	Standard Requirements for Liquid Immersed Power Transformers	Approved 2017
PC57.15/ PC57.19.01 (Revision)	Standard for Performance Characteristics & Dimensions for Transformer and Reactor Bushings	Approved 2017



PC57.19.04 (Revision)	Standard for Performance Characteristics & Dimensions for High Current Power Transformer Bushings with Rated Continuous Current in Excess of 5000A in Bus Enclosures	Approved 2018
PC57.119 (Revision)	Recommended Practice for Performing Temperature Rise Tests on Oil-Immersed Power Transformers at Loads Beyond Nameplate Ratings	Approved 2018
PC57.147 (Revision)	Guide for Acceptance and Maintenance of Natural Ester Insulating Liquid in Transformers	Approved 2018

Activity overview,

- 4 new WGs have been approved
- 1 Technical Brochure and 1 Reference Paper have been published

Brochures and papers published since 2017

- Insulation Condition during Transformer Manufacturing – Electra 299, August 2018
- TB 735 – Transformer Post Mortem Analysis – June 2018

Major meetings:

CIGRE SC A2 Colloquium 2017 in Krakow (Poland), Oct. 1-6, 2017

Session 47 in Paris (FR) Aug. 26-31, 2018

Next Meeting will be at Joint Colloquium A2, B2 and D1 18-22 Nov. 2019 in New Delhi, India.

Tutorials delivered:

“Assessment of Transformer Ageing and Post Mortem Analysis”, August 27, Cigre Paris Session 47, 2018.

A Cigre 2018 Technical Council Award was presented to Marie-Claude Lessard (CA).

### 3. Preferential Subjects

#### Preferential Subjects for the joint A2/B2/D1 Colloquium on 18-22 November 2019

The following preferential subjects were agreed after the 2018 Paris Session.

##### ***PS 1: Advances in Transformer design, including the use of new materials***

- Development and application of new materials / insulating liquids
- Improvements in transformer specifications to enhance reliability of transformer design and construction
- Operation experience and advances in OLTCs, including application to phase-shifting transformers

##### ***PS 2: Quality Assurance and Short-Circuit Withstand Capability of Transformers***

- Short-circuit testing of power transformers, including failure case studies
- Alternatives to short-circuit testing
- Quality control and factory acceptance testing

##### ***PS 3: Operational Experience with Transformers (supports WG A2.58 and WG A2.59)***

- Required site commissioning tests for transformers and reactors
- Additional site commissioning tests for transformers and reactors, depending on circumstances
- Trial operation of transformers and reactors, including requirements for additional monitoring



The proposed preferential subjects for the 2020 Paris Session are:

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

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

(Intended to support Cigre's mission of "Sustainable Electricity for All")

**PS 2: Advances in Dielectric Design and Testing**

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

(Intended to support new WG A2-63)

**PS 3: Sustainability and Transformers**

- Sustainable sourcing of transformers, transformer components, and transformer materials
- Life extension, adaptation to new use, repair, and refurbishment of transformers
- Recycling of transformers, transformer components, and transformer materials

(Intended to support Cigre's mission of "Sustainable Electricity for All")

## 4. Proposed New Working Groups

Four new SC A2 working groups were proposed this year and are approved to commence at the start of 2019.

*A2.60 Dynamic Thermal Behaviour of Transformers – AP A2 member nominee Yuriy Odarenko (Wilson Transformers)*

The scope of this working group is to review the state-of-the-art tools and approaches to power transformers dynamic thermal modelling (DTM) with the aim of proposing suggestions for improvement of the existing standard models, taking into account the effects of using new insulating liquids and sub-zero ambient temperature operational conditions.

Scope :

- Literature review in DTM development: historical background, dynamic heat transfer processes, methodologies (thermal-electrical analogy, thermal hydraulic network, computer fluid dynamics, machine learning), advantages and limitations of different models, seasonal model accuracy, application examples.
- Improvement of DTM accuracy considering cooling system state, transformer design (core, shell type), winding arrangement, type of fluid, viscosity, load profile (e.g. cold start, step load) with explanation of the DTM input parameters.
- On-line DTM applications for new and existing transformers: dynamic overload capability evaluation, cooling system performance monitoring, ageing assessment.
- Provide guidelines for Heat Run test specification and the methodology to extract the required DTM input parameters (exponents, time constants, thermal overshoot, temperature rises).



*A2.61 On-load tap-changer best practice – AP A2 member nominee to be decided*

The scope of this working group is to provide information on open topics related to the recommended practice of using non-vacuum type as well as vacuum type OLTCs in power transformers and address new input for related standards and guides. The Technical Brochure shall give advice and guidance to transformer manufacturers and end users of OLTCs.

Scope :

- Special applications of OLTCs not covered completely by existing standards (OLTCs applied to e.g. shunt reactors, phase-shifting transformers, HVDC transformers, arc furnace transformers). Additionally, paralleling of regulated transformers is an issue to be considered.
- Guidelines for the proper selection of OLTCs (transformer design and alternative fluid considerations, life cycle cost, specification and design review)
- Actions on OLTCs during the lifetime of regulated transformers (commissioning, maintenance, field testing, end of life decision making – refurbish or replace?)
- Failure modes, i.e. what can go wrong with an OLTC and what are the possible consequences for the transformer (not included will be health index issues of transformers and accessories, because they are handled in CIGRÉ WG A2.49. A practice to gain failure rates for OLTCs is discussed in CIGRÉ TB 642 (WG A2.37, published in December 2015)

*A2.62 Analysis of Transformer Reliability – AP A2 corr. member nominee is Dan Martin (UQ)*

After almost 10 years an update in reliability performance of transformers and reactors is proposed with a broad scope.

Scope :

- Update of questionnaire regarding new experiences.
- Conduction of a new survey about major failures and replacement for the period 2010 to 2019 for AC power transformers of 100 kV and above.
- Analysis of failure data in terms of failure rate, location, mode and cause.
- Analysis of failures due to high loading regimes
- Individual analysis of failures of transformers connected to GIS, wind farm transformers, transformers filled with new liquids, transformer subjected to overloads, shunt reactors.
- Determination of the hazard curve of failure and replacement for different transformer populations.

*A2.63 Transformer Impulse Testing – AP A2 member nominee is Arun Mathur (Wilson Transformers)*

The working group will focus on studying of transient phenomena and material properties and on accumulation of best practices for testing in order to establish the recommendations for IEC 60076-3 and IEC 60076-4 improvement.

Scope :

- Full wave lightning impulse test
  - Influence of front time and tail time, improving of IEC 60076-3.
  - Influence of overshoot on insulation stresses, applicability and improvement of k-factor.
  - Recommendations for IEC 60076-3 (modification related to k-factor and overshoot).
- Chopped wave lightning impulse test
  - Influence of undershoot, frequency of oscillation after chopping.
  - Testing the low voltage windings and providing the zero crossing after chopping.
  - Recommendations for IEC 60076-3.

- Switching impulse test
  - Avoiding of phase-to-phase insulation overstressing when testing phase-to-earth insulation.
- Non-standard waveforms and high-frequency overvoltages
  - Assessment of insulation stresses.
  - Evaluation of equivalent factory test (if necessary) and recommendations on factory test.
  - Investigation on real wave forms occurring in the field.
  - Recommendation for tests representatives of VFTO by studying the withstand of insulating materials to VFTO.
  - Impulse wave forms for HVDC transformers.
- Positive and negative polarities in impulse test
  - Influence of polarity on the insulation system.
  - Test instruction about the procedure with positive and negative polarity.
  - Advantages and risks with positive impulse test.
  - Influence of polarity on air clearances.
  - Recommendations for IEC 60076-3.
- Use of internal surge arresters
  - Considerations for the transformer reliability.
  - The effect on testing.
  - Consideration of insulation coordination and protective margins.

## 5. Specific Activities of the Australian Panel

Activities of the Australian A2 panel over the last 12 months have included:

- 2018 Annual A2 Meeting – the 2018 annual meeting was held in Adelaide on 1<sup>st</sup> and 2<sup>nd</sup> August. The second day was devoted to presentations and a technical tour where speakers delivered powerpoint presentations on topics of high interest to the Australian electrical industry.
- A2 Workshop – a one day workshop was hosted by AP A2 on 16<sup>th</sup> April. The workshop topic was “Transformers – Condition Assessment with a Focus on Bushings – an Interactive Workshop”. There were 6 speakers including 2 who were also members of the AP. Two speakers were specialists from the electrical industry, plus 2 from the insurance company FM Global. The day commenced with two CIGRE Tutorials followed by three presentations from a test equipment supplier, an insurance company and utility backgrounds. The presenters provided delegates with experience, guidance, advice and recommendations on how different stakeholders position themselves to address HV bushing risk in power transformers. Also refer to the separate event report.
- Representation at 2018 Paris Session was by AP A2 convener Ross Willoughby. Contributions included:
  - Attending technical and public SC A2 meetings
  - Giving keynote address on OEM expectations for site acceptance testing and trial operation to introduce PS 3 in the public session of SC A2.
  - Attended AG A2.04 (Utilization) and AG A2.06 (SC A2 green book) meetings
  - Convened the 4<sup>th</sup> meeting of WG A2.58. Prepared the WG poster for the poster session
  - Assisted the PS3 special reporter and contributed to finalising the Australian interventions for the PS3 special reporter questions.
  - Delivering the accepted Australian interventions in the SC A2 open meeting



AP A2 Members co-authored paper A2-302 “The Emerging Role of FRA as a Required Commissioning Test” - J. Tusek, R Willoughby, M Cotton. The poster for this paper was presented in the poster session by Ross Willoughby

- WG A2.58, convened by Ross Willoughby, continued its activities during 2018 with two meetings. A world-wide survey on current practices in site installation, site acceptance testing and trial operation was the key deliverable in 2018 and was capably managed by AP A2 corresponding member Matt Gibson.
- Again, many requests for observer access to the AU A2 Transformers space on the KMS were received in 2018. Nearly all have been rejected after first sending them a personalised email response. In many instances, requests have come from the staff of a Cigre Australia collective member and which already has an A2 panel representative. In those instances, the applicant was informed who their company representative is and asked not to bypass that role. The only observers approved on the AU A2 space are the ATC and ANC stakeholders that need the access for monitoring, together with the KMS coordinator Rod Hughes.

## 6. Meeting Report: Australian Panel

The most recent AP A2 meeting was co-hosted by ElectraNet and SA Power Networks and was held at the Stamford Plaza Hotel, Adelaide on 1<sup>st</sup> and 2<sup>nd</sup> August 2018. 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.

The convener discussed the Special Report for A2 as a precursor for the preparation of any contributions to the 2018 Paris session. Reports were also provided about the work of the Australian standards committee.

On the second day, presentations were given by an invited visitor, as well as local experts. Topics discussed in the 2<sup>nd</sup> day presentation session included:

- “Power Quality experiences in Germany” – Ingo Ziemke, invited visitor of MR
- “Emerging Network Issues” – George Bergholcs of ElectraNet
- “Transformer Fire Suppression System Selection” – Marko Prokic of ElectraNet
- “Experience with Terminal Boxes” – Andrew Wheatland of SA Power Networks
- “Response to Catastrophic Failures” – Andrew Wheatland of SA Power Networks

Visits to City West Substation (ElectraNet site) and SA power Networks’ Innovation Centre followed.

## 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. Report on AP Seminars/ Conferences

AP A2 hosted an interactive workshop in Sydney, in conjunction with Techcon Asia Pacific. The workshop was titled “Transformers – Condition Assessment with a Focus on Bushings – An Interactive Workshop”. The event was in Sydney at the Hilton Hotel on Monday 16 April, 2018, and was attended by 84 delegates and 6 speakers. The workshop was held in conjunction with Techcon Asia Pacific, which was held later at the same venue on the 17 and 18 April. The workshop operated using 4:3 format powerpoint presentations. The workshop had two parts, a morning session where speakers presented CIGRE tutorials or technical papers, followed, after lunch, by a panel session where speaker/experts 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 2018 CIGRE Event.

## 9. Proposed Activities

Another seminar, to be held in April 2019 in conjunction with Techcon Asia Pacific, is being planned. The proposed workshop title is “Transformers – Focus on Tapchangers – An Interactive Workshop”

The proposed topics are:

- OLTC types and application to different transformer design. Onerous applications – Kevin
- Voltage regulation, FAT Testing and service considerations
- ANZ failure statistical evaluation results (based on material from tap-changer course at TIC 2018)
- OLTC technology development over the last decades and what to come in the future – how far away is the maintenance free OLTC?
- Tapchanger failure modes listed and respective assessment criteria (based on work of WG A2.49 Tx Condition assessment)
- Reverse power flow and limitations by OLTC
- Service requirements of tapchangers
- OLTC testing (Wdg R and Dynamic Resistance)
- Silver sulphide issue for tapchangers
  - Formation on tapchanger silver contacts, both OLTC and DETC (photo examples of Ag<sub>2</sub>S deposits and tapchanger failure examples)
  - How can presence of silver sulphide be detected or suspected?
  - Formation of corrosive sulphur and impacts on transformer components, sulphide detection and solutions to deal with corrosive sulphide

The next panel meeting will be convened in Sydney on April 2, immediately before the 3-5 April 2019 Cigre/TechCon Conference, also in Sydney. This will minimise travel expenses for 2019, facilitate preparation of material for the Colloquium in November 2019 and also increase the likely attendance and involvement of the A2 panel membership in the Cigre Transformer Workshop held on April 3. The panel meeting will be hosted by TransGrid and/or Ausgrid.

## 10. ANC Members on Working Groups

The following are all the current AP representatives on Working Groups. I have also listed CIGRE Australia members if they are not actually AP A2 representatives.

WG	Title	Australian or NZ Member
A2.43	Bushing Reliability	Jonathon Brown (NZ)
A2/D1.46	Field Experience with Transformer Solid Insulation Ageing Markers	Joe Tusek
A2.49	Transformer Condition Assessment	Peter Cole (Convener) Ross Willoughby Chris Beckett NGN (editorial) Tara-Lee Macarthur NGN (editorial)
A2/D1.51	Improvement to Partial Discharge Measurements for Factory and Site Acceptance Tests of Power Transformers	Jose Lopez-Roldan, Dan Martin, John Tonkin, Joe Tusek
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
A2.54	Power Transformer Audible Noise Requirements	Nil
A2.55	Transformer Life Extension	Ross Willoughby (observer)
A2.56	Power Transformer Efficiency	Rob Milledge (corresponding)



WG	Title	Australian or NZ Member
A2.57	Effects of DC Bias on Power Transformers	Nil
A2.58	Installation and Pre-Commissioning of Transformers and Shunt Reactors	Ross Willoughby (Convener) Rafik Shenouda (corresponding) 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	Yuriy Odarenko (nominee)
A2.61	On-load Tapchanger Best Practice	TBA
A2.62	Analysis of Transformer Reliability	Dan Martin (nominee)
A2.63	Transformer Impulse Testing	Arun Mathur (nominee)

## 11. Membership of the Australian Panel

Name	Organisation	Type
Nick Blakeney	Individual	Individual
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
Tara-Lee Macarthur	Energy Queensland	Distribution
Rob Milledge	ABB Australia Pty Limited	Manufacturer
Peter New	Snowy Hydro	Generator
Shawn Nielsen	Queensland University of Technology	University
Phil Onions	Stanwell Corporation Ltd	Generator
Mohinder Pannu	Wilson Transformer Co. Pty Ltd	Manufacturer
Mark Pritchard	SA Power Networks	Distribution
Marko Prokic	ElectraNet	Transmission
Tapan Saha	University of Queensland	University
Thomas Smolka	Reinhausen Australia	Manufacturer
Gregory Spence	TransGrid	Transmission
Tri Van Tran	AGL	Generator
Joe Tusek	Ampcontrol ETM	Contractor
Walter Wasinger	Wasinger Transformer P/L	Consultant
Kerry Williams	K-BIK Power Pty Ltd	Consultant
Ross Willoughby	GE Grid Australia Pty Ltd	Manufacturer / Contractor



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

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

## AP 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 A3.30 Substation equipment overstresses.

In addition to classical, condition based, end of life considerations, a specific aspect of lifetime management is the possibility that, during its operational lifetime, equipment becomes subject to system conditions which exceed its (proven) capabilities; often termed (potential) overstressing. The proposed Working Group will review this aspect concerning end of life decision making as it applies to high voltage substation equipment. The brochure is expected to be published in 2019.

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

The use of digital output for ITs (magnetic or electronic) requires development & adaptation of the accuracy testing procedures and the development of appropriate methods for in factory and on-site calibration which may become more frequent with the deregulation of electric power companies. The redundancy of various equipment and links will also need to be considered to achieve the high reliability and availability levels required for a modern electrical network. This accuracy testing & calibration activity is the main focus of this Working Group. The brochure is expected to be published in 2019.

- WG A3.35      Commissioning and Operation of Controlled Switching Projects
- 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. This guide will reflect the recent field experience with CSS including pitfalls to avoid. The draft brochure is currently being reviewed with expected issue by the end of 2018.
- 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 SF<sub>6</sub> devices (HV) separately. The draft TB is scheduled to complete 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 SF<sub>6</sub> free switching equipment.
- This working group will collect available interrupting and switching performance data with different SF<sub>6</sub> free gas alternatives, and evaluate the expected lifetime and consider long term stability and impact on the maintenance works related to switching. It will review the advantages and disadvantages of all SF<sub>6</sub> free solutions in comparison with the state of the art solution based on SF<sub>6</sub>. The final brochure will provide a guideline to utilities to keep in mind which factors when they use SF<sub>6</sub> 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 utilities' policy with respect to life management, sub-population replacement, inspection and diagnostics, reporting, risk assessment and specifications. It will analyse the failures, simulation of results and determine the most probable root causes, and recommend specific requirements for IT's, additional type and routine tests and advanced diagnostic techniques. The final report is due in 2021.

### 3. Preferential Subjects

The proposed preferential subjects for the 2019 SC A3 & B3 Colloquium in Bucharest, Romania are:

- PS1 – Lifetime Management of increasing ageing transmission and distribution assets.
- PS2 – New challenges including monitoring and diagnostics of substation and equipment for future T&D networks.
- PS3 – Impact of rapid penetration of renewable energy of substations and equipment.
- PS4 – Application of information technology tools for development & management of substation equipment.

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

- Development of Transmission and Distribution equipment
- Lifetime management of Transmission and Distribution equipment
- Impact on Transmission and Distribution equipment under the introduction of renewables, distributed generation and storage

### 4. Proposed New Working Groups

During the A3 Study Committee meeting in Winnipeg in October 2017, the following proposal were put forward as possibilities for new working group topics to be developed further:-

- 2014-2017 Equipment Reliability Survey
- Identification of frequency response characteristics of conventional and non-conventional voltage instrument transformers
- Limitations in Operation of High Voltage Equipment resulting of Frequent Temporary Overvoltages
- Procurement, quality control and commissioning of equipment
- Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems

### 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:

- **SF<sub>6</sub> gas management** – Provide practical information on design factors which contribute to SF<sub>6</sub> leakage for high voltage equipment from a practical experience perspective. Provide information on techniques to detect SF<sub>6</sub> 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 Romania (2019) and India (2021). 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
A3.35	Commissioning and Operation of Controlled Switching Projects	Jose Lopez-Roldan
A3.42	Failure analysis of recent AIS Instrument Transformer Incidents	Wayne Pepper

## 8. Membership of the Australian Panel

Name	Organisation	Type
Nandana Boteju	AusNet Services, VIC	Transmission & Distribution
Kasun Fernando	Transgrid, NSW	Transmission
Vinay Krishnamurthy	EPC International, VIC	Vendor
David Kruijver	TasNetworks, TAS	Transmission & Distribution
Ankur Maheshwari	Western Power, WA	Transmission & Distribution
Wayne Pepper (convenor)	Ausgrid, NSW	Distribution
David Pita	Powerlink, QLD	Transmission
Matthew Ridgely	Ergon Energy, 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](mailto:wpepper@ausgrid.com.au)  
**Phone:** 0408 667 076

## AP 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 Paris in August as part of the 2018 Session. All the active Working Groups met in Paris as well.

The SC continues to focus on its two technological fields of activity while beginning to incorporate the distribution, medium voltage, systems 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 500 experts within the B1 community and hosts 28 active working groups, 7 of those being JWG's.

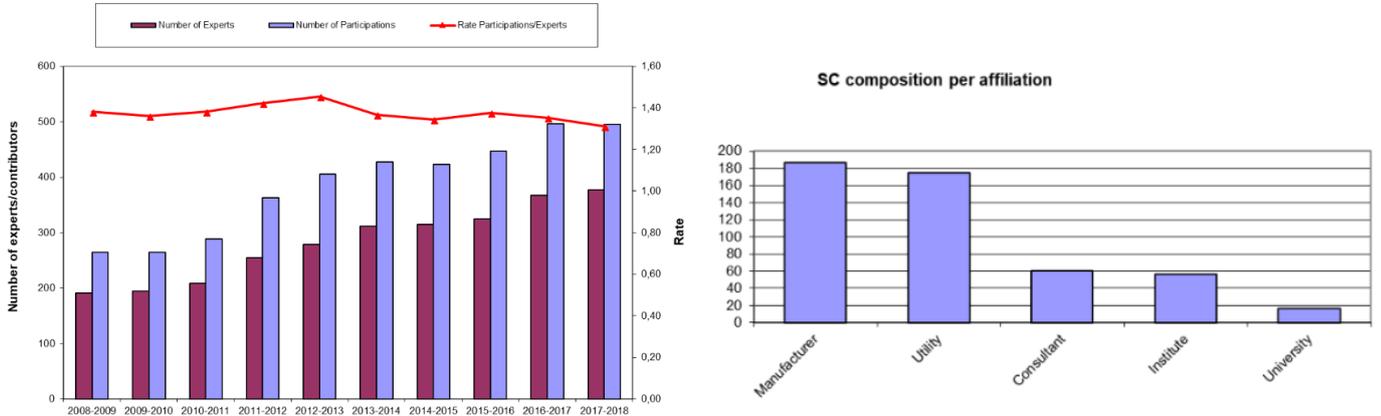
Overall SC B1 activities are extremely well attended with:

- Over 100 members and delegates and invited experts attended the SCB1 meeting in Paris
- Over 300 delegates attending the tutorial on Fault location on land and submarine cables
- Over 400 people attending the day long General Discussion meeting

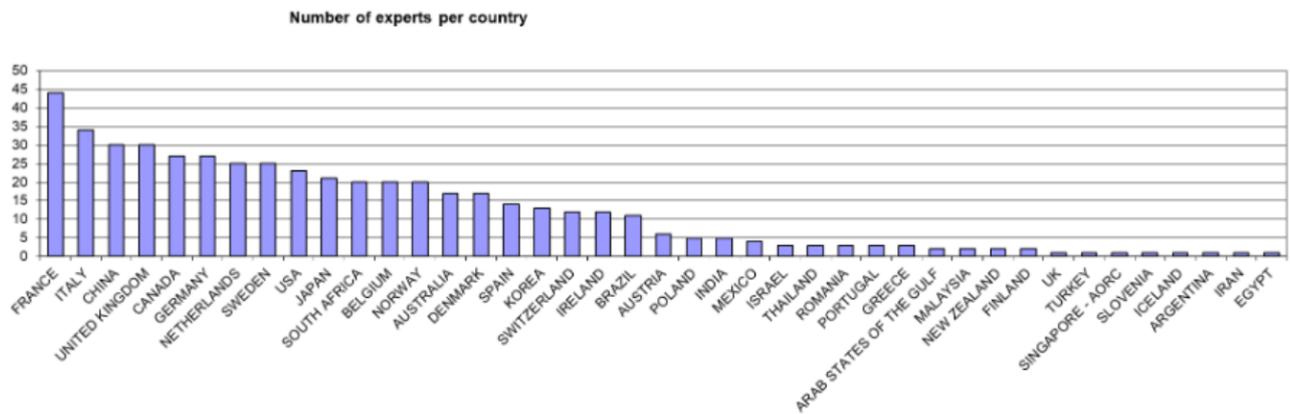
In October 2018 we learnt of the passing of Eugene Bergin, a personal, long-time friend of many in the SC. Eugene was an expert recognized worldwide for his knowledge and judgement about cables and also utility systems in general. As a professional he was beyond reproach. But he also was a most enjoyable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

#### 4. Study Committee Statistics

The participation and number of experts continues to rise and the composition of the community is healthy



While the number of experts from Australia still remains strong, the number reflects Australia’s participation in the SC and WGs and TFs. The APB1 is constantly seeking people who are willing to get involved.



#### 5. Preferential Subjects

The preferential subjects agreed for 2020 are:

**PS 1: Cables for future power systems**

- Innovative cables and systems
- Big Data and Industry 4.0: prospective impacts on cable life cycle
- 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

*Note after the SC meeting : the TC has asked to reverse the order of the sentence “Big Data and Industry 4.0: prospective impacts on cable life-cycle” to avoid focus on IT technologies and any conflicts with SC D2*

## 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 2017, the SC published

- Tutorial : Long term performance of soil and backfill systems
- Tutorial : Fault location on HVAC and HVDC land and Submarine links
- Technical Brochure : Onshore generation cable connections
- Technical Brochure & Tutorial : Implementation of Long AC HV & EHV Cable System

During 2018, the SC will publish

- Technical Brochure & Tutorial : On site PD assessments of HV and EHV cable systems
- Technical Brochure & Tutorial : Fire issues for insulated cables installed in air
- Technical Brochure & Tutorial : Recommendations for additional testing for submarine cables 6-60 kV

## 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 B1.65	Installation of offshore Cable System	Soren Krüger Olsen (DK)
WG B1.67	Loading pattern on cables connected to windfarms	Volker Werle (DE)
WG B1.68	Condition evaluation and lifetime strategy	Jacco Smit (NL)
WG B1.69	Recommendations for the insulation coordination on AC cable systems	Thinus Du Plessis (ZA)
WG B1.70	Recommendations for the use and the testing of optical fibres in submarine cable systems	Roman Svoma (GB)
WG B1.71	Guidelines for safety risk management in cable system	Julio Lopes (BR)
WG B1.72	Cable ratings verification (2 <sup>nd</sup> part)	Frank de Wild (NL)
<b>New Task Forces</b>		
TF B1.73	Recommendations for the use and the testing of optical fibres in land cable systems	Alexandra Burgos (SP)
TF B1.74	Recommendations for a performance standard of insulated busbars	Pierre Mirebeau (FR)

## 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) AP 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.

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

## 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.

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 AP members are shown below.

Working Group	Title	AU / NZ Representative
WG B1:44	Guidelines for safe work on cable systems under induced voltages or currents	George Bucea
WG B1:48	Trenchless Technologies	Henry Kent
JWG B1/B3:49	Standard design of a common, dry type plug-in interface for GIS	Peter Robinson
WG B1:50	Sheath Voltage Limiters and Bonding Systems (Design, Testing, Operation and Monitoring)	George Bucea
WG B1:51	Fire issues for insulated cables installed in air	Richard Joyce
WG B1:54	Behaviour of cable systems under large disturbances (earthquake, storm, flood, fire, landslide, climate change)	Richard Joyce Russell Wheatland
WG 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)	Ken Barber
WG B1:57	Update of service experience of HV underground and submarine cable systems	John Lansley
WG B1:58	Asset Management in MV Cables Networks	Dong Chur Lee
WG B1:60	Maintenance of HV Cable Systems	Joska Ferencz
WG B1:61	Installation of HV Cable Systems	Peter Robinson
WG B1.67	Loading pattern on cables connected to windfarms	Kerry Prickett
WG B1.68	Condition evaluation and lifetime strategy	Rob Bradley
WG B1:69	Recommendations for the insulation coordination on AC cable systems	Tony Auditore
WG B1.71	Guidelines for safety risk management in cable system	Carmelo Noel
<b>New Task Forces</b>	<b>New Task Forces</b>	
TF B1.73	Recommendations for the use and the testing of optical fibres in land cable systems	Graeme Barnewall

## 11. Membership of the Australian Panel

Name		Position	Organisation	Type
Russell	Wheatland	Convener	AusNet Services	Utility
Peter	Robinson	Secretary	Cable Systems Engineering	Consultant
Ken	Barber	Representative	Istanapark P/L	Consultant
Graeme	Barnewall	Representative	Essential Energy	Utility
Evan	Bayliss	Representative	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
Joska	Ferencz	Representative	Basslink	Asset Owner
Richard	Joyce	Representative	Transpower	Utility
Seong Woo	Ju	Representative	Taihan	Manufacturer
Henry	Kent	Representative	Energy Action	Consultant
John	Lansley	Representative	Energy Queensland	Utility
Dong-Churl	Lee	Representative	Select Solutions	Service Provider
James	Lyll	Representative	Retired	Academia
Albert	Majadire	Representative	Prysmian Group	Manufacturer
Carmelo	Noel	Representative	Energy Queensland	Utility
David	Paul	Representative	Vector Ltd.	Utility
Colin	Peacock	Representative	SA Power Networks	Consultant
David	Pearce	Representative		Utility
Tim	Popkiss	Representative		Intertech Engineering
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



## AP B2 Overhead Lines

### 1. Study Committee Scope

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

### 2. Specific Activities of the Study Committee

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

- Strategic Advisory Group (SAG) reviews SC performance and develops strategy for future direction of the SC; reviews/endorsees 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 2018 are:

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

SC Activities in 2018 include

- Paris Convention; B2 tutorial "Experiences with non-conventional (High Temperature Low Sag) Conductor".
- SC meeting: Strategic plan reviewed; ToR evaluated; WG Progress Reports; Preferential subjects proposed
- 3 new WG's established



- 9 new ToR under consideration (including two proposed by the AP).
- 3 new proposals for WG being prepared by TAG07 including one initiated by 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
B2.69	Coatings for Power Network Equipment	Masoud Farzaneh (Canada)	Corrosion mitigation, noise/pollution reduction
B2.70	Aerial Warning Markers	Naji Sahlani (USA)	Develop industry guidelines for design of materials and installation on OHL
B2.71 (tbc)	Interphase spacers	Jean-Philippe Paradis (CA)	Provide guidelines for selection & specification of Interphase spacers
ToR TAG07	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.
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 TAG07	UAV's for power line inspections	Nishal Mahotho (South Africa) tbc	Survey industry practice and provide guidelines (technical, safety, environmental, legal and economic) for use of UAVs on overhead distribution networks
ToR TAG07	MV Conductors	Bruce McLaren (South Africa) tbc	Survey industry practice and provide guidelines for selection & use of MV covered conductors
ToR TAG07	LV conductors	Andreas Beutel (South Africa) tbc	Survey industry practice and provide guidelines for selection & use of LV conductors
ToR TAG05	Foundations for Difficult Soils	tbc	Survey industry practice and provide guidelines for selection of appropriate footing systems.
ToR	Condition Monitoring in remote sites	Lin Yang (China) tbc	Review all available (CM) devices suitable for the power lines in uninhabited areas. Provide



TAG07			guidelines for design, selection, operation, tests, acceptance, & wide-area detection of CM devices.
ToR TAG04	Lightning Performance & Grounding of OHL	tbc	Review effects of lightning and provide design guidelines
TAG05/07 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

## 5. Australian Panel Activities Report

### i) General

Year 2018 Panel activities include:

- Annual Panel Meeting & “Asset Management” case studies from members
- Planning for proposed 1 day seminar linked with 2019 Sydney panel meeting
- 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: Hobart 2018

- 1x day for CIGRE SC, TAG & WG reports; AORC report
- 1x day for technical presentations and local case studies including presentations by NGN members and other invited guests.

### iii) 1-day Technical Seminar: Sydney 2019

- Preliminary planning for proposed 1 day B2 seminar.

### iv) Future Activities: Australian Panel - 2019

- Panel meeting, Sept, Sydney
- Proposed B2 technical seminar linked with panel meeting, Sept, Sydney
- Proposed B2/B1 joint panel meeting Sydney

### v) Future Activities: SCB2 & International Symposiums

- SCB2 - 2018 August, Paris
- 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. Invitations for SC or WG’s to meet in Australia

Notification issued to B2 chairman of intention to invite SC to Cairns in 2023.



It is unlikely the SCB2 will accept. This is partly due to the strategy to support a proposal from China NC for a symposium in the near future that will compete with the Cairns bid.

## 7. ANC Members on Working Groups

Active WG and current AP representatives.

<b>WG</b>	<b>Title</b>	<b>Australian Member</b>
WG23	Geotechnical and structural design of the foundations of HV & UHV Lines, application to the updating to the refurbishment and upgrading guide	CM: Graeme Paterson
WG24	QUALIFICATION OF HV AND UHV OVERHEAD LINE SUPPORTS UNDER STATIC AND DYNAMIC LOADS	CM: Elias Elkhoury
WG40	Calculations of the electrical distances between live parts and obstacles for OHL	Convenor: Rob Lake
WG45	Bushfire characteristics and potential impacts on Overhead Line Performance	WG: Francis Lirios
WG50	Safe handling of fittings and conductors	Convenor: Peter Dulhunty
WG52	The use of robotic in assessment and maintenance of OHL	CM: Francis Lirios
WG55	Conductors for the Uprating of Existing Overhead Lines	CM: Glenn Ford
WG56	Ground Potential Rise at Overhead AC Transmission Line Structures during Faults	CM: Charles Crew
WG57	Survey of operational Composite Insulator Experience and Application Guide for Composite Insulators	CM: Steve Redhead
WG58	Vibration Modelling of High Temperature Low Sag Conductors - self damping characterization	CM: Jack Roughan
WG59	WG B2.59 Forecasting Dynamic Line Ratings	WGM: Michael Lee
WG60	Affordable Overhead Transmission Lines for Sub-Saharan Countries	CM: Elias Elkoury
WG61	Transmission Line Structures with Fibre Reinforced Polymer (FRP) Composites	WGM: Francis Lirios
WG62	Design of Compact HVDC Overhead Lines	CM: Asif Bhangor
WG63	Compact AC Transmission Lines	CM: David Morato
WG64	Inspection and Testing of Equipment and Training for Live-Line Work on OHL	CM: Simon Leitch; WGM: Alex Price
WG65	Detection, Prevention and Repair of Sub-surface Corrosion in OHL Supports, Anchors and Foundations	CM: Elias Elkhoury
WG66	Safe handling and installation guide for high temperature low sag conductors	CM: Michael Wilson
WG67	Assessment and testing of wood and alternative material type poles	Convenor: Ahsan Siddique Secretary: Nathan Spencer
WG68	Sustainability of Conductor & Fittings	WGM: G Brennan, J McCormack, P Dulhunty CM: Andrew Taylor
WG69	Coatings for Power Network Equipment	tbc
WG70	Aerial Warning Markers	CM: Jack Roughan
WGxx	Interphase spacers	tbc

## 8. Membership of the Australian Panel



<b>Name</b>	<b>Group Role</b>	<b>Company</b>	<b>Type</b>
John MCCORMACK	owner	ElectraNet	Transmission
Frank Yeo	Secretary (NGN)	APD	Transmission
Ken Barber	Specialist / B1 representative	Nancable	Consultant
Asif BHANGOR	representative	Jacobs	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	representative	TransGrid	Transmission
David MATE	representative	Endeavour Energy	Transmission/ Distribution
Brent MCKILLOP	representative	TasNetworks	Transmission/ Distribution
Michael Murtagh	representative	NT Power & Water	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
Morgan Williams	representative	Entura	Consultant
Michael Wilson	specialist	Transpower NZ	Transmission
Philip DULHUNTY	specialist	Dulhunty Poles Pty Ltd	
Henry HAWES	specialist		

## 9. Other Business



1. John McCormack appointed TAG07 convenor.
2. APB2 members attending Paris 2018 include
  - Asif Bhangor (1<sup>st</sup> event attended)
  - Nathan Spencer (1<sup>st</sup> event attended; chaired WG 67)
  - Peter Dulhunty.
3. A proposal was put to the SAG for improving timeliness for dissemination of new learnings by directing that a summary paper or tutorial be presented within 18 months of initiation of the WG. The proposal was rejected on the basis that the key deliverable of a WG was the TB. This has been re-routed via the ANC.
4. **APB2 Convenors/sponsored members**

<b>WG</b>	<b>Active Convenor/ Sponsored member Nominee</b>	<b>Comment</b>
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	Ahsan Siddique	WG target completion 2021; continued sponsorship recommended.
ToR under review Risk	Asif Bhangor (Nominee)	Planned start 2019. ToR initiated by APB2; potentially need an AP convenor
ToR under review OHL & fires	Peter Dulhunty (Nominee)	Planned start 2019. ToR initiated by APB2; potentially need an AP convenor
TAG07 Proposal: Asset Management	Francis Lirios	Planned start 2020. Proposal to be prepared by APB2; potentially need an AP convenor

**Convenor:** John McCormack  
**Email:** [mccormack.john@electranet.com.au](mailto:mccormack.john@electranet.com.au)  
**Phone:** 0418 400 866



### Appendix A: Recent and Pending Publications

WG	Title	Status	Ref.
B2.23	Geotechnical and structural design of the foundations of HV & UHV Lines,	Final draft in preparation 2018	
B2.24	Qualification of HV and UHV Overhead Line Supports under static and dynamic Loads	Final draft in preparation 2018	
B2.40	Calculations of the electrical distances between live parts and obstacles for OHL	Final draft in preparation 2018	
B2.44	Coatings for protecting overhead power network equipment in winter conditions	Published 2015	TB 631
B2.45	Bushfire characteristics and potential impacts on Overhead Line Performance	Issue for final review 2018	
B2.47	Guide for repair of conductors & conductor fitting systems	Published 2017	TB 708
B2.48	Experience with non-conventional conductor	Published 2017	TB 695
B2.50	Safe handling of fittings and conductors	Issue for final review 2018	
B2.51	Methods for optimized design of overhead transmission lines	Published 2016	TB 638
B2.52	The use of robotic in assessment and maintenance of OH	Published 2018	TB 731
B2.53	Management guidelines for outsourcing OHTL technical expertise	Issue for Publication 2018	
B2.55	Conductors for the Uprating of Existing Overhead Line	Under Review 2017	
B2.56	Ground Potential Rise at Overhead AC Transmission Line Structures during Faults	Published 2018	TB 694
JWG C3/ B1/B2.13	Environmental Issues for Transmission Lines in Rural & Urban Areas	Issue for final review 2018	
	Calculation accuracy of high-temperature sag for ACSR in existing lines	Published June 2017	CSE 7
	Efficient Computation and Experimental Validation of ACSR OHL Conductors under Tension and Bending	Published October 2017	CSE 9



## AP B3 Substations and Electrical Installations

### 1. Study Committee Scope

#### Our Mission

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

#### Scope of SC B3

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

### 2. SC Activities in 2018 Include

- 7 Working Group (WG) Meetings:
- SF6 Green Book on Sat - Sun Aug 25-26
- B3 Annual Study Committee Meeting, 40 countries represented.
- B3 Poster Session, 35 posters displayed : 484 visitors
- B3 Tutorial “Low-Cost Substations in Developing Countries” :206 registered attendees
- B3 Discussion Meeting: 568 attendees, 56 prepared, plus 89 spontaneous contributions
- The AP.B3 had 7 contributions to the Special Report
- B3 Workshop “Safe Working in Substations” : 70 attendees
- AP. B3 Substation Conference – Hunter Valley Nov-Dec 2019
- Chairing IEEE Power and Energy Society in Victoria
- Contribution to IEEE standards

### 3. Preferential Subjects

PS1: Advances in substation technology and design

- GIS and GIL developments including HVDC
- Adapting substations to meet emerging power system requirements and optimised availability including modular, fast deployment substations and live working
- Changing roles and opportunities for substations including challenges for Medium Voltage and integration of storage systems

PS2: Evolution in substation management

- Advanced technologies for substation management, new information technologies, robotics and the application of 3D techniques
- Risk quantification and optimised asset decision-making, substation economics, maintenance management and life cycle management
- Substation asset performance, residual life, health and condition metrics
- Operations and maintenance of offshore substations

PS3: Health, Safety, Environmental and Quality Assurance considerations in substations

- Customer and stakeholder interaction to reduce substation impact including aesthetics, noise and fire management
- Design for safety, eco-design / recycling and product development



- Physical and cyber-security considerations for substations
- Managing the implementation of health, safety and environmental requirements for substations, including training

#### 4. 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: Robert Li, Dan Tang, Michael Verrier, Kerry Williams
- 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

##### Australian Contributions to WG.B3

Adams	Bob	Full Member	M	WG B3.43	B3	Australia
Addison	Gabriel	Young Member	M	WG B3.43	B3	Australia
Arora	Nipun	Young Member	M	WG B3.43	B3	Australia
Carman	Bill	Convener	M	WG B3.35	B3	Australia
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
Dantalis	James	Corresponding	M	WG B3.47	B3	Australia
KLEPAC	Angela	Full Member	F	WG B3.38	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



<b>Lee</b>	Terry	Full Member	M	WG.B53	B3	Australia
<b>LI</b>	Yi	Corresponding	M	WG B3.47	B3	Australia
<b>LOPEZ-ROLDAN</b>	Jose	Full Member	M	WG B3.24	B3	Australia
<b>Margitich</b>	Todd	Full Member	M			
<b>MCCORMACK</b>	John	Corresponding	M	WG B3.39	B3	Australia
<b>Palmer</b>	Stephen	Secretary	M	WG B3.35	B3	Australia
<b>Palmer</b>	Stephen	Convener	M	WG B3.35	B3	Australia
<b>Perkins</b>	Derek	Corresponding	M	WG.B3.53	B3	Australia
<b>QUACH</b>	Minh	Corresponding	M	WG B3.39	B3	Australia
<b>RAYAPROLU</b>	Ram	Corresponding	M	WG B3.39	B3	Australia
<b>Ridgley</b>	Matthew	Corresponding	M	WG B3.42	B3	Australia
<b>Tonking</b>	Peregrine	Convener	M	WG B3.43	B3	Australia
<b>Tonking</b>	Peregrine	Corresponding	M	WG B3.46	B3	Australia
<b>Verrier</b>	Michael	Corresponding	M	WG B3.48	B3	Australia
<b>Verrier</b>	Michael	Member	M	WG.B3.53	B3	Australia

## 5. Australian Panel

### Activities Report Year

#### 2018 Panel Activities

##### Include:

- Two days annual meeting held in Sydney
- Seven Paris contributions to the Special Report
- 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

##### Future Activities: Australian Panel – 2019

- Proposal for a Substation Conference to be held in Hunter Valley – date to be locked in shortly
- The topic of the conference to be: Connection of the Renewables to the Existing Infrastructure
- One day workshop on Designing a Battery Storage principles
- One day of Down to Earth – Earthing Seminar
- One day annual meeting AP.B3

##### Future Activities: SCB2 & International Symposiums

- 2019 Symposium in Chengdu, China - with C6; and also B5, C1, C3, and D2
- 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

**6. Membership of the Australian Panel**

There are 32 members and 3 pending for assessment.

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

**Convener:** Crina-Miana Costan Principal Primary Design Engineer at CPP and Design Manager at ElectraNet

**Email:** [ccostan@conpower.com.au](mailto:ccostan@conpower.com.au) ; [costan.crina@electranet.com.au](mailto:costan.crina@electranet.com.au)

**Phone:** 0407970295

## **AP B4 DC and Power Electronics panel name**

### **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:

- CIGRE Paris 2018
  - B4 Poster Session – Monday 27 August
  - Technical Session – Tuesday 28 August
  - Study Committee Meeting – Friday 31 August 2018
  - B4 & CENELEC Workshop: “System aspects of HVDC grids” on Wednesday 29 August; and
  - A3 & B 4 Workshop: “DC circuit breakers” on Thursday 30 August.
- 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 2015-2016 are currently being collated for publication in Paris next year (2018).
- Performance of SVC/STATCOM - The collation of data and analysis of performance of FACTS devices, particularly SVCs and STATCOMs is underway.
- FACTS Green Book – The Study Committee is preparing a text-book on Flexible AC Transmission Devices (FACTS). The work is in progress.
- 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. Country representatives are asked to drive provision of the information for HVDC systems within their country.

### **3. Preferential Subjects**

Preferential subjects selected by the Study Committee for the future Paris Session and/or other Study Committee events.

The 2019 SC B4 Colloquium will be held between 28 September and 5 October on Johannesburg, South Africa. For this Colloquium, papers are invited related to the application of HVDC and FACTS for planning, technology, projects and operational experience with focus on the following subjects:

- Network stability
- Renewable energy

- Regional interconnections
- LVDC and MVDC distribution and microgrids
- Distributed FACTS devices
- Impact of renewable energy/changes in transmission patterns
- Inverter based energy storage technologies
- Synthetic inertia
- Economic solutions for tapping small power from HVDC lines
- Refurbishment and upgrades of HVDC and FACTS installations

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**

Two new working groups have been created during 2018:

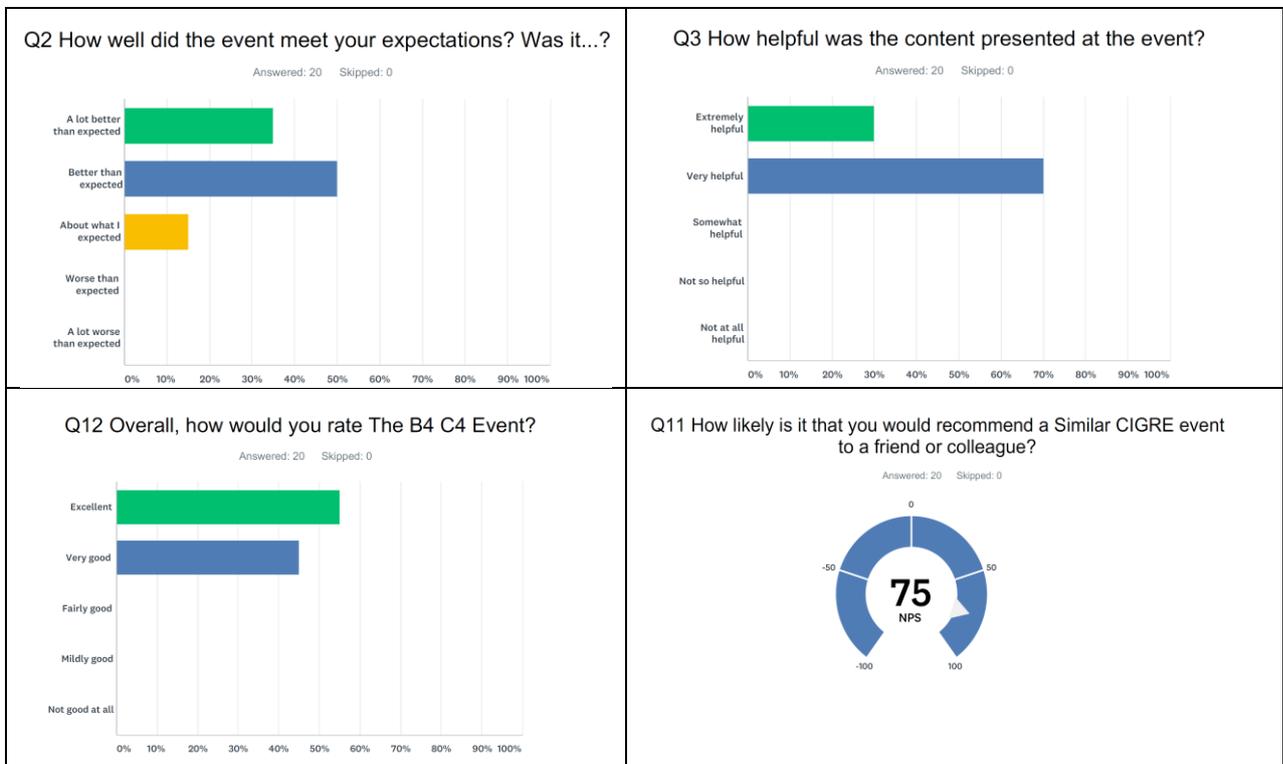
- JWG C6/B4.37 – “Medium Voltage DC distribution systems”
  - Two APB4 panel members are regular members of this working group;
  - High relevance to Australia - Opportunities for the application of Medium Voltage DC (MVDC) concepts within the Australia-Pacific region, including the connection of remote islands and potential for MW long distance supply to rural areas.
- B4.79 - Hybrid LCC/VSC HVDC Systems
  - Seeking ways to combine the two technologies to leverage of the relative merits of each.
  - Particularly important to balance the economics of HVDC systems against the technical challenges currently being experienced in AC transmission networks worldwide, including lack of inertia and weakening of networks.
- The APB4 convenor (Les Brand) has proposed two key working group activities to the Study Committee:

- a working group to develop guidelines for the operation and maintenance of HVDC systems. This has received support within the Study Committee, however there is an action to perform a gap analysis against the relevant IEC standard and to develop a TOR for Study Committee approval.
- Update of TB97 – Commissioning of LCC HVDC Systems – After the issue of the recent technical brochure on commissioning VSC systems, it was suggested that the document for LCC systems (created in 1997) be revised and updated to bring it in line with the VSC one. Les Brand from Australia has taken an action to investigate the need and develop a TOR.

## 5. Specific Activities of the Australian Panel

Activities of the Australian B4 panel over the last 12 months have included:

- B4/C4 Seminar – B4 and C4 joined forces to deliver a seminar on 9 and 10 November 2017 on the topic “The impact of power electronics on network performance and capability”. There was significant interest in the event and a greater than expected attendance. The seminar received excellent feedback through the post-seminar online survey, with some examples of the outcomes shown below.



- 2017 Annual B4 Meeting – the 2017 annual meeting was held in Brisbane immediately prior to the B4/C4 Seminar, on 8 November 2017.
- 2018 Annual B4 Meeting – the 2018 annual meeting is scheduled to be held in Melbourne on 12 and 13 November 2018.
- The APB4 Convenor has been assigned the task by the Study Committee to create and prepare a “Common Terminology and Symbols” document for Voltage Source Converter (VSC) HVDC technology. The intent is for this document to be referenced by all future technical brochures related to VSC HVDC technology and avoid the need to have each TB provide its own introductory chapters and definitions. The document will include basic descriptions of VSC technology, topology and configurations.

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

There are no current invitations for SC B4 study committee meetings or working group meetings to be held in Australia.

## 7. ANC Members on Working Groups

The following are all the current AP representatives on SCB4 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
Green Book	FACTS	Babak Badrzadeh

## 8. 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
Gerard Ledwich	Queensland University of Technology	University
Angelo Iacono	Siemens	Vendor
Michael Dalzell	Transpower, New Zealand	Transmission
Stuart Dodds	APA Group	Transmission
Marian Piekutowski	Hydro Tasmania	Generation
Yau Chow	Western Power	Transmission / Distribution
Georgios Konstantinou	University of NSW	University
Nadesan Pushparaj	AEMO	Market Operator

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

## AP 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 2018 Paris session

- PS1 - Protection under System Emergency Conditions
- PS2 - User Experience and Current Practice with IEC 61850 Process Bus

25 B5 Working Groups are active

### 3. Preferential Subjects

#### Preferential Subjects 2019 Tromsø Norway

1. Time in Protection Applications –Time Sources and Distribution Methods
2. Leveraging PMU Data for Better System Protection
3. Future technologies for inter-substation communication
  - Migrating Digital Teleprotection Channels to Packet-Based Networks

#### Preferential Subjects 2020 Paris France

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

### 4. Proposed New Working Groups

During the Paris 2018 session three new working groups were proposed:

1. Experience feedback and Recommendation for implementation of process bus in PACS
2. Optimisation of the IEC 61850 PACS engineering process and tools/ Challenges and Best Practices for Managing PACS Configuration Software
3. Methods of Evaluating and Comparing Reliability of PACS Architectures/ Guide for reliability calculation and specification for PACS functions and architecture

During 2018 the following Australian corresponding members were accepted for the following recently created working groups:

B5.62	Life Cycle Testing of Synchrophasor Based Systems used for Protection, Monitoring and Control	Ritesh Bharat (C)
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B5.65	Enhancing Protection System Performance by Optimising the Response of Inverter-Based Sources	Leonardo Torelli (C)
B5.66	Cyber Security Requirements for PACS and the resilience of PAC architectures	David Taddeo (C)
B5.67	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods	Benjamin Haines (C)

## 5. Specific Activities of the Australian Panel

The 2018 Australian Panel B5 meeting was hosted by Transpower in Christchurch with 21 members (3 were substituted) and various guests in attendance.

The following presentations were given.

Satendra Bhola	TasNetworks	TasNetwork's Adaptive UFLS
Terry Foxcroft	Snowy Hydro	Snowy 2.0 Generation Update
Khang Dang	Western Power	MMS control scheme using Wide Area Network
Shane Kerr	PSC Consultants	CT saturation investigations result
Kevin Hinkley	Transgrid	Transgrid first digital substation commissioning
Marino Pallotta	Electranet	South Australian Energy Transformation Plans
Peter Bishop	Transpower	NZ Energy Futures

Plans were discussed for the South East Asia Protection & Automation Conference (SEAPAC) conference in Sydney on 19-20 March 2019.

All Special Reporters' Questions for Paris 2018 were reviewed. Fourteen contributions were prepared with assistance from Transgrid, Western Power, Electranet, Snowy Hydro and Rod Hughes consulting.

After the panel meeting a technical tour was conducted to a distribution substation that was redeveloped after the 2011 Christchurch earthquake. Copper cabling was minimised with extensive use of fibre between merging units at the primary equipment and the protection relays in the relay room.

The next Australian panel meeting is planned to be hosted by Snowy Hydro at Khancoban NSW in May 2019.

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

The Cigre Australia 2023 Cairns Symposium proposal was tabled and circulated at Paris 2018 SC B5 meeting. Interest was shown by the SC B5 chairman and secretary, but it was too early to make a decision.

## 7. ANC Members on Working Groups

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

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
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

## 8. Membership of the Australian Panel

Name	Organisation	Type
D Harper	AECOM NZ	Consultant
K Ward	BECA NZ	Consultant
R Hughes	Rod Hughes Consulting	Consultant
P Blanchfield	Jacobs Australia	Consultant
D Collins	Tesla Consultants NZ	Consultant

G.Munting	Entura	Consultant
S Kerr	PSC	Consultants
R Johnston	Essential Energy	Distribution
D Dwyer	Energex	Distribution
B.Haines	Ausgrid	Distribution
R Coggan	Ergon Energy	Distribution
M Doherty	SA Power Networks	Distribution
M Browne	Endeavour Energy	Distribution
R Anegondy	Actew AGL	Distribution
R Simpkin	United Energy	Distribution
T Foxcroft	Snowy Hydro	Generation
M Pallotta	ElectraNet	Transmission
B Capstaff	Powerlink Queensland	Transmission
M Sokolowski	AusNet Services	Transmission
S Bhola	TasNetworks	Transmission
K Hinkley	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
G Tolo	Relay Monitoring Systems	Vendor
B Hampson	SEL NZ	Vendor
F Lu	Siemens	Vendor
F Pambrun	Grid Solutions	Vendor
S Allan	Dynamic Ratings	Vendor

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

The highlighted organisations have not attended the last 3 AP meetings

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

## **AP C1 panel name**

### **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**

PS 1: Power system resilience planning:

- Evaluating, improving and measuring power system resilience, given increasing threats from human and natural hazards, including climate change, specifically in system planning, economic assessment and asset management.

PS 2: Energy sector synergies for decarbonisation efficiency:

- Planning approaches addressing energy sector synergies across power, gas, transport, heating/cooling and new energy carriers, in order to optimise overall decarbonisation efficiency. How do these planning approaches include aspects of energy conversion and storage, technical and economic sector interfaces?

PS 3: Distributed Energy Resources in transmission planning:

- Tools and techniques used in transmission system planning and investment decisions to evaluate the high levels of renewables and storage at all voltage levels, as well as growing customer flexibility, especially in holistic approaches that combine technical assessment and reliability impacts on customers.

### **4. Proposed New Working Groups**

**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 propitiation - 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 Support from: Cornelis Plet to check in TenneT

**5. Specific Activities of the Australian Panel**

The key activities of the Australian Panel during 2017 included actively participating in ongoing C1 working groups including convening working group C1.38 and contributing to the C1 Green Book on Asset Management.

Four papers from AP C1 were presented at the Paris Session 2018.

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

There were no seminars or conferences organised during 2018 by APC1.

**7. ANC Members on Working Groups**

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

WG	Title	Australian Member
C1.34	ISO Series 55000 Standards: General Process Assessment Steps and Information Requirements for Utilities	Herath Samarakoon
C1.38	Valuation as a comprehensive approach to asset management in view of emerging developments	Graeme Ancell (Convener)
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"	Narelle Fortescue and Jonathan Dennis Phil Southwell (Convener)

**8. Membership of the Australian Panel**

Name	Organisation	Type
Graeme Ansell	Ansell Consulting	Consultant
Herman De Beer	Ausnet services	Distribution
Keith Frearson	Jacobs	Consultant
Mark Hibbert	Aurecon	Consultant
Stephen Hodgkinson	ESTE	Consultant
Cristiano Marantes	Vector	Distribution
Yateendra Mishra	QUT	University
Lekshmi Jaya Mohan	Western Power	Transmission and Distribution
Enrique Montiel	Powerlink	Transmission
Brad Parker	Electranet	Transmission
Herath Samarakoon	Tasnetworks	Transmission
Christian Schafer	AEMO	MSO and Transmission
Julian Swartz	GHD	Consultant
Donald Vaughan	Entura	Generation
David Volwes	University of Adelaide	University
Matthew Zillmann	Ergon Energy	Distribution

**Convener:** Graeme Ansell  
**Email:** [graeme.ansell@ansellconsulting.nz](mailto:graeme.ansell@ansellconsulting.nz)  
**Phone:** +64 21 283 036

## **AP 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.

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

### **2. Specific Activities of the Study Committee**

The Study Committee met in Paris in August 2018 as part of the 2018 Paris Session. A teleconference meeting was held in January 2018 to assist in preparing for the Paris Session.

Active Working Groups met in Paris and a number of new Working Groups also held their initial meetings at this time.

The Study Committee co-ordinated the system operation component of the Large Disturbance Workshop which is held in conjunction with SC C5. The workshop covered the following power system events:

- South Australian system black in 2016;
- USA Hurricanes Irma and Harvey in 2017; and
- Brazilian blackout in 2018.

In the last 12 months the following publications have been made as a result of work done by SC C2 Working Groups:

- TB712 – System Restoration Procedure and Practices (WG C2.23)
- TB732 – Advanced Utility Data Management and Analytics for Improved Operation Situational Awareness of EPU Operations (JWG D2/C2.41)
- TB733 – System Operation Emphasising DSO/TSO Interaction and Coordination (JWG C2/C6.36)
- TB742 – A Proposed Framework for Coordinated Power System Stability Control (JWG C2/C4.37)

### **3. Preferential Subjects**

Preferential subjects for the 2020 Paris Session will be finalised during the November 2018 Technical Committee Meeting.

### **4. Proposed New Working Groups**

During the Study Committee meeting the discussion on potential new WG topics included:

- Operational management of interactions between power electronic based controllers; and
- Possible JWG with D2 on cybersecurity.

### **5. Specific Activities of the Australian Panel**

The Australian Panel C2 met twice during the year:

- July 2018 – Teleconference meeting to plan and prepare contributions for the Paris Session; and
- October 2018 – Annual meeting held in Adelaide and hosted by ElectraNet.

At the Annual Meeting Greg Hesse updated the panel on the C2 activities from the Paris Session, including:

- The Large Disturbance workshop, which featured the South Australian Blackout;
- The Study Committee C2 meeting, including updates on the activities of all Working Groups;
- C2 Tutorial on system operation emphasising DSO/TSO interaction and co-ordination which was based on the outcomes from JWG C2/C6.36 and Technical Brochure 733;
- C2 Poster Session; and
- C2 Group Discussion Meeting

The Panel then discussed ideas for joint activities with other Australian Panels as a way to encourage other Cigre work to consider operational applications. Ideas for future papers were discussed with the goal to have a pipeline of papers ready for future Symposia and Paris Sessions.

Members then shared recent operating incidents from their networks, a number of which highlighted the impact that decreasing system inertia and system strength is already having on the operation of the power system, particularly under abnormal conditions.

## 6. 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 decision has yet been made.

## 7. ANC Members on Working Groups

The following are all the current AP 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 Greg Hesse
C2.39	Operator Training in Electricity grids at Different Control Levels and for Different Participants / Actors in the New Environment	Daniel 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
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

## 8. Membership of the Australian Panel

Name	Organisation	Type
Geoff Burgess	Essential Energy	Distribution
Graeme Carter	Endeavour Energy	Distribution
Malcolm Conway	Power and Water Corporation	Operator / Transmission / Distribution
Stuart Donaldson	Ausgrid	Distribution
Andrew Dunn	PSC Consulting	Consultant
Shane Duryea	Western Power	Transmission
Greg Hesse	Powerlink	Transmission

Name	Organisation	Type
Mark Miller		Consultant
Chong Ong	TasNetworks	Transmission / Distribution
Andrew Power	TransGrid	Transmission
Matthew Rigano	Energy Queensland	Distribution
Richard Sherry	Transpower	Operator / Transmission
Colin Taylor	ElectraNet	Transmission
Mehdi Toufan	AEMO	Operator
Tjaart Van Der Walt	AEMO	Operator
Chris Wembridge	TasNetworks	NGN

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



## AP C3 System Environmental Performance

### 1. Study Committee Scope

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

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

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

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

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

### 2. Specific Activities of the Study Committee

SC C3 currently has 10 active working groups:

- WG C3.01 EMF and Health
- WG C3.09A Corridor management. Report attached - Ales Kregar
- WG C3.12 Methodologies for GHG inventory and reporting for T&D utilities - Mercedes Vazquez
- WG C3.14 Impact of environmental liability on transmission and distribution activities - Vincent Dufour
- WG C3.15 Best environmental and socio-economic practices for improving public acceptance of high voltage substations - Marijke Wassens
- WG C3.16 Interactions between electric infrastructure and wildlife - Cécile Saint Simon
- WG C3.17 Interaction between wildlife and emerging RES and submarine cables - Katherine Palmquist
- WG C3.18 Eco-friendly approaches in Transmission and Distribution - Anne Sophie Desaleux
- WG C3.19 Responsible management of the Electric and Magnetic Field Issue – James Hart
- WG C3.20 Sustainable development goals in the electric power sector – Christian Capello

SC C3 is proposing to meet in Denmark in 2019 in conjunction with the Danish National Committee symposium. The symposium topics will include:

- 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.

### 4. Proposed New Working Groups

Working groups which have commenced in 2018 include:

- WG C3.19 Responsible management of the EMF issue – James Hart
- WG C3.09A Corridor management - Ales Kregar
- WG C3.20 Sustainable development goals in the electric power sector – Christian Capello

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

- Environmental aspects of SF6.
- Stakeholder engagement in the planning process (this is an old joint WG with C1).
- Life cycle assessment.
- Vegetation management around substations.
- Environmental effects of decommissioning.

Other ideas suggested, which may become future working groups, include sustainable supply chain, environmental aspects of storage, adaptation to climate change, social aspects of sustainability, promoting biodiversity and offsets and environmental management systems.

### 5. Specific Activities of the Australian Panel

During 2018 AP C3 has been heavily focused on Paris 2018 with members active in 4 working groups. Further, two AP members attended Paris 2018 with roles including Special Reporter and Working Group convenor.

AP C3 is due to meet in Sydney on 9 November 2018.

### 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–7<sup>th</sup> 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

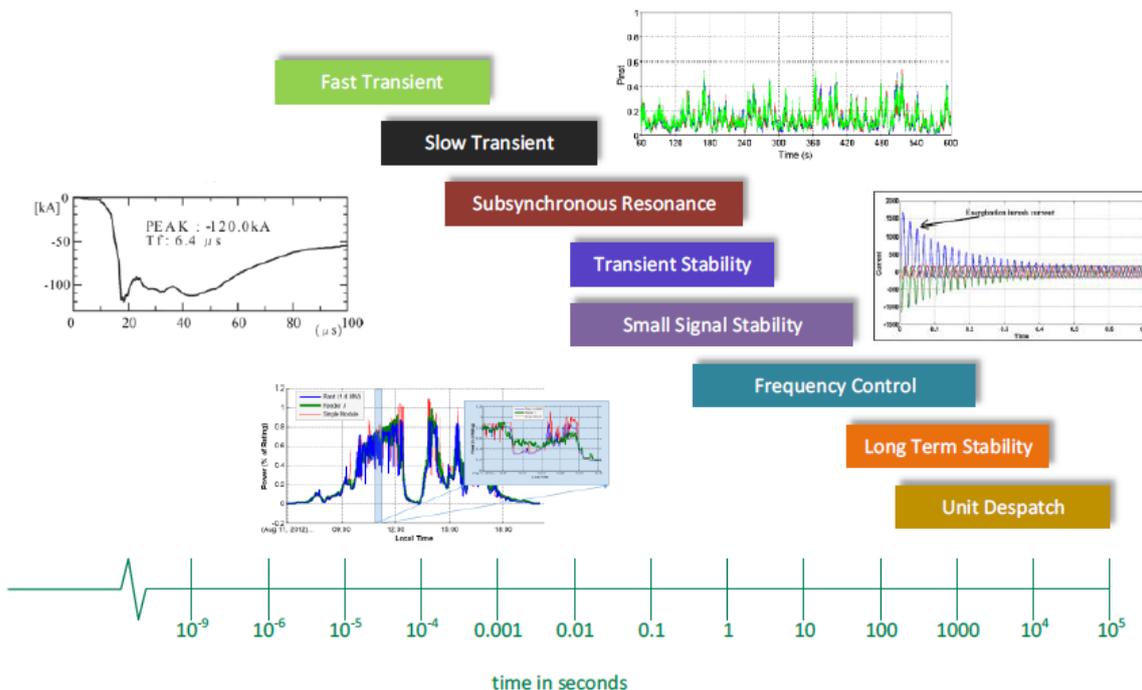
Name	Organisation	Type
James Hart	Ausgrid	Distribution/Transmission
Michael Roberts	Endeavour Energy	Distribution
Brett Haywood	Essential Energy	Distribution
Andrew Johnson	ElectraNet	Transmission
Ed Parker	TasNetworks	Distribution/Transmission
David Donehue	TransGrid	Transmission
Linda Dawson	Powerlink	Transmission
Sonya Bryce	Energy Queensland	Distribution/Transmission
Claire Royston	Western Power	Distribution/Transmission

**Convener:** James Hart  
**Email:** [jhart@ausgrid.com.au](mailto: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 to the interaction between the power system and its apparatus/subsystems (including external causes of stress and other installations). Specific issues related to the design and manufacturing of components and apparatus 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 supports and encourages working jointly with other study committees.



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

To better describe the spectrum 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 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 grid, micro grid, 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. Specific Activities of the Study Committee

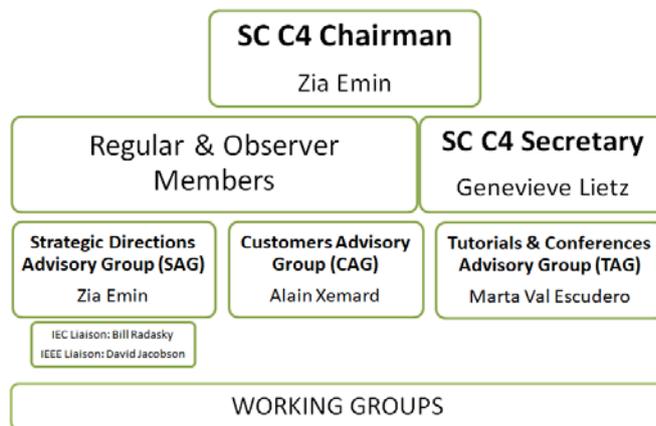
### 2.1 Release of updated Strategic Plan

Study Committee (SC) C4 has recently updated and released its strategic plan for the period 2018 to 2022. The document will be routinely reviewed by Advisory Group One (AG1) and revised as necessary in consultation with SC members. The strategic direction of SC C4 focuses on the following main objectives:

- Structured interaction with stakeholders (facilitated through a new Customer Advisory Group).
- Interaction with other SC's and organisations.
- Dissemination of technical achievements.
- Promoting training of the next generation of power system engineers.

The organisational structure of SC C4 has been revised accordingly to help deliver the objectives.

Figure 2: SC C4 revised structure



From AU C4, Andrew Halley and Sarath Perera are both members of AG1. Andrew is also a Regular Member of the SC, being one of twenty four (24) national representatives.

### 2.2 Active Working Groups

SC C4 currently has twenty nine (29) active Working Groups (WG). The breakdown by sub-topic is:

- Power quality, 4
- Electromagnetic Compatibility and Interference (EMC/EMI), 4
- Insulation Co-ordination, 5
- Lightning, 6
- Power Systems Dynamics and Numerical Analysis, 10

WG #	Title	Convener	Schedule
WG C4.23	Guide to Procedures for Estimating the Lightning Performance of Transmission Lines	C. Engelbrecht (Netherlands)	2012 - 2015
WG C4.25	Issues related to ELF Electromagnetic Field exposure and transient contact currents	K. Kopsidas (UK)	2011 - 2017
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

<b>WG #</b>	<b>Title</b>	<b>Convener</b>	<b>Schedule</b>
WG C4.31/CIRED	EMC between Communication Circuits and Power Systems	D. Thomas (UK)	2012 - 2016
WG C4.32	Understanding of the Geomagnetic Storm Environment for High Voltage Power Grids	W. A. Radasky (USA)	2013 - 2015
WG C4.33	Impact of Soil-Parameter Frequency Dependence on the Response of Grounding Electrodes and on the Lightning Performance of Electrical Systems	S. Visacro (Brazil)	2013 - 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
JWG C4/B4.38	Network Modelling for Harmonic Studies	M. Val Escudero (Ireland)	2014 - 2017
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 (PSR WG)	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 #	Title	Convener	Schedule
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
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 C2/C4.37	Recommendations for Systematic Framework Design of Power System Stability Control	Y. Fang (China)	2015 - 2017
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

### 2.3 Green Books

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

- *Electricity Supply Systems of the Future*, C4 will provide a complete chapter on system technical performance issues expected in the future. Publication is due in August 2020.
- *FACTS Devices*, Publication is being led by SC B4, with C4 providing specific technical input.

### 2.4 International events

The following upcoming international events are being supported directly by SC C4.

- CIGRE-IEC Colloquium on EHV & UHV (AC & DC), “**New Trend of Advanced Technology for Efficient, Economical and Resilient Power Systems**”, April 2019, Hakodate, Japan.
- CIGRE Symposium 2019, Aalborg, Denmark, (C4 lead), “**Going Offshore – Challenges of the future power grid**”, 3-6 June 2019.
  - The C4 SC meeting for 2019 will be held in conjunction with the Danish event.
- International Colloquium on “**Lightning and Power Systems**”, October 2019, Delft, Netherlands.
- International Colloquium on “**Lightning and Power Systems**”, 2021, Suzhou, China.
  - The C4 SC meeting for 2021 will be held in conjunction with the Chinese event.

## 2.5 CIGRE Science and Engineering Journal

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

- Reference paper jointly with SC C2: “*Effects of Increasing Power Electronics (PE) based Technology on Power System Stability Performance and System Operations*”.
  - The full Reference Paper is available in the CSE Journal, June 2018.
- Ten (10) SC C4 related papers were published in the CSE Journal during 2017.
- It is expected that a similar or higher number of papers will be achieved for the full calendar year of 2018.

## 2.6 Published Technical Brochures

The following Technical Brochures have been published by SC C4 since November 2017.

TB 716: System conditions for and probability of out-of-phase.

TB 718: Benchmarking of power quality performance in transmission systems.

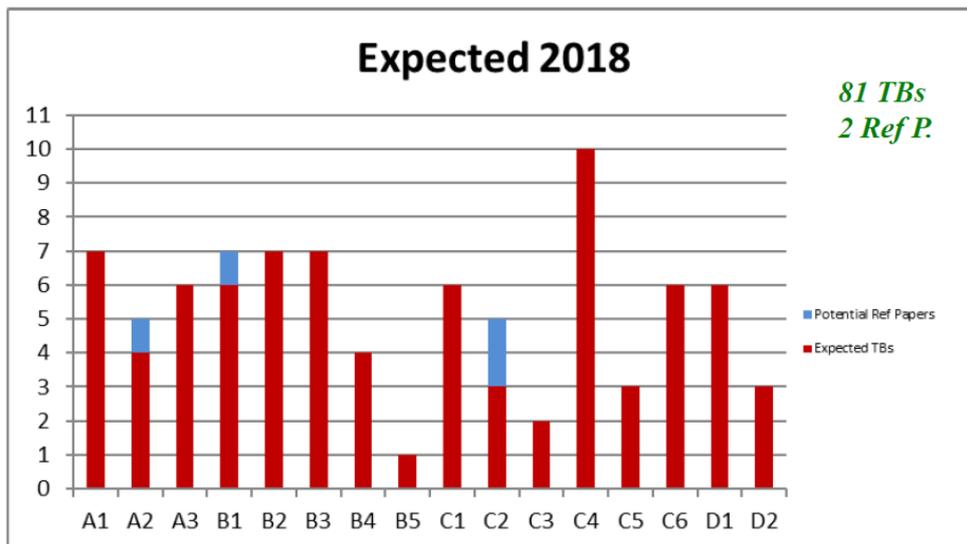
TB 719: Power quality and EMC issues associated with future electricity networks.

TB 727: Modelling and dynamic performance of inverter based generation in power system transmission and distribution studies.

TB 736: Power system test cases for EMT type simulation studies.

A number of other TB's are either currently being reviewed by the SC or are due for imminent completion prior to submission for formal review.

Figure 3: Expected TB publications in 2018 calendar year.



## 3. Preferential Subjects

The preferential subjects for the **2019 Danish Symposium** are available online at:

[https://cigreaalborg2019.dk/wp-content/uploads/2018/09/CigreAalborg2019\\_Call-for-Papers\\_ver2.2.pdf](https://cigreaalborg2019.dk/wp-content/uploads/2018/09/CigreAalborg2019_Call-for-Papers_ver2.2.pdf)

The draft preferential subjects as discussed at the 2018 SC meeting for the **2020 Paris General Session** are as follows:

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

- the analysis of widespread dynamic security issues including IEMI, weather and GIC disturbances,
- the use of big data analytics for the assessment of frequency stability, system strength or power quality,
- 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 and techniques for evaluating lightning, power quality and insulation coordination to enhance the performance of the evolving grid including:**

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

#### **4. Proposed New Working Groups**

The following WG terms of reference (ToR) are either under review by the SC, the CIGRE Technical Council (TC), or are in the process of final approval prior to commencement.

WG C4.51	Connection of railway traction systems to power networks.
WG C4.xx	Advanced metal-oxide varistors for surge arresters with better protection properties.
WG C4.xx	Insulation coordination of wind power plants.
JWG B4/C4.xx	Guidelines for sub-synchronous oscillation studies in power electronics dominated power systems.
WG C4.xx	Protection of high voltage power network control electronics from high-altitude electromagnetic pulse (HEMP).
WG C4.xx	Primary & secondary arc current calculation for neutral reactor sizing.

#### **5. Specific Activities of the Australian Panel**

The Australian Panel has continued to be active in 2018 with ongoing involvement in a number of WG, the Paris General Session and contributions to various local initiatives. The following summary highlights the major achievements of those involved.

### 5.1 Paris General Session

AU C4 had five papers accepted for the Paris Session which was the highest number across all of the sixteen Australian Panels. The final papers were of a high quality and were well received, with notable interest observed during the SC C4 Poster Session.

Andrew Halley was the Special Reporter for Preferential Subject Three (PS3) at the C4 General Meeting.

### 5.2 AU C4 Tutorial – Wollongong, NSW

A tutorial titled “*Application of synchrophasor solutions for the monitoring and control of power systems*” was held on the 13 and 14 August at the University of Wollongong at the Innovation Centre Campus. We were fortunate to obtain the support of three international guest speakers from the University of Manitoba (Prof. Udaya Annakkage and Prof. Athula Rajapakse) and from Teshmont (Dr. Vajira Pathirana) to present the course material.

The tutorial was based on CIGRE Technical Brochure 702 titled “*Application of Phasor Measuring Units for monitoring power system dynamic performance*”, produced by WG C4.34. The course covered technical fundamentals together with practical applications in areas such as Wide Area Control Schemes (WACS), post disturbance analysis, system model validation and real time system analysis. During the afternoon of the second day, shared experiences from around Australia were presented by some of the attendees which triggered excellent discussions.

Numbers were down on expectations with only 22 registered participants. This was somewhat disappointing, with the notable absence of many Network Service Providers.

A summary of the event has been submitted as an ‘In the Loop’ article.

### 5.3 Contributions to WG

The following CIGRE Australia members are contributing to active C4 Working Groups.

WG Ref	Title	AU.C4 Reps	Involvement	Status	TB Ref
C4.51	Connection of railway traction systems to power networks	Igor Perin Phil Coughlan	Proposed Members (pending confirmation)	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 Blizard	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. Due by end of 2018.
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. Due by end of 2018.
C4.39	Effectiveness of line surge arresters for lightning protection of overhead transmission lines	Thomas DALY	Corresponding Member	In progress.	Pending.
C4/C6.35/CIREC	Modelling and dynamic performance of inverter based generation in power system transmission and distribution studies.	Andrew HALLEY Robert ADAMS  Babak Badrzadeh	Members  Corresponding Member	<b>Complete 2018.</b>	<u>Technical Brochure TB 727</u>
C4.32	Understanding of the geomagnetic storm environment for high voltage power grids.	Andrew HALLEY Robert ADAMS	Members	TB under final review by SC.	Pending. Will be published in 2018.
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.
C4.27	Benchmarking of power quality performance in transmission systems.	Sean ELPHICK	Member	<b>Complete 2018.</b>	<u>Technical Brochure TB 718</u>

#### 5.4 Contributions to other significant industry activities

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

Reference	AU representative	Contribution
<u>B4 Green Book</u> <i>"FACTS Devices"</i>	Babak Badrzadeh	Lead Author, Chapter 22: "Commissioning tests for FACTS devices"
	Rizah Memisevic Andrew Van Eyk Peeter Muttik	Contributing members to Chapter 22
<u>CIGRE Green Book</u> <i>"Electricity Supply Systems of the Future"</i> .	Andrew Halley	Contributing author to Chapter 13, Section 5 – System Technical Performance, Dynamic Stability.
<u>SC C4 Science and Engineering Journal</u> <i>"Effects of Increasing Power Electronics (PE) based Technology on Power System Stability Performance and System Operations"</i> .	Andrew Halley	Contributing author. Published June 2018.
<u>IEC SC77A WG8:</u> <i>"Description of the electromagnetic environment associated with the disturbances present on electricity supply networks"</i> .	Alex Baitch	Member
<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).
<u>JWG C1/C6.37/CIRE</u> <i>"Optimal transmission and distribution investment decisions under increasing energy scenario uncertainty"</i> .	Alex Baitch	Member

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

The convenor of AU C4 presented to the SC C4 meeting in Paris recommending support for Australia to host the Cigre Symposium in 2023. The proposed location for the symposium is Cairns. The symposium is likely to be supported by a number of SCs and WGs including C4. The response from

the SC chairman and members was of initial support, with more significant commitment only able to be provided at the next Paris Session in 2020 (given the five year time frame of the proposal). AU C4 will continue to work with CIGRE Australia and other AU panels in helping work toward securing this major international event.

No other 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 five (25) members which includes one Next Generation Network (NGN) representative who also provides secretariat services to the Panel.

<b>Name</b>	<b>Organisation</b>	<b>Type</b>
Alex Baitch	BES (Aust) Pty Ltd	Consulting
Babak Badrzadeh	Australian Energy Market Operator (AEMO)	System Operator
Errol Bebbington	PSC Australia	Consulting
Tom Daly	Consolidated Power Projects	NGN / Service Provider
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
Devinda Perera	ElectraNet	Network Service Provider
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
Brett Roberts	AUSGRID	Network Service Provider
David Roby	ABB Australia Pty Limited	Equipment Supplier
David Vowles	University of Adelaide	Academia
Neville Watson	University Of Canterbury	Academia
Ruchira Withanage	GHD Hill Michael	Consulting
Albert Pors	Endeavour Energy	Network Service Provider

## 8. Panel contact details

For further information or questions, please contact:

**Convener:** Andrew Halley

**Email:** [andrew.halley@tasnetworks.com.au](mailto: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>

## **AP C5 Markets and Regulation**

### **1. Study Committee Scope**

The scope of Study Committee C5 is the 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 on Monday during the General Session to:

- 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.

### **2. Specific Activities of the Study Committee**

The Study Committee met in Paris in May as part of the 2018 Session. All the active Working Groups met in Paris as well.

The Study Committee is continuing its focus on market developments, both at the macro and the micro level. The focus on distribution networks and the edge of the grid was included in the preferential subjects for 2018 and 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 the evolution of markets and environmental impacts of markets in 2018.

Study Committee C5 is supporting 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.

Overall SC C5 activities were well attended with:

- 242 delegates attending the tutorial on demand response;
- Over 400 viewing the 26 posters on display;
- Over 300 attending the General Discussion meeting, which had 166 contributions and a good discussion

### 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

### 4. Proposed New Working Groups

Currently there are five proposed working groups in SC C5. They are:

Working Group	Title	Convener
JWG C5/C6.01	Local energy communities	Alain Taccoen
TBD	Retail pricing structures	Angela Chuang
TBD	Forward Market Liquidity	TBD
TBD	Classification of energy market models	TBD
TBD	Carbon pricing in electricity markets	Anthony Giacomani
TBD	Impact of blockchain technologies	David Bowker

### 5. Specific Activities of the Australian Panel

The Australian Panel held its meeting in Melbourne on Friday 15<sup>th</sup> of June, hosted by AEMO. Fifteen panel members attended the meeting. On the evening prior to the meeting, AP C5 hosted a web meeting between members of AP C5 and the chair and secretary of SC C2 to discuss the presentations on the SA and NEM issues for the Large Disturbance workshop. A short discussion on the National Energy Guarantee was conducted after the Panel meeting for interested members.

### 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 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	Mark Miller(C2)
WG C5.16	Market Cost of Electric Service	Alex Cruickshank
WG C5.20	Evolution of Markets – completed during 2018 - Convener: Greg Thorpe	Tim Baker* Julian Eggleston David Bowker (t)
WG C5.21	Environmental Impacts on Markets – completed during 2018	Greg Thorpe*
WG C5.22	Management of Systemic Market Risk in Electricity Markets – Convener: David Bowker	Greg Thorpe* Tim Baker Andrew Jones Alex Cruickshank
WG C5.23	Wholesale Market Price Caps	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	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	TBD

## 8. Membership of the Australian Panel

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

<b>Name</b>	<b>Organisation</b>	<b>Type</b>
Jonathon Dennis	NGN/Powerlink	TNSP
Ian Rose/Ben Vanderwaal	Ernst&Young	Consultant
David Swift	AEMO	Operator
Gregor Verbic	University of Sydney	Lecturer

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

## **AP 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 proposed to be co-chaired by both C2 and C6.

#### **4. Specific Activities of the Australian Panel**

There were three Australian papers accepted for C6 for the 2018 Paris Session.

Australia Panel C6 held its annual meeting in Perth, hosted by Western Power and Horizon Power, on 8-9 November 2018. The meeting was attended by 14 current C6 members. The meeting included visits to the Western Power control room, the Horizon Power control room and a new community energy storage system in Mandurah.

AP C6 will host the third Conference on the Integration of Distributed Energy Resources (CIDER) in Melbourne on 20-21 August 2019.

Professor Michael Negnevitsky of the University of Tasmania has received the 2018 ACPE - CIGRE award which is an annual award recognising exceptional Australasian academics for outstanding career-long contributions to teaching and research in electric power engineering as well as contribution to industry and CIGRE activities.

#### **5. 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.

#### **6. AP Members on Working Groups**

The following are current AP representatives on Working Groups.

WG	Title	Australian Member
C6/C2.34	Flexibility Provision from Distributed Energy Resources	Pierluigi Mancarella (convenor)
C6.35	DER Aggregation Platforms for the Provision of Flexibility Services	Jenny Gannon
C6.35	DER Aggregation Platforms for the Provision of Flexibility Services	Archie Chapman
C1/C6.37/ CIRED	Optimal Transmission and Distribution Investment Decisions under Increasing Energy Scenario Uncertainty	Alex Baitch
C6/B4.37	Medium Voltage DC Distribution Systems	Georgios Konstantinou
C6.38	Rural Electrification	Jaimee Hosking
C6.39	Distribution Customer Empowerment	Matthew Zillmann

## 7. 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
Sean Elphick	University of Wollongong	University
Shervin Fani	Western Power	Distribution
John Fletcher	University of NSW	University
Jenny Gannon	Ergon Energy (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
Albert Pors	Endeavour Energy	Distribution
Jenny Riesz	AEMO	Operator
Thomas Smolka	Reinhausen	Manufacturer
David Stephens	Horizon Power	Distribution
Pradip Verma	Pacific Power Association	Distribution
Mike Wishart	EcoJoule Energy	Manufacturer
Matthew Zillmann	Ergon Energy (Energy Queensland)	NGN Rep.

**Convener:** Ray Brown

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

## AP D1 Materials and Emerging Test Techniques

### 1. Study Committee Scope

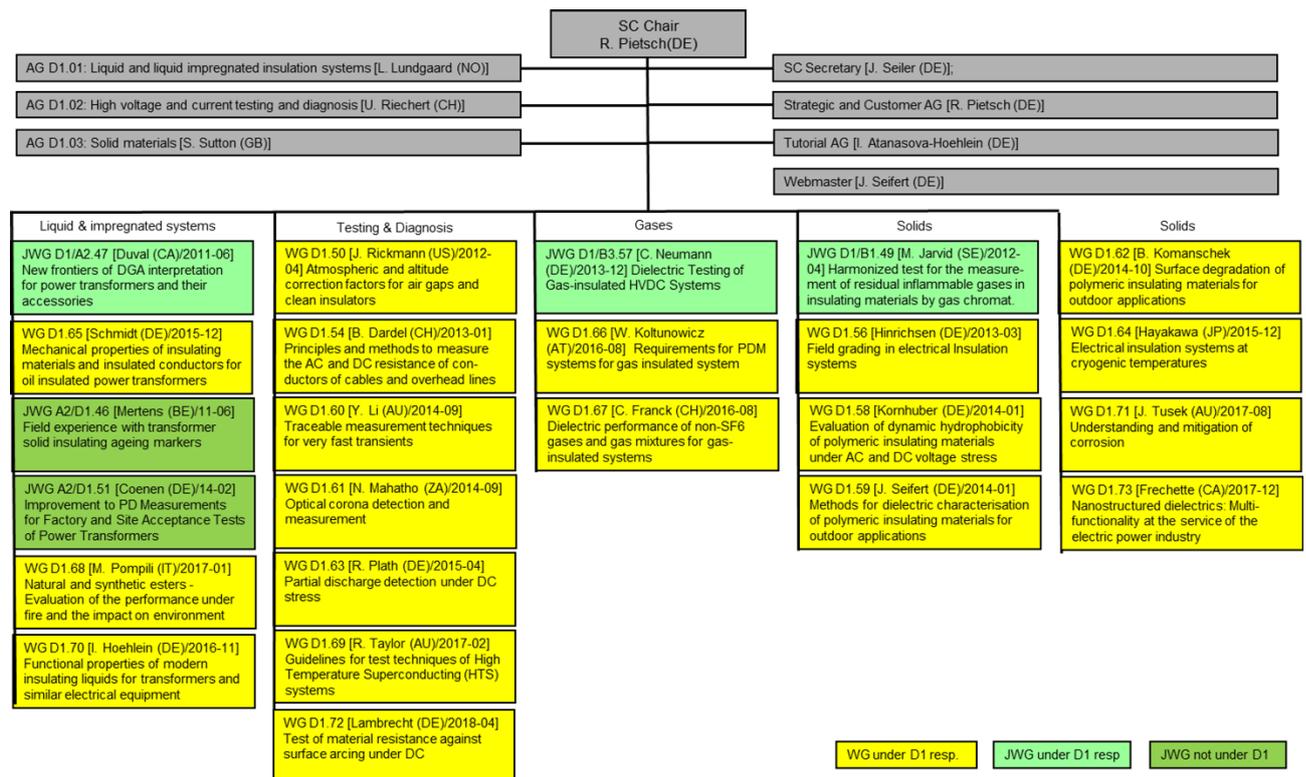
The D1 study committee deals with testing techniques and material developments that support HV plant. It is one of the two horizontal committees and thus is a service provider to other SCs. Typically, it partners with a SC to provide engineering and scientific input into their understanding of plant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

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,

- 4 new WGs have been approved
- 5 Technical Brochures have been published
- 4 Tutorials were held

Brochures published since 2017

- TB 741 - Moisture measurement and assessment in transformer insulation - Evaluation of chemical methods and moisture capacitive sensors - 2018
- TB 738 - Ageing of liquid impregnated cellulose for power transformers- 2018
- TB 730 - Dry air, N<sub>2</sub>, CO<sub>2</sub>, and N<sub>2</sub>/SF<sub>6</sub> mixtures for gas-insulated systems - 2018
- TB 706 - Guidelines for the use of statistics and statistical tools on life data - 2017
- TB 705 - Guidelines for altitude correction of pollution performance of insulators - 2017
- TB 703 - Insulation degradation under fast, repetitive voltage pulses - 2017
- TB 691 - Pollution test of naturally and artificially contaminated insulators - 2017
- TB 676 - Partial discharges in transformers - 2017

Major meetings:

CIGRE SC A3/B4/D1 Colloquium 2017 in Winnipeg (CA), Oct. 1-6, 2017

Session 47 in Paris (FR) Aug. 26-31, 2018

Next Meeting will be at Joint Colloquium A2, B2 and D1 18-22 Nov. 2019 in New Delhi, India.

New Tutorials

1. D1-T019 Moisture Measurement in Insulating Fluids and Transformer Insulation – an Evaluation of Solid State Sensors and Chemical Methods WG D1.52, Ivanka Atanasova-Hoehlein
2. D1-T020 Guidelines for altitude correction of pollution performance of insulators WG D1.44, Igor Gutman

Tutorials delivered:

1. “Pollution Test of Naturally and Artificially Contaminated Insulators”, Igor Gutman (WG D1.44), CIGRE A3, B4 & D1 Colloquium, Winnipeg, MB Canada, September 30th till October 6th, 2017
2. “High Voltage On-Site Testing with Partial Discharge”, Ralf Pietsch (WG D1.33), CIGRE A3, B4 & D1 Colloquium, Winnipeg, MB Canada, September 30th till October 6th, 2017
3. “Capacitive Sensors for Moisture Measurement”, Ivanka Atanasova-Hoehlein (WG D1.52), 8th southern Africa Regional Conference, Cape Town, South Africa, November 14th till November 17th, 2017
4. “Pollution Test of Naturally and Artificially Contaminated Insulators”, Igor Gutman (WG D1.44), 8th southern Africa Regional Conference, Cape Town, South Africa, November 14th till November 17th, 2017
5. “Guidelines for altitude correction of pollution performance of insulators”, August 28, Cigre Paris Session 47, 2018.

Cigre 2018 Technical Committee Award was presented to Okabe, Shigemitsu (JP).

### 3. Preferential Subjects

Suggested preferential subjects for Joint Colloquium in India in 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 2020 SC D1 meeting in Paris,

PS1 Testing, Monitoring and Diagnostics

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

PS2 Materials – functional properties and degradation

- New stresses (e.g. power electronics and semiconductors, load cycling, higher temperatures, compact applications, etc.).
- Materials with lower environmental footprint (e.g. production, operation, disposal, etc.).
- Characterization methods for validating functional properties.

PS3 Insulation systems of advanced components

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

### 4. Proposed New Working Groups

Since the last report the following WG's have been proposed or initiated,

1. D1.68 Natural and synthetic esters - Evaluation of the performance under fire and the impact on environment. Convenor: Massimo Pompili (IT) – Has had two meetings.
2. D1.69 Guidelines for test techniques of High Temperature Superconducting (HTS) systems. Convenor Richard Taylor (AU) – has last meeting planned for Milan in April 2019.
3. D1.72 Test of material resistance against surface arcing under DC. Convenor: J. Lambrecht (DE) – New WG
4. D1.73 Nanostructured dielectrics: Multi-functionality at the service of the electric power industry. Convenor: M. Frechette (CA) – First meeting in May 2018.
5. Draft TOR G N° D1/B4/...YY, PD measurement on insulation systems stressed from HV power electronics
6. Draft TOR in discussion for follow up to WG D1.71, to target Corrosion Management. JWG is proposed and likely to be formed in early 2019, proposed Convenor J.Tusek.

## 5. Specific Activities of the Australian Panel

During the 2018 Paris session (apart from attending at all the SC D1 meetings), Joe Tusek convened the poster session form SC D1 which had 39 posters. Attended AG D1.01 and AG D1.03 meetings, as well as a meeting with the secretary of WG D1.71 to finalise the working group's brochure. Attended the SAG meeting and contributed to the preferential subjects for 2020. Also, gave an invited presentation to the B1 Session on the outcomes of the WG D1.71 work.

For the Paris Session, across all SCs, D1 panel members had four papers and posters.

### **Papers authored or co-authored by AP D1 Members for Paris Session**

1. D1-310 Parametric Frequency Response Interpretation using Frequency Localising Basis Functions - J. Tusek
2. D1-320 Steep-front impulse voltage tests on high-voltage equipment – Dr Y. Li
3. A2-302 The Emerging Role of FRA as a Required Commissioning Test - J. Tusek
4. C6-312 Learning from a 3.275 MW Utility Scale PV Plant Project: Update and New Remarks – Prof T. Saha.

The D1 secretary, Robert Li was awarded CIGRE Young Engineer Scholarship to attend the 2018 Paris Session 47.

In support of the “Sustainable Electricity for All” strategic initiative between Cigre and the World Bank, Joe Tusek assisted with the booth at the Paris Session

AP D1 met 6-7th November in Newcastle, NSW at Verico Asset Integrity Services offices. The panel discussed SC D1 documents form Paris, including the SC Chair, Advisory Committee and Working Group reports, terms of reference and publications.

Presentations were made or submitted covering: new technology for inspection of wooden power poles; detection of high impedance arcing faults in DC systems; dynamic resistance measurement, automation of partial discharge calibrator calibrations; improvements to voltage transformer calibration at National Measurement Institute as well as their investigations into the performance of very fast ceramic dividers. Also, filtering power supply coupled noise in PD measurements systems; issues in automation of Frequency Response Analysis (FRA) interpretation; as well as new work that aims to eliminate some of the connection issues that presently affect the high frequency band of FRA tests.

The meeting also had the benefit of a presentation from Hossein Rahimpour (NGN member) on outcomes of his research into online FRA measurement developments. As well as, a brief presentation on research activities underway at the Transformer Innovation Centre in Queensland.

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

The next instance that SC D1 is considering coming to Australia is listed for 2023 Cairns (Australia), Symposium, 4 – 7. September (planning started by NC C6). Presently there are no D1 WG's planning to meet in Australia in the next year. ANC Members on Working Groups

## 7. ANC Members on Working Groups

The following are current AP representatives on Working Groups.

WG	Title	Australian Member
D1.48	Properties of insulating materials under VLF voltages	Prof Trevor Blackburn and Hans Mayer
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)
D1.71	Understanding and mitigating corrosion	Joe Tusek (Convenor)
A2.53	Objective interpretation methodology for the mechanical condition assessment of transformer windings using Frequency Response Analysis (FRA)	Joe Tusek (corresp.)
B3.47	Application of Robotics in Substations	Robert (Yi) Li
D1.51	Dielectric performance of eco-friendly gas insulated systems	Daniel Martin (corresp.)
D1.65	Mechanical properties of insulating materials for power transformers	Daniel Martin (corresp.)
A2.54	Power transformer audible sound requirements	Mohinder Pannu
SAG	Strategic Advisory Group	Joe Tusek
CAG	Customer Advisory Group	Joe Tusek

**8. Membership of the Australian Panel**

Name	Organisation	Type
Joe Tusek	Verico AIS	Consultant
Prasanna Wickramasuriya	Energex	Distribution
Wenyu Guo	Omicron	Manufacturer
Mark Cotton	AusNet Services	Transmission
Mohinder Pannu	Wilson Transformers	Manufacturer
Karl Haubner	Doble	Manufacturer
Phil Ramsay	Plus ES	Distribution
Andrew Wilkinson	ElectraNet	Transmission
Robert Li	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](mailto:joe.tusek@verico.com.au)**

**Phone: 02 4941 5340**



## AP D2 Information Systems and Telecommunication

### 1. Study Committee Scope

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

### 2. Specific Activities of the Study Committee

In the area of information systems, SC D2 continues to see a shift in way Electric Power Utilities (EPUs) collect, process and extract value from information technologies. This is a result of changes in the electricity market worldwide due to the advances in adoption renewables, and new potential brought by emerging technologies such as big data, software defined network and cloud computing.

The area of security continues to be an area of focus in the D2 Study Committee, as shown during the 2018 Paris Session Group discussion, and the number of active SC D2 working groups related to security.

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 Strategic Plan is currently under review by the D2 Strategic Advisory Group.

In the 2018 Paris Session, the Study Committee had an outgoing Chair (Philippe Quenaudon) who retired, and the incoming chair was Olga Sinhenko.

The current organisational structure of SC D2 is shown in Figure 1. Australia has membership in this Study Committee and is a member of the Strategic Advisory Group (SAG) Experts. The SAG Experts provide strategic advice and direction to the Study Committee.

The upcoming events which SC D2 are participating in are as follows:

1. Helsinki SC D2 Colloquium (12 – 13 June 2019)
2. Chengdu Symposium (20 – 20 Sept 2019)



Study Committee D2  
Organisation

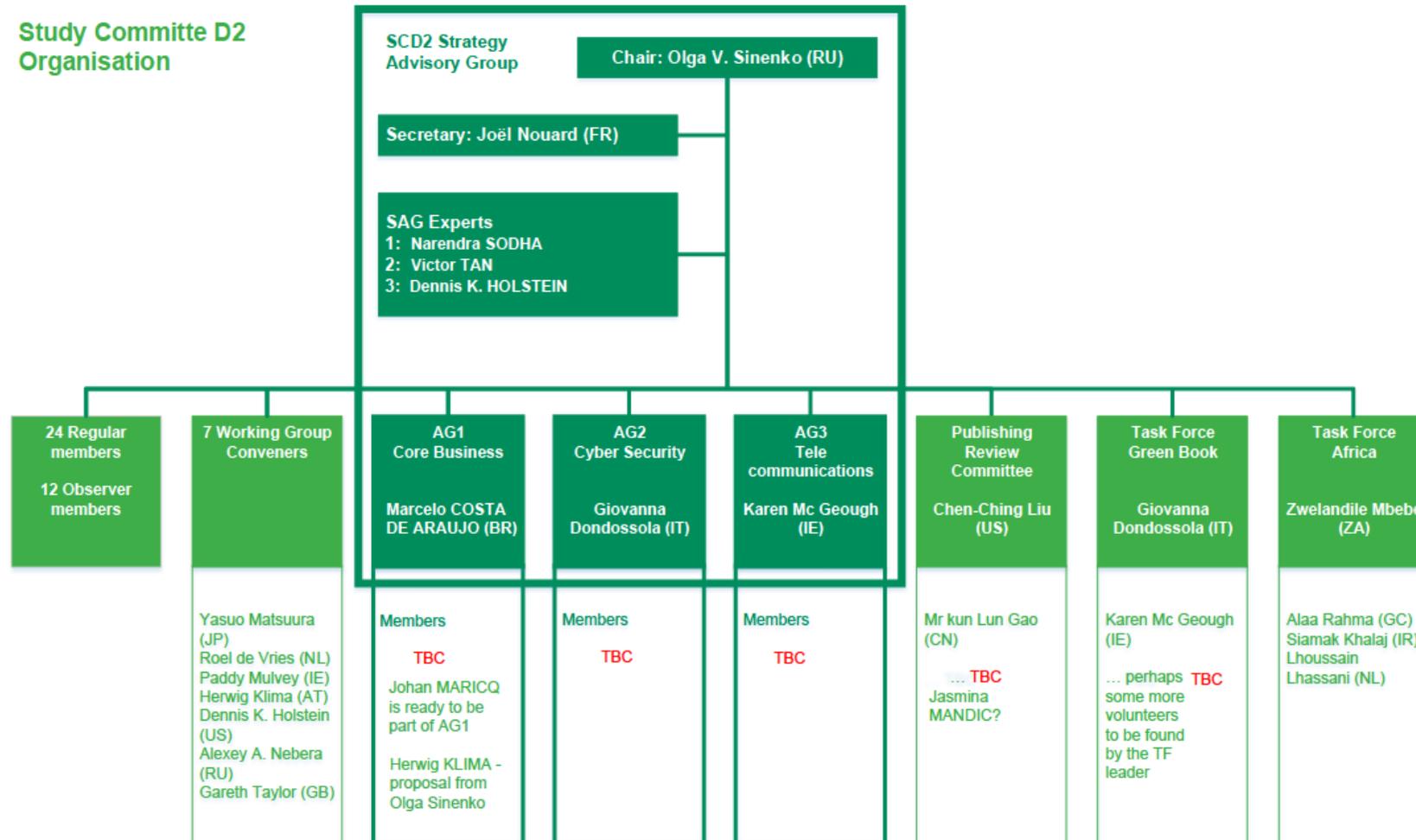


Figure 1 - Study Committee D2 - Organisational Structure

### 3. 2018 Paris Session

Preferential subjects (PS) by the Study Committee for the 2018 Paris Session were as follows:

- a) PS1: Opportunities and challenges in ICT applied to microgrid and DER
  - Communication solutions to remotely monitor and operate off-grid premises
  - Facilities for control, monitoring, physical security and safety.
  - Standards, interoperability and cyber security issues.
  
- b) PS2: Potential applications and implementation of network and infrastructure virtualization
  - Opportunities and benefits using Software Defined Networking and Network Function Virtualization (SDN/NFV).
  - Issues identified in implementation and operation of virtualization architectures.
  - Strategies to operate a secure SDN/NFV deployment.
  
- c) PS3: Maintaining reliable and secure operation in an evolving environment
  - ICT to support asset management and maintenance.
  - Life cycle management and integration of legacy and new devices.
  - Situational awareness, risk management and cyber incident responses.

The special reporters were Giovanna Dondossola for PS1, Victor Tan for PS2, and Narendra Singh Sodha for PS3



*Figure 2 - Special Reporters for the SC D2 Group Discussion Session*

A total of 24 synopses have been selected, with 23 full papers submitted by paper authors (5 on PS1, 2 on PS2 and 16 on PS3).

Australia's representative was a Special Reporter for PS2.

Around one hundred people attended the SC D2 group discussion session. There was a total of 29 contributions.

The SC D2 poster session had 22 paper posters, and 3 working group posters.

Australia had 3 posters presented (2 papers, 1 working group).

#### 4. Working Group Status

The summary of working group status is shown in Figure 3.

WG	Title	Convenor	2018		2019		2020		2021	
			S2	S1	S2	S1	S2	S1	S2	
WG D2.40	Cyber risks and cyber security for the next generation of digital systems in EPU	J. ZERBST / D.K. HOLSTEIN								
WG D2.43	Enabling Software Defined Networking for EPU telecom applications	V. TAN								
WG D2.44	Usage of public or private wireless communication infrastructures for monitoring and maintenance of grid assets and facilities	P. MULVEY								
WG D2.45	Impact of governance regulations and constraints on EPU sensitive data distribution and location of data storage	H. KLIMA								
WG D2.46	Cybersecurity future threats and impact on EPU organizations and operations	D.K. HOLSTEIN								
JWG D2/B5.67	Time in Communication Networks, Protection and Control Applications – Time Sources and Distribution Methods	R. DE VRIES								
JWG D2/C6.47	Advanced consumer side energy resource management systems	A.A. NEBERA								
JWG D2/C2.48	Enhanced information and data exchange to enable future transmission and distribution interoperability	G. TAYLOR								

Figure 3 - SC D2 working group status

**Australia has the following participation in the above working groups:**

1. D2.40 – Victor Tan (PSC Australia) as Member
2. D2.43 – Victor Tan (PSC Australia) as Convener, Greg Helps (ElectraNet) and Louise Watts (SA Power Networks) as Members

Three Technical Brochures have been published and one is on publication process:

1. TB 685 – “Communication solutions for information exchange in the smart delivery of electrical energy”
2. TB 698 – “Framework for EPU operators to manage the response to a cyber-initiated threat to their critical infrastructure”
3. TB 732 – “Advanced utility data management and analytics for improved operation situational awareness of EPU operations”
4. TB XXX – “Design, Deployment and Maintenance of Optical Cables Associated to Overhead Transmission Lines”

**Australia’s contribution to the above TB are as follows:**

- a) TB 685 – Louise Watts (SA Power Networks) as Member
- b) TB 698 – Victor Tan (PSC Australia) as Member
- c) TB 732 – Rohan Fernandez (ElectraNet) as Member

#### 5. Specific Activities of the Australian Panel

The Australia D2 Panel held its annual meeting in Darwin between 26 July 2018 and 26 July 2018, hosted by Power and Water Corporation and co-hosted by PSC Australia.

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



*Figure 4 - Australia Panel D2 Panel Meeting in Darwin (clockwise from top-left: presentation underway in Hilton Darwin, technical tour at a communications site, tech tour participants, conference dinner participants)*



**6. Membership of the Australian Panel**

Name	Organisation	Type Vendor Tx Utility Dx Utility Consultant Academic
Aaron Gates	Western Power	T
Alan Wallace	Tesla Consultants	C
Andy Hemming	Transpower	T
Aruna Yahampath	Endeavour Energy	D
Branko Andric	Horizon Power	D
David Paramandan	CommTel	D
David Taddeo	GHD Pty Ltd	V
Glenn Firth	Ergon Energy	D
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	PSC Australia	C

**Convener:** Victor Tan

**Email:** [victor.tan@pscconsulting.com](mailto:victor.tan@pscconsulting.com), [emailvictor@gmail.com](mailto:emailvictor@gmail.com)

**Phone:** 0871092604



## Working Group A2.58 Site Installation and Pre-commissioning of Power Transformers and Shunt 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](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

1<sup>st</sup> Meeting 6-7 April Sydney hosted by GE

2<sup>nd</sup> Meeting 30-31 August Nuremberg Germany hosted by Siemens

2018

**3<sup>rd</sup> Meeting 26-27 February Klaus Austria** hosted by Omicron

It was decided that an additional task force should be formed to review current practice and establish WG guidelines on all site activities relating to moisture management. The four task forces are, “Site Installation”; “Site Testing;” “Trial Operation” and “Moisture”.

A review of Site Installation topics lead to sorting the brainstorming activities into their order of execution. It is proposed to start the technical discussion with a general section.

The new General section at the beginning of the TB, would include the following items:

- a. Introduction of Brochure (use flow chart/diagrams in the introduction of the TB to show typical assembly, acceptance tests, and trial period activities)
- b. EHS requirements, work permit
- c. Documentation – general rules for site installation documentation
- d. Site access, site conditions, installation competencies – for supervisor, mechanics, test technicians, ...
- e. Inventory on site: office, sanitary facilities ...
- f. Readiness of civil works
- g. Time schedule
- h. Work zone, induction hazard, electrical clearances to live equipment

The Site Installation section shall have a summary of issues to consider for the vacuum and oil filling process and include a table listing the requirements for different voltage classes.

The draft WG survey on site installation and site acceptance testing was reviewed and then the WG added many more questions and further refined others. The definition of trial operation was discussed, as well as the need to add related questions in the survey. The activities to be captured are the period

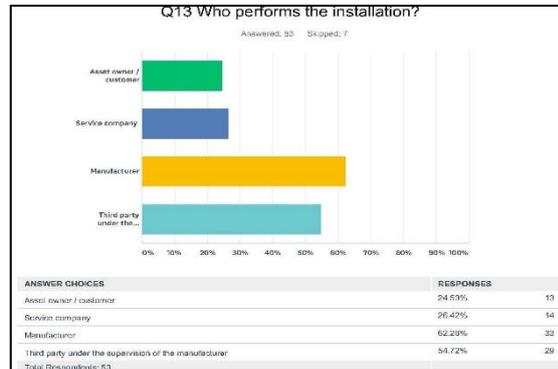
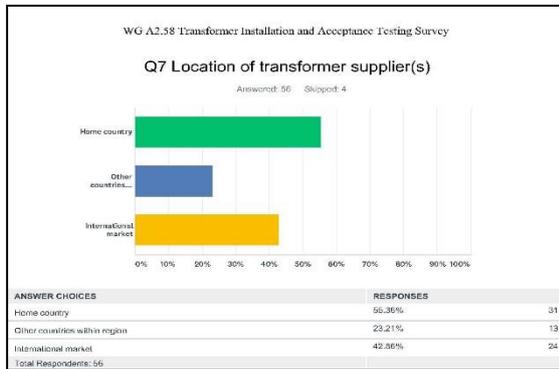
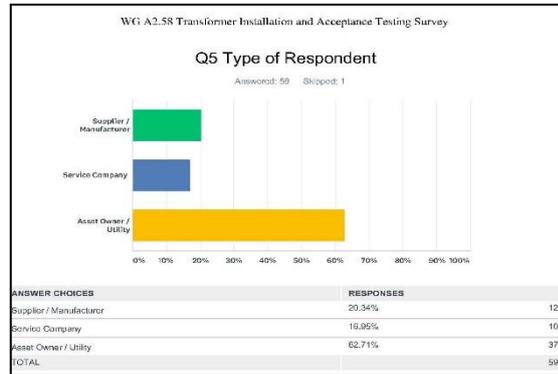
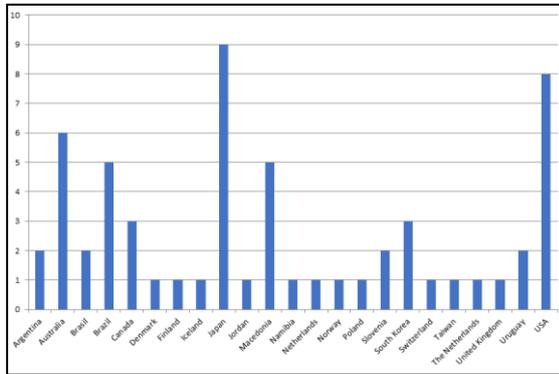


after energization up to first maintenance cycle, especially period before loading, then follow-up DGA and IR scanning for benchmarking, and checks on whether all components functioning as designed?

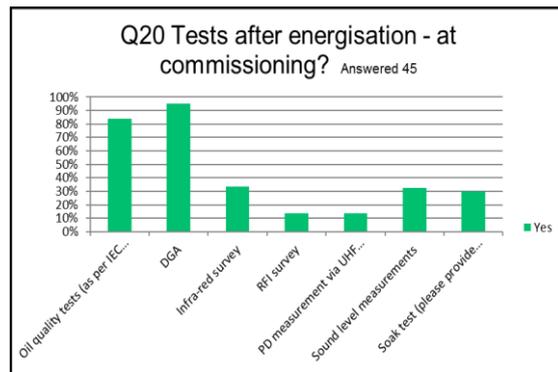
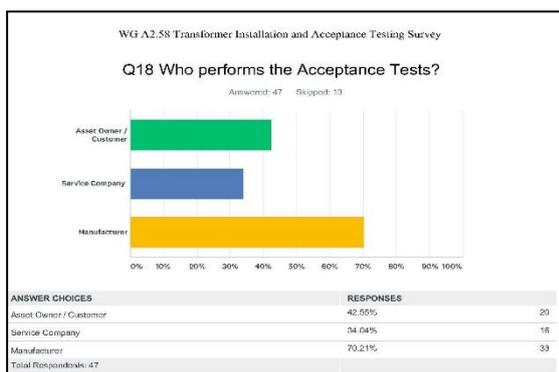
Please find attached PDF version of the finalised survey in the form it was disseminated via SC A2.

**4<sup>th</sup> Meeting 25-25 August Paris** hosted as part of CIGRE 47<sup>th</sup> Paris Session

The WG Survey had 60 responses as at 24 August. The following graphs provide an idea of the type of respondents, relative location of transformer supplier to the installation, and who performs installation.



The following graphs show 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.



The survey has provided useful insight into what is being done in the “trial period” following energisation by asking respondents to answer:

Tests after energisation – at commissioning?

What are the key acceptance tests and criteria?

If any, what tests are repeated through the warranty period?

Who defines the site acceptance tests and tests during the warranty period?



The WG has prepared drafts chapter(s) for TF1 Site installation, TF2 Site Acceptance Testing and TF 4 Moisture Management. The survey responses and WG discussion were used to develop an agreed direction for TF3 Trial Operation.

A poster for WG A2.58 was presented in the A2 poster session on Wednesday 29 August. It was decided to keep the survey open till the end of September 2018. Please find poster attached.

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.

### **3. Working Group Program**

Three WG meetings are planned in 2019 that are intended to be used to consolidate and then review the draft technical brochure. The 5<sup>th</sup> meeting will be hosted by Doble in Boston USA in April 2019.

The 6<sup>th</sup> meeting will either be hosted by Polar Diagnostics in Scotland, or by Electrarenska in Czech Republic, in August 2019.

The 7<sup>th</sup> meeting will be held during the SC A2 Colloquium in New Delhi in November 2019.

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](mailto:ross.willoughby@ge.com)**

**Phone: +61 417 712 879**



## 1. General

### Notes on Installation and Acceptance Testing

CIGRE Working Group A2.58 was set up in Spring 2017 to produce a Guide on the Installation and Pre-Commissioning of Transformers and Shunt Reactors to allow all stakeholders to appreciate the important stages, tasks, risks and competencies.

This questionnaire was devised to survey current practices and areas of concern. Respondents are requested to answer on behalf of their country or company/ies - please clarify in boxes 1 and 2. Please supply contact details in boxes 3 and 4 so that we can revert to clarify any answers.

### Definitions

“Installation” normally refers to assembly and similar activities which take place on site following delivery to prepare the transformer for service.

“Pre-commissioning” normally refers to checks and tests which take place following “installation” and before first energisation.

“Commissioning” normally means either integration of the transformer into substation systems or else first energisation.

“Trial operation” refers to the period following first energisation where additional checks and tests are made to ensure that the transformer is in good condition. In most cases this is equivalent to the Guarantee or Warranty period.

“Site Acceptance Tests” (SAT) will likely form part of pre-commissioning, but the scope of pre-commissioning activities may be wider and include functional tests and visual inspection etc.

This working group is interested in the Installation and Pre-commissioning stages, particularly in which site acceptance tests (SAT) are carried out to complement factory acceptance tests (FAT) and any special requirements within the trial operation or warranty period.

Note that the special activities of site assembly (i.e. involving work on the core and winding assembly) and heavy-duty site testing (e.g. HV dielectric tests) are the scope of a companion working group.

### 1. Country

### 2. Company name

### 3. Contact person

### 4. Email address

### 5. Type of Respondent

- Supplier / Manufacturer
- Service Company
- Asset Owner / Utility

### 6. How many transformer suppliers are used?

- Range of suppliers
- Mainly one supplier

### 7. Location of transformer supplier(s)

- Home country
- Other countries within region
- International market

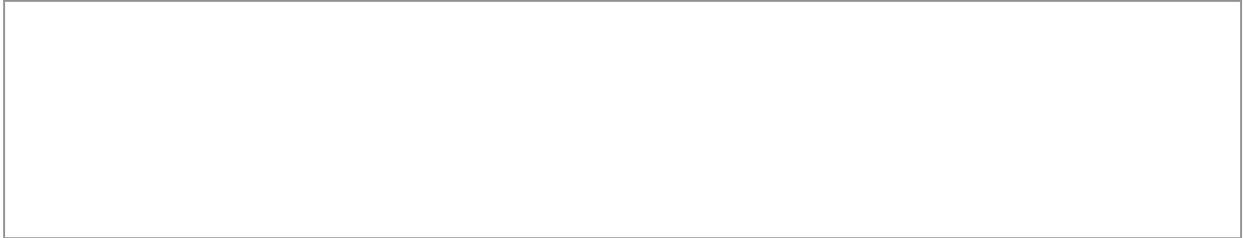
### 8. Number of transformers installed over the last 5 years

### 9. Voltage range of transformers installed

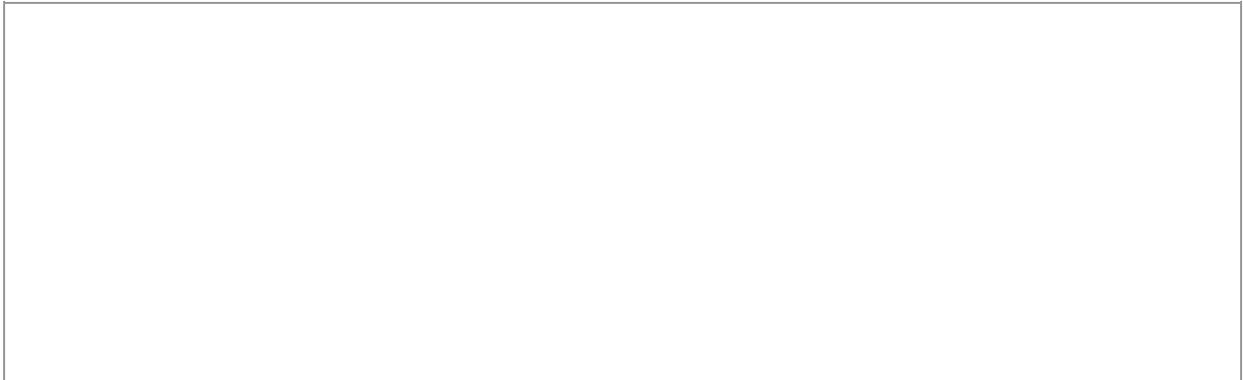
### 10. MVA range of transformers installed

**11. Commercial terms of supply (e.g. DAP - Delivered at Place, or other Incoterms\*) and how this affects Site Acceptance Tests**

*(\*Incoterms = International Commercial Terms, published by the International Chamber of Commerce. Some aspects of Incoterms as applied to transformers are described in CIGRE brochure 673)*



**12. Topics of concern relating to Installation and Site Acceptance Testing**





## 2. Installation Questions

### 13. Who performs the installation?

- Asset owner / customer
- Service company
- Manufacturer
- Third party under the supervision of the manufacturer

### 14. What checks are done after delivery and before installation?

- External visual inspection
- Impact recorder analysis
- Core / frame insulation resistance check
- FRA test
- Gas pressure and dew point check
- Internal visual inspection
- Review of incident reports
- Other / Most important (please specify)

### 15. Drying / oil processing criterion is based on:

	Before oil filling	After oil processing
Dew point	<input type="text"/>	<input type="text"/>
Moisture in oil (ppm) / Relative Saturation	<input type="text"/>	<input type="text"/>
Electrical tests on insulation	<input type="text"/>	<input type="text"/>

**16. Is there any requirement for a minimum number of passes through the oil processing plant? If so, how many?**

**17. Is there any requirement for a minimum "resting" or "standing" time between oil processing and energisation? If so, how long?**



## 3. Acceptance Testing Questions

### 18. Who performs the Acceptance Tests?

- Asset Owner / Customer
- Service Company
- Manufacturer

Comments

### 19. Off-line tests

Please only indicate tests that are always done on a regular basis. For tests done only occasionally, in special circumstances or for specialised transformers (e.g. HVDC), please provide details in the other/comments box at the end of the table.

	At commissioning before energisation?	Routinely after commissioning?
Ratio and vector group	<input type="checkbox"/>	<input type="checkbox"/>
Winding resistance	<input type="checkbox"/>	<input type="checkbox"/>
Demagnetisation	<input type="checkbox"/>	<input type="checkbox"/>
Magnetising / excitation current	<input type="checkbox"/>	<input type="checkbox"/>
Capacitance and DDF (or PF)	<input type="checkbox"/>	<input type="checkbox"/>
Impedance	<input type="checkbox"/>	<input type="checkbox"/>
Winding insulation resistance	<input type="checkbox"/>	<input type="checkbox"/>
Core / frame insulation resistance	<input type="checkbox"/>	<input type="checkbox"/>
Frequency Response Analysis (FRA)	<input type="checkbox"/>	<input type="checkbox"/>

**At commissioning before energisation?**

**Routinely after commissioning?**

PDC / FDS

High voltage tests  
(usually combined  
with PD  
measurements)

CT checks

OTI and WTI checks

Functional checks on  
[other]  
indicating/protective  
devices

External visual  
inspection

Internal visual  
inspection

Other / Comments

## 20. Tests after energisation

	At commissioning?	Routinely?
Oil quality tests (as per IEC 60422)	<input type="checkbox"/>	<input type="checkbox"/>
DGA	<input type="checkbox"/>	<input type="checkbox"/>
Infra-red survey	<input type="checkbox"/>	<input type="checkbox"/>
RFI survey	<input type="checkbox"/>	<input type="checkbox"/>
PD measurement via UHF couplers	<input type="checkbox"/>	<input type="checkbox"/>
Sound level measurements	<input type="checkbox"/>	<input type="checkbox"/>
Soak test <i>(please provide details in the Other/Comment field below)</i>	<input type="checkbox"/>	<input type="checkbox"/>

Other / Comments

## 21. What are the key acceptance tests and criteria?

## 22. If any, which tests are repeated during the warranty period?

**23. Who defines the Site Acceptance Tests and tests during the warranty period?**



# Installation and Pre-Commissioning of Transformers and Shunt Reactors

## Terms of Reference

- Considers the installation of power transformers and reactors into switchyards, power stations and substations including small power, medium power and large power transformers of all voltage levels above 11kV primary voltage. Excludes small power (auxiliary) distribution transformers (which are usually complete and operational prior to their transportation), kiosk and pole mounted transformers
- Excludes site assembly and heavy-duty site testing (eg HV dielectric tests) covered by WG A2.59. Site assembly is defined to involve special installation where assembly work on the core and winding assembly is required.
- Considers context with existing CIGRE documents relating to transformer diagnostics, specifications, monitoring, life management, transport, maintenance, fire safety and economics

## Activities Discussed

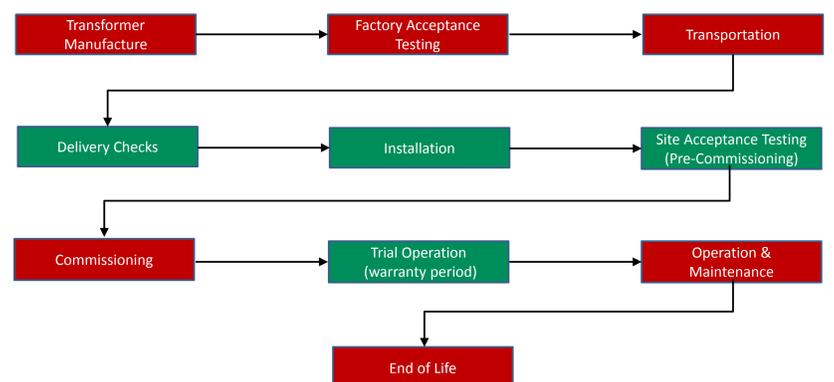
- Deliver, handle and position the main tank and transformer accessories
- Beware of readiness of civil works and site access/resources/interfaces, define the demarcation between installation and other site activities
- Manage dielectric liquid handling and proper filling of the transformer, including all aspects associated with the different types of dielectric liquids
- Ensure the transformer is ready for service
- Consider tasks and items often overlooked in site installation, risks, competencies
- Consider specialised transformer accessories, electrical connections, monitoring
- Perform inspection and test plans, understand the roles of factory and site testing, and adopt recommended site tests
- Benchmark for tests and condition monitoring
- Prepare documentation for final substation integration testing / commissioning to integrate the new transformer/reactor into the substation and its secondary systems. It is very important to have documentation which precisely shows what pre-commissioning was done and how. There needs to be a minimum standard of information and format of the handover manuals, document(s) / drawings etc.

- Prepare or train substation operators in transformer controls, accessories, functions and how to interpret their performance. There may even be new technology incorporated into the transformer which the customer did not specify. This could even be in the form of instrumentation or primary trip devices thought necessary by the transformer manufacturer to suit the special application of the transformer.
- Consider using a no-load 'soak' period following first energization and precautions to be observed in this period
- Consider staged load increase and what additional checks or tests should be made during this period
- Consider requirements for the warranty period and what additional checks or tests should be made during this period

## Complements a series of CIGRE Technical Brochures

- TB 528 - Technical Specification
- TB 529 - Contract Review and Design Review
- TB 673 - Transportation
- TB 445 - Guide to Transformer Maintenance
- TB 227 - Life Management Techniques

## Relevance to the Transformer Life Cycle



 Denotes stages within the scope of this WG

# Installation and Pre-Commissioning of Transformers and Shunt Reactors

continued

## WG Survey – 23 Questions

[https://www.surveymonkey.com/r/WGA2\\_58\\_Survey](https://www.surveymonkey.com/r/WGA2_58_Survey)

## Acceptance Testing Questions

**WG A2.58 Transformer Installation and Acceptance Testing Survey**

1. General

Notes on Installation and Acceptance Testing

CIGRE Working Group A2.58 was set up in Spring 2017 to produce a Guide on the Installation and Pre-Commissioning of Transformers and Shunt Reactors to allow all stakeholders to appreciate the important stages, tasks, risks and competencies.

This questionnaire was devised to survey current practices and areas of concern. Respondents are requested to answer on behalf of their country or company/fes - please clarify in boxes 1 and 2. Please supply contact details in boxes 3 and 4 so that we can revert to clarify any answers.

**Definitions**  
 "Installation" normally refers to assembly and similar activities which take place on site following delivery to prepare the transformer for service.  
 "Pre-commissioning" normally refers to checks and tests which take place following "installation" and before first energisation.  
 "Commissioning" normally means either integration of the transformer into substation systems or else first energisation.  
 "Trial operation" refers to the period following first energisation where additional checks and tests are made to ensure that the transformer is in good condition. In most cases this is equivalent to the Guarantee or Warranty period.  
 "Site Acceptance Tests" (SAT) will likely form part of pre-commissioning, but the scope of pre-commissioning activities may be wider and include functional tests and visual inspection etc.

This working group is interested in the installation and Pre-commissioning stages, particularly in which site acceptance tests (SAT) are carried out to complement factory acceptance tests (FAT) and any special requirements within the trial operation or warranty period.

Note that the special activities of site assembly (i.e. involving work on the core and winding assembly) and heavy-duty site testing (e.g. HV dielectric tests) are the scope of a companion working group.

1. Country

2. Company name

**WG A2.58 Transformer Installation and Acceptance Testing Survey**

3. Acceptance Testing Questions

18. Who performs the Acceptance Tests?

Asset Owner / Customer  
 Service Company  
 Manufacturer

Comments

19. Off-line tests

Please only indicate tests that are always done on a regular basis. For tests done only occasionally, in special circumstances or for specialised transformers (e.g. HVDC), please provide details in the other/comments box at the end of the table.

	At commissioning before energisation?	Routinely after commissioning?
Ratio and vector group	<input type="checkbox"/>	<input type="checkbox"/>
Winding resistance	<input type="checkbox"/>	<input type="checkbox"/>
Demagnetisation	<input type="checkbox"/>	<input type="checkbox"/>
Magnetising / excitation current	<input type="checkbox"/>	<input type="checkbox"/>
Capacitance and DDF (or PF)	<input type="checkbox"/>	<input type="checkbox"/>
Impedance	<input type="checkbox"/>	<input type="checkbox"/>
Winding insulation resistance	<input type="checkbox"/>	<input type="checkbox"/>
Core / frame insulation resistance	<input type="checkbox"/>	<input type="checkbox"/>
Frequency Response Analysis (FRA)	<input type="checkbox"/>	<input type="checkbox"/>

## Installation Questions

**WG A2.58 Transformer Installation and Acceptance Testing Survey**

2. Installation Questions

13. Who performs the installation?

Asset owner / customer  
 Service company  
 Manufacturer  
 Third party under the supervision of the manufacturer

14. What checks are done after delivery and before installation?

External visual inspection  
 Impact recorder analysis  
 Core / frame insulation resistance check  
 FRA test  
 Gas pressure and dew point check  
 Internal visual inspection  
 Review of incident reports  
 Other / Most important (please specify)

15. Drying / oil processing criterion is based on:

	Before oil filling	After oil processing
Dew point	<input type="checkbox"/>	<input type="checkbox"/>
Moisture in oil (ppm) / Relative Saturation	<input type="checkbox"/>	<input type="checkbox"/>
Electrical tests on insulation	<input type="checkbox"/>	<input type="checkbox"/>

## Trial Operation Questions

20. Tests after energisation

	At commissioning?	Routinely?
Oil quality tests (as per IEC 60422)	<input type="checkbox"/>	<input type="checkbox"/>
DGA	<input type="checkbox"/>	<input type="checkbox"/>
Infra-red survey	<input type="checkbox"/>	<input type="checkbox"/>
RFI survey	<input type="checkbox"/>	<input type="checkbox"/>
PD measurement via UHF couplers	<input type="checkbox"/>	<input type="checkbox"/>
Sound level measurements	<input type="checkbox"/>	<input type="checkbox"/>
Soak test (please provide details in the Other/Comment field below)	<input type="checkbox"/>	<input type="checkbox"/>

Other / Comments

21. What are the key acceptance tests and criteria?

22. If any, which tests are repeated during the warranty period?

**WG Survey  
QR Code**



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

### 1. Working Group Scope

The working group has four main focus areas as illustrated in Figures 1 and 2.

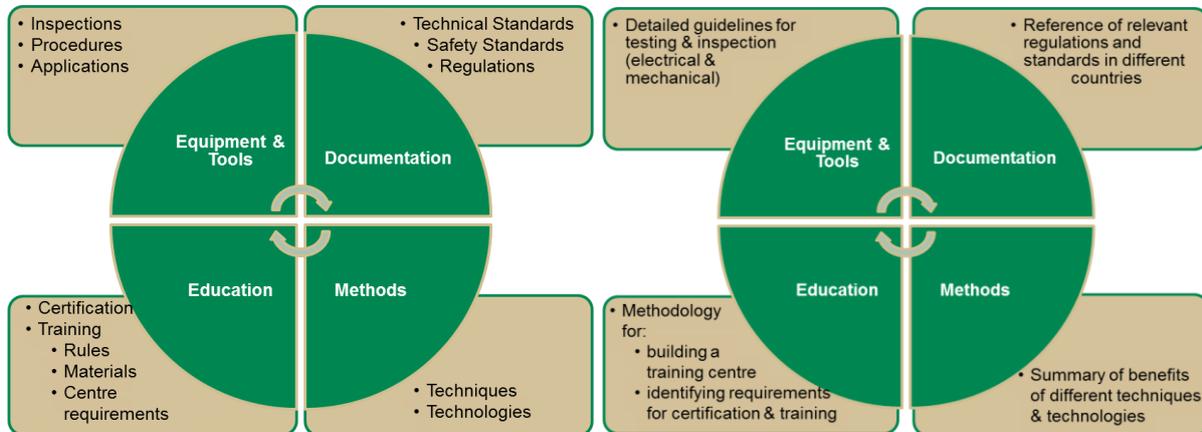


Figure 1. Working Group Objectives

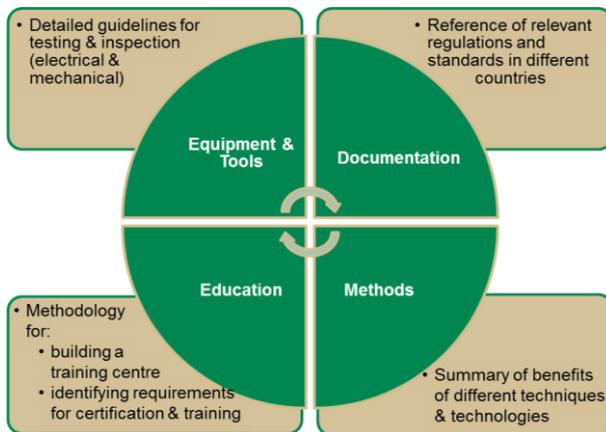


Figure 2. Working Group Outputs

WG deliverables include: Brochure, Electra Article and Tutorial. See the [Terms of Reference](#) for more detailed information.

### 2. Working Group Activities

Working group meetings/activities are shown in the table below:

Activity	Location	Date
1 <sup>st</sup> WG Meeting	Mulhouse, France	Apr 2016
2 <sup>nd</sup> WG Meeting	Wurzburg, Germany	Oct 2016
3 <sup>rd</sup> WG Meeting	Strasbourg, France	Apr 2017
4 <sup>th</sup> WG Meeting	Toronto, Canada	21-22 Sep 2017
Survey Closed	-	31 Dec 2017
5 <sup>th</sup> WG Meeting	Bergen, Norway	13-14 Apr 2018
6 <sup>th</sup> WG Meeting	Ankara, Turkey	3-4 Oct 2018
7 <sup>th</sup> WG Meeting (Final - confirmed)	Budapest, Hungary	13-14 Mar 2019
WG deliverables completed	-	Mid 2018

This year's focus was initially on restructuring the document. Following the restructure, survey results, various local and international standards, and local work practices have been used to populate the chapters documenting the various testing and training practices around the world. The brochure is divided into two parts; live line training, and live line equipment and tools and currently totals around 100 pages.

For the Australian live line industry, the key takeaway is that there are vastly different approaches to live work throughout the world particularly in regard to the:

- Hierarchy of accountability and responsibilities during live work;
- Training and competency assessment regime and format;
- Preference for highly prescriptive work instructions for workers or general rules allowing for a flexible approach to activities; and the
- Frequency of testing and inspection of tools and equipment.

This is arguably not unexpected given the differences in network, regulatory environment and perception of live work as greater/lesser risk to linespersons than 'dead' work. However, one aspect



seemed consistent across countries; the perceived lack of adequate regulations and oversight of low voltage live work.

### **3. Working Group Program**

The program was pushed out by six months as a result of changes in the structure of the document but is now in finalisation stage. The forecast completion date is now June 2018.

**Convener:** Dr Bálint Németh (Hungary)

**Email:** [nemeth.balint@vet.bme.hu](mailto:nemeth.balint@vet.bme.hu)

**Phone:** N/A

**Australian Regular Member:** Alexandra Price

**Email:** [alexandraprice@energex.com.au](mailto:alexandraprice@energex.com.au)

**Phone:** 0428 674 873



## Working Group B2.67 Assessment and testing of wood and alternative material type poles

### 1. Working Group Scope

Responding to various reported issues with the performance of wood poles the working group is seeking to develop a consolidated global view of best practice in terms of the assessment and testing of wood and alternative material type poles. The Working Group is aiming to:

- Determine the present status of wood pole experience and extent of failures in utilities worldwide.
- 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).
- 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.
- Identify and discuss the various methods used to strengthen or reinforce degraded poles, including their impact on the foundation arrangement.
- Provide guidance on alternate preservatives/treatments and compare their potential environmental impacts.
- 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 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.

Further details are provided in the terms of reference available via the following link:

[https://www.cigre.org/userfiles/files/News/2018/TOR-WG%20B2\\_67\\_Assessment%20and%20Testing%20of%20Wood%20and%20Alternative%20Material%20Type%20Poles.pdf](https://www.cigre.org/userfiles/files/News/2018/TOR-WG%20B2_67_Assessment%20and%20Testing%20of%20Wood%20and%20Alternative%20Material%20Type%20Poles.pdf)

### 2. Working Group Activities

During 2018 Nathan Spencer took over as convener from Ashan Siddque. Nathan had previously been serving as the WG secretary.

The WG membership was expanded to include representatives from the USA providing greater access to North American experience.

A first survey was released at the beginning of 2018, however rework was required and a revised survey is now available for release. Preparation of a draft report has commenced.

Interesting insights gained to date include:

- USA practice appears to under-design their poles. Even their strengthening programs use loads less than we would in Australia.
- There appears to be minimal knowledge in utilities about timber pole design and performance from most countries.
- Many people are starting to come across problems with wood poles.
- Consensus view is that inspection technologies are poorly assessed around the globe.

In 2019 a face to face meeting is proposed for either Denmark on June 2<sup>nd</sup> or as part of the SCB2 meeting in New Delhi in November 2019.

### 3. Working Group Program

The working group began in May 2017 and is aiming to complete its work by August 2020.

**Convener:** Nathan Spencer  
**Email:** [nathan@uriengineering.com](mailto:nathan@uriengineering.com)  
**Phone:** [+61 439 511 836](tel:+61439511836)



## Task Force TFB4.77 AC Fault Response Options for VSC HVDC Converters

### Task Force Scope

This is an important Task Force for Australia as it investigates new solutions to the challenges faced by weak AC power systems with little or no synchronous generation. The rapid growth of solar and wind generation in Australia, particularly in states such as South Australia and north Queensland, together with recent major disturbances in the NEM make this a very timely piece of work. The Task Force will consider what is required to change the design and cost of HVDC VSC inverters so that new HVDC VSC interconnectors perform as Virtual Synchronous Machines. The work will include a range of specification options, model simulations, converter valve ratings and a broad cost benefit analysis.

### Task Force Activities

The task force met three times in the past 12 months:

December 2017 : Manchester, UQ – inaugural meeting

February 2018, Paris France

August 2018, Paris France – final meeting

Professor Simon Bartlett, Australia's representative on the task force attended all three meetings and co-ordinated the drafting of the Problem Definition chapter of the task force's report which is currently due to be released in April 2019.

### Task Force Program

Completed task force activities include the problem definition, specification options and model simulations. Remaining work at the August meeting included the implications for converter ratings and performance as well as the cost-benefit assessments.

The initial program to complete the task force report by October 2018 has been deferred to April 2019 to align with the CIGRE symposium in Hakkaido Japan. This is a challenging program, noting that no further task force meetings are planned.

### Links

<https://www.cigreaustralia.org.au/news/in-the-loop-news/task-force-tfb4-77-ac-fault-response-options-for-vsc-hvdc-converters/>

**Convener:** John Gleadow

**ANC representative on Task Force:** Simon Bartlett

**Email:** Simon.bartlett@uq.edu.au

**Phone:** +61 (0) 411 600 584

## **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 has been carried out and analysis is underway. Writing of the report is underway.

### **3. Working Group Program**

Survey design will be complete in Q1 2018. The survey will be carried out in Q2 2018. Analysis and report writing will take place in Q2 to Q4 2018. The technical brochure and Electra article will be finished in mid 2019.

**Convener:** Graeme Ansell  
**Email:** [graeme.ancell@ancellconsulting.nz](mailto:graeme.ancell@ancellconsulting.nz)  
**Phone:** +64 21 382 036



## 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 two meetings to date.

The first WG meeting was held in Canada in conjunction with the meeting of WGC3.01 EMF and Health, a meeting of the Utilities Threshold International Consortium and a presentation from the International Commission on Non Ionising Radiation about their EMF guideline including their next revision.

WG 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 powerfrequency 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. Key achievements to date include:

- Draft technical brochure with draft text for all sections.
- 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 is due to complete the technical brochure by the end of 2020.

A key focus for 2019 will be reaching agreement on wording for dealing with uncertainty and the application of precaution. There are presently multiple and varying views on how this information should be presented. Other challenges include:

- The brochure also needs to address DC fields and information is currently being collated for consideration.
- A number of members do not regularly attend meetings and there is significant correspondence via email.

Realistically the final brochure, Electra article and tutorial are likely to be approved ready for the meeting in 2021 (location and theme yet to be determined).

**Convener: James Hart**  
**Email: [jhart@ausgrid.com.au](mailto:jhart@ausgrid.com.au)**  
**Phone: 0412070574**



## Working Group C5.22: The Management of Systemic Market Risk in Electricity Markets

### 1. Working Group Scope

This working group has collected information on various markets on the way in which systemic market risk is approached. The broad approach was to assess:

- Is there a systemic risk in your market?
- How is the systemic risk addressed?
- Is a central counterparty or clearing house the solution?
- What other methods could be used to mitigate the risk?

For the purposes of this project it was proposed to define Systemic Risk in the following way:

Systemic risk is the risk of collapse of an entire market, as opposed to risk associated with any one individual entity, group or component of a system that can be contained within the market without harming the entire system. It can be defined as "market system instability, potentially catastrophic, caused or exacerbated by idiosyncratic events or conditions in intermediaries". It refers to the risks imposed by interlinkages and interdependencies in a system or market, where the failure of a single entity or cluster of entities can cause a cascading failure, which could potentially bankrupt or bring down the entire system or market.

A couple of examples which we expected to consider were:

- Where a very large market participant who is too big to fail does fail
- A very severe drought in a market heavily dependent on hydro-generation

The outcome was an assessment of the overall approaches which have been adopted and an attempt to categorise approaches and link these to basic market, cultural or geographic parameters

### 2. Working Group Activities

The survey form was developed and sent out during 2017 so 2018 has been a year of refining the results and developing the Technical Brochure. The Working Group had 21 members and 7 Corresponding members from 20 countries.

On 9 June the initial results and a compilation of all responses for the 11 markets was sent out to the Working Group for comment.

Following a review of the initial responses, it was noted that the risks identified in these responses do not typically lead to the end of the market, so it was decided to gather some additional data. This took the form of a few one-page case studies on markets which have failed so that, with hindsight, the circumstances which lead to their failure could be understood, including whether it was the result of a foreseeable systemic risk. A pro forma for collecting this case study data was circulated on 22 June. This exercise failed to elicit any market failures but did identify a couple of incipient failures which were pre-empted.

The C5.22 Working group met in Paris on Saturday 25 August before the Paris Session proper had started. There were 15 attendees at the meeting including Andy Ott and Alex Cruickshank. Two members skyped in from Croatia and Italy.

This meeting endorsed the proposed approach and agreed to the draft timeframe for producing the Technical Brochure and other deliverables.

In addition, there was a good level of interest in the initial results when I presented them at the C5 committee meeting in Paris.

On 2 September a final draft Technical Brochure was circulated to the Working Group for comment based on the comments received at the Paris meeting.



On 20 December, a Technical Brochure was sent in for approval and this was circulated to the Study Committee on 21 December for their comment. No comments have been received to date.

The broad conclusion from this review by C5.22 is that while the level of systemic risk is very different across different markets, this study has not found any underlying correlations which can explain this variation.

It does appear that a good consideration of the risks can reduce the level of risk.

The issues which are of particular relevance to the Australian power industry are that the systemic risk of poor policy decisions and no coherent policy direction pose a significant risk to Australian energy markets. Affordability issues caused by the poor policy decisions are also a significant risk to the markets in Australia

### **3. Working Group Program**

The overall program of activities for the Working group in 2018 and 2019 is shown below. It is planned that the Working Group will be finalised by March 2019.

<b>Task</b>	<b>Planned Date</b>	<b>Actual</b>
Review of data and develop insights (Paris)	25 August 2018	Completed
Provide comments on draft Technical Brochure and any additional survey responses for additional markets	20 October 2018	Completed
Draft Technical Brochure with conclusions for final comments	30 November 2018	Completed
Final Technical Brochure submitted for Approval to CIGRE	30 January 2019	20 December
Final Technical Brochure approved and Electra Article delivered	30 March 2019	30 March 2019

**Convener: David Bowker**  
**Email: [dgbowker@gmail.com](mailto:dgbowker@gmail.com)**  
**Phone: +61418136493**



## Working Group D1.69 “Guidelines for test techniques of High Temperature Superconducting (HTS) systems”

### Working Group Scope

To study the existing HTS power installations and compile the relevant data that will assist the power industry to test HTS technology used in the transmission and distribution grid.

Special attention will be paid to:

- The present and future need for HTS power installations.
- Update on the status of field test experience of HTS power installations and comparison with existing guidelines.
- Aging of electrical insulation, superconductors and cooling systems.
- Failure mode analysis

The WG will summarise the best practices in the above mentioned topics and provide guidelines for test techniques of High Temperature Superconducting (HTS) systems.

### Working Group Activities

The kick off meeting was held in Brisbane, Australia on the 29<sup>th</sup> June 2017.

The 2<sup>nd</sup> WG meeting was held at EUCAS in Geneva on 22<sup>nd</sup> September 2017.

The 3<sup>rd</sup> WG was held in Shanghai from the 16<sup>th</sup> to the 18<sup>th</sup> of May 2018. As well as a D1.69 WG discussion to progress the TB, a joint meeting was held with D1.64 with Jun Fujikami of TC 90 also present.

A 4<sup>th</sup> WG has been held at the IEE ASC conference in Seattle in October 2018. At this meeting the first draft of five Chapters of the CIGRE TB were compiled and reviewed by the attendees. The D1.69 WG is in the process of using the KMS protocol to consolidate and coordinate their TB activities. This may take some time, but we expect this is the most effective method to capture all revisions, content and share progress with all the members of D1.69.

The 5<sup>th</sup> WG meeting is planned for Milan in April 2019. This is also configured around a joint session with D1.64 with participation of TC 90.

### Working Group Program

**Approach:** There will be coordination with this WG and D1.64 as they share some common members, and can usefully coordinate on technical topics where appropriate. Also coordination and participation with IEC/TC90 to attend the WG D1.69 meetings when possible.

**Achievements:** Preliminary chapter allocations based on the scope dot points have been agreed, and WG Member Leads have been assigned.

TB content is being coordinated with the allocated Chapter Leads and this material was reviewed at the 4<sup>th</sup> WG meeting in October 2018. This chapter development will form the basis of the further discussions in Milan in April 2019.

The completion date goal is August 2020.

**Convener: Dr Richard Taylor**

**Email: rr.taylor@qut.edu.au**

**Phone: +61 (0)427 115 468**



## 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

The survey work stream has been initiated with the initial results being processed. Figure 1 shows the country distribution of the respondents. A follow up survey will be sent out sometime early this year to gather additional responses, with the help of the country National Committees.

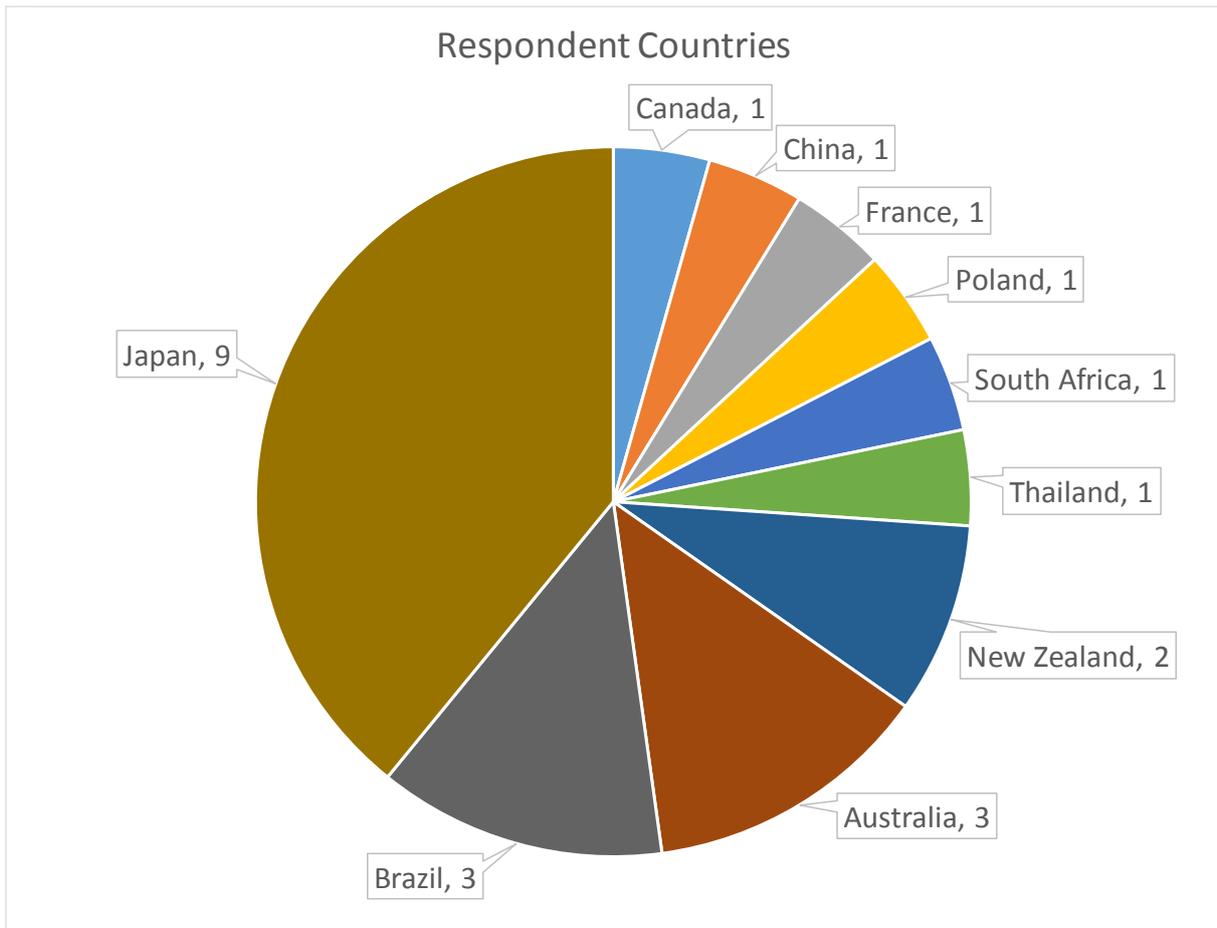


Figure 1 - Survey respondents



### 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 Building 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.

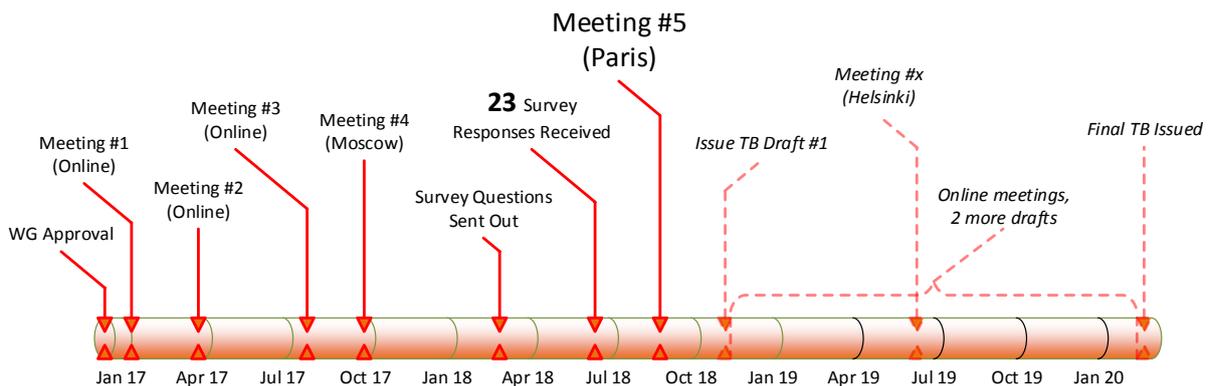


Figure 2 - Current Timeline

Convener: Victor Tan

Email: [emailvictor@gmail.com](mailto:emailvictor@gmail.com), [victor.tan@pscconsulting.com](mailto:victor.tan@pscconsulting.com)

Phone: +61422881273

## CIGRE Workshop presented by AP A2 Transformers and Reactors

### “Transformers – Condition Assessment with a Focus on Bushings – An Interactive Workshop”

#### 1. Details of the Workshop

The workshop was held in Sydney at the Hilton Hotel on Monday 16 April, 2018, and was attended by 84 delegates and 6 speakers. The workshop was held in conjunction with Techcon Asia Pacific, which was held later at the same venue on the 17 and 18 April. The workshop operated using 4:3 format powerpoint presentations. The workshop had two parts, a morning session where speakers presented CIGRE tutorials or technical papers, followed after lunch by a panel session where speaker/experts received questions initially from the facilitator, which led into spontaneous questions and interactive discussion from the delegates.

#### 2. Workshop Program

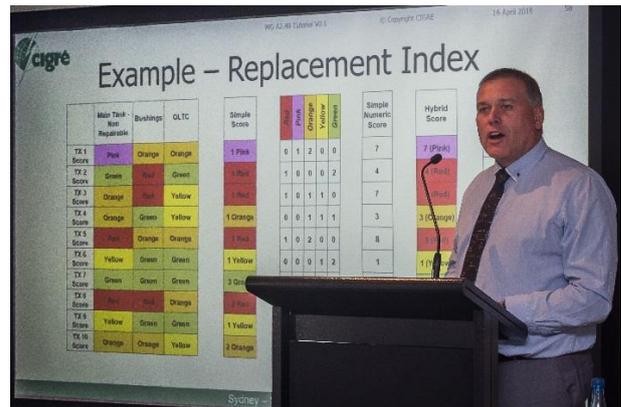
The day commenced with two CIGRE Tutorials followed by three presentations from a test equipment supplier, an insurance company and utility backgrounds. The presenters provided delegates with experience, guidance, advice and recommendations on how different stakeholders position themselves to address HV bushing risk in power transformers.

Ross Willoughby & Kerry Williams	Introductions & explanation of workshop proceedings.
Jon Brown (Transpower NZ)	<b>CIGRE Tutorial - A2.43 - Transformer Bushing Reliability</b> The tutorial covered the work done in the WG A2:43 and discussed the bushing failure mechanisms, some failure prevention methods, off-line & on-line testing, storage and lots more. Some recommendations for bushing reliability improvements and possible changes to standards were also presented.
Peter Cole (convener CIGRE WG A2.49)	<b>CIGRE Tutorial - A2.49 - Condition Assessment of Power Transformers</b> This Tutorial covered the work done in WG A2:49 The tutorial discussed the types of transformer assessment indices that can be developed and the critical steps to develop an index to suit the user’s needs. The tutorial also briefly discussed how to deal with uncertainty in information, the use of on-line monitors and criticality and other considerations.
Wenyu Guo (Omicron)	<b>HV Bushing Testing &amp; Condition markers</b> This presentation discussed the various bushing tests that can be performed and presents an overview of off-line bushing diagnostics by dissipation factor and capacitance measurement at different frequencies. What this means and how it can be used to determine bushing condition and help with asset decision making.
Terence Lee & Terence Rademeyer (FM Global)	<b>Considerations for HV bushing failures &amp; the impact on Insurance risk</b> The presenter discussed the loss history where bushings have resulted in transformer failures and also recommendations for managing this risk. Presented what their clients are doing in terms of best practice and how these practices can be used as a guide on the best way to manage bushing risks. Discussed the use of spare bushings for risk mitigation and how insurers underwrite companies that manage this risk well versus those that don’t.
Peter New (Snowy Hydro)	<b>HV Bushing Case Study &amp; Scenarios</b> This presentation focussed on a case study of a bushing failure and the consequences of that failure. Discussed the aftermath and what it meant to the company. What changes were made to mitigate further failures. Also, posed some scenarios for discussion in the Panel session.

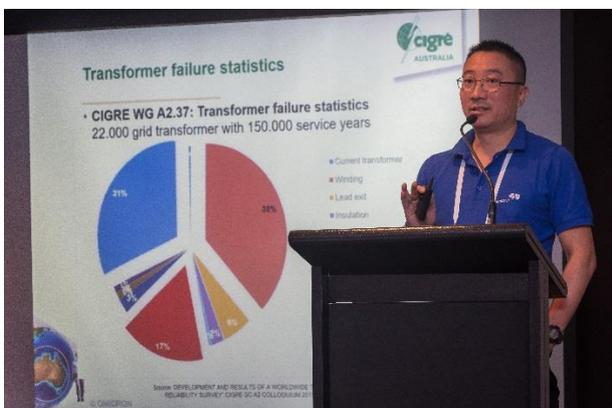
These presentations provided the delegates with the background knowledge and case examples for dealing with transformer bushing failure risks. In the afternoon, the speakers and an invited expert formed a panel to take questions from facilitators and then from delegates as interaction developed.



Jon Brown – Tutorial from WG A2.43 Transformer Bushings Reliability



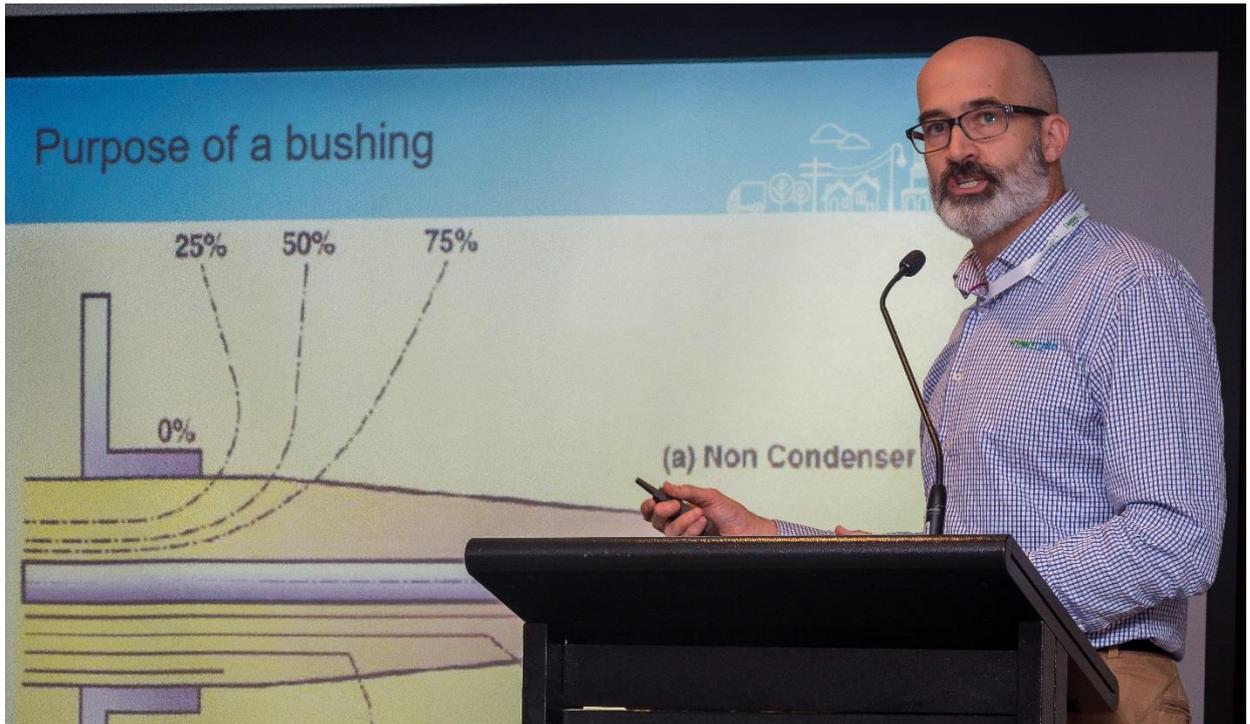
Peter Cole - Tutorial from WG A2.49 Condition Assessment of Transformers & Assessment Indices



Wenyu Guo – HV Bushing Testing



Terence Rademeyer & Terence Lee – Insurer’s view



Peter New – HV bushing failure case study

Facilitators and speakers in the panel session



### 3. Conclusion

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

- the perceived short life expectancy of this component (25-30) compared to that of a power transformer (40+)
- the relatively short escalation period from causal failure initiation to catastrophic failure of a bushing
- bushings usually do not appear in criteria for transformer replacement, because bushings are replaceable at moderate cost
- various failure modes to consider (thermal, dielectric, high freq transients from GIS etc)
- good on-line and off-line electrical testing is available, as well as thermal imaging and hand-held partial discharge noise signal and corona camera detectors
- insurance companies see very early mortality age in bushings. Spare bushings can be a good risk mitigation but is not always well implemented
- electrical testing requires careful execution and careful interpretation
- specialised bushings exist (eg re-entrant type and HVDC converter transformers)

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 (Secretary ANC) and Ross Willoughby (Convener AP 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 2017 event where 74 delegates attended.

The affiliation of the speaker presenters (with AP A2 members accented) and the invited expert for the afternoon panel session:

Jonathan Brown (Transpower NZ), Peter Cole (Consultant), [Wenyu Guo \(Omicron\)](#), Karl Haubner (Doble), Terence Lee (FM Global), [Peter New \(Snowy Hydro\)](#), Terence Rademeyer (FM Global).

Event photography was provided by Peter Cole.

The event was chaired by Kerry Williams (CIGRE Australia Secretary) and Ross Willoughby (Convener AP A2). Tara-Lee Macarthur (Ergon Energy) assisted with organising and facilitating during the workshop.

**Name:** Ross Willoughby

**Email:** [ross.willoughby@ge.com](mailto:ross.willoughby@ge.com)

**Phone:** 0417 712 879