

Report to the CIGRE Australian Technical Council

Study Committee SC A3 and Australian Panel AU A3 Activities



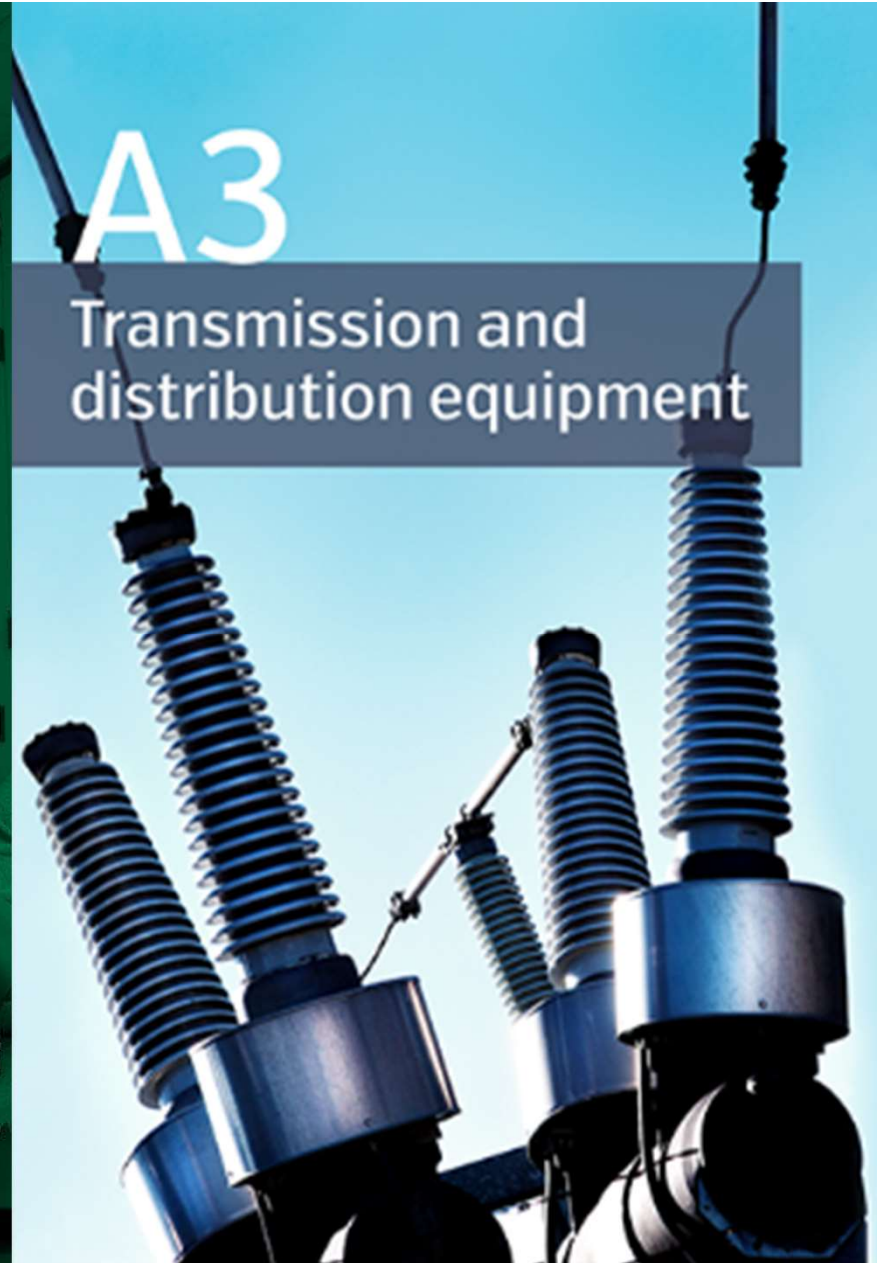
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AU A3 Report 2023
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A3

Transmission and
distribution equipment



News from CIGRE A3 Transmission and Distribution Equipment

Nenad Uzelac, SC A3 Chair

May 2023



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SC A3 at a glance

SC A3 is constituted as follows:

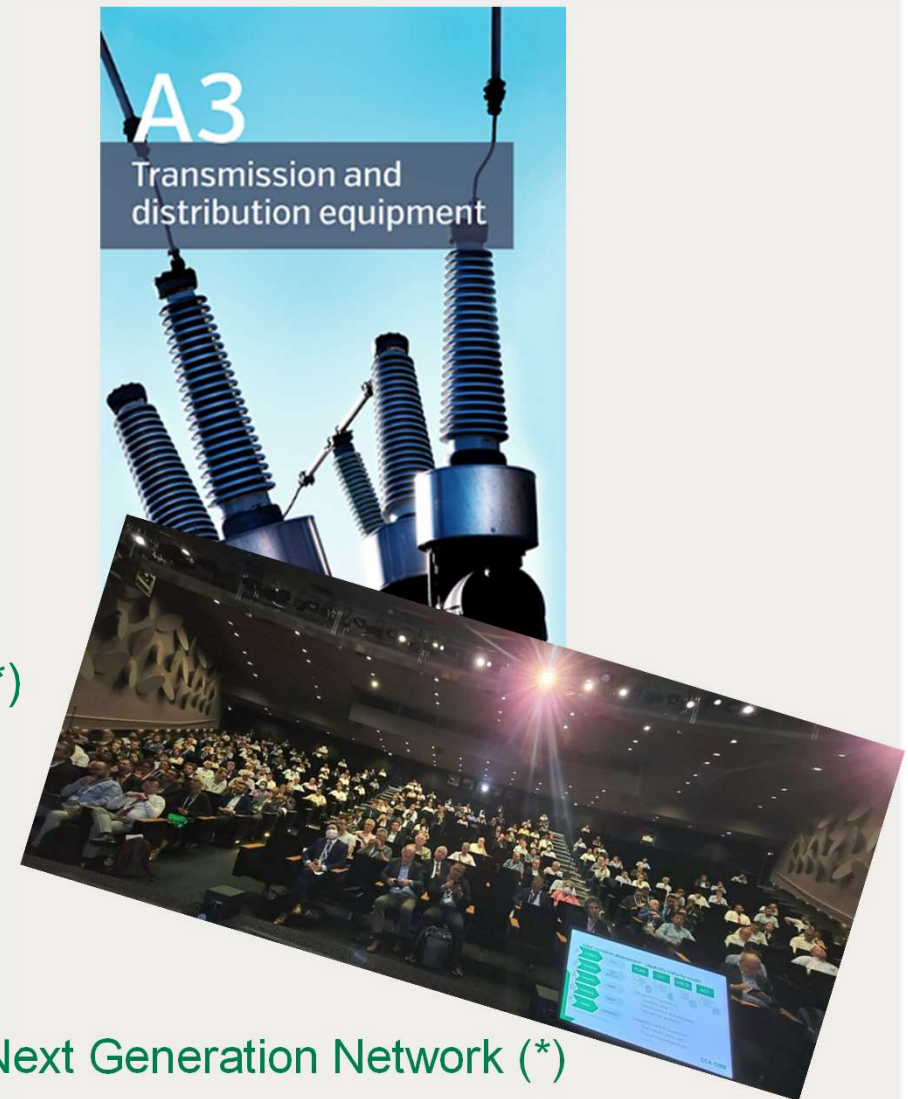
- A Chairman
- A secretary
- 24 regular members
- 16 observer members
- 6 additional members
- Conveners of AGs, WGs, TFs

Technical work performed through working bodies (*)

- 3 Advisory Groups
- 11 Working Groups
- 2 Preparatory Task Forces
- 4 Joint Working Groups

With participation of approx. 250 experts, 3% from Next Generation Network (*)

(*) at [Ref Date]



Main Technical Directions – Focus of WGs in SC A3

SC A3 Scope:

- Responsible for theory, development, design, performance, testing, installation, operation and application of equipment components, equipment, and equipment systems applied to both AC and DC systems from distribution up to highest transmission voltage levels
- Equipment covered includes: Switching equipment, Gas Insulated Switchgear (GIS), Instrument transformers, Surge arresters, Capacitors, Bushings, Insulators, Fault current limiters, and other equipment not covered under other study committees

SC A3 Main Technical Directions:

- To follow 4 x major strategic directions or CIGRE Technical Committee:
 - The Electrical Power Systems of the Future
 - Making the Best of the Existing Systems
 - Focus on Environment and Sustainability
 - Network, develop knowledge and distribute information
- This is to be achieved by:
 - The early formation of appropriate WGs and Task Forces
 - Selection of preferential subjects with a new technology focus
 - Standardization to enable the early adoption of new technology in a close cooperation with standards

taking into account 3 mega-trends:

- Decarbonisation
- Decentralization
- Digitalization



Main Technical Directions – Focus of WGs in SC A3

The new technology of particular interest to SC A3 include:

- Development of the new technologies for changing network conditions (e.g HV DC and MVDC T&D equipment, higher ratings equipment, faster, compact, intelligent..)
- Focus on environment and sustainability (e.g. lower carbon footprint equipment with SF6 alternative gases, reduce visual and spatial impact of T&D equipment)
- Implementing of intelligence and control of switching devices to T&D equipment (e.g POW relays, PIR)
- Digitalization and automation, advanced sensors, diagnostic and monitoring technologies of T&D equipment (including LPIT, novel energy meters etc.)
- Improving condition monitoring and diagnostic techniques
- New and improved testing techniques
- Application of new dielectric materials
- Reliability assessment, refurbishment and lifetime management

Main Technical Challenges

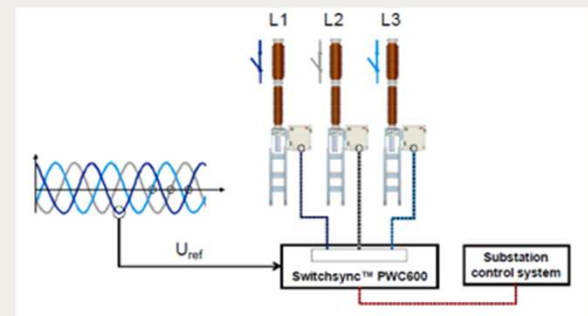
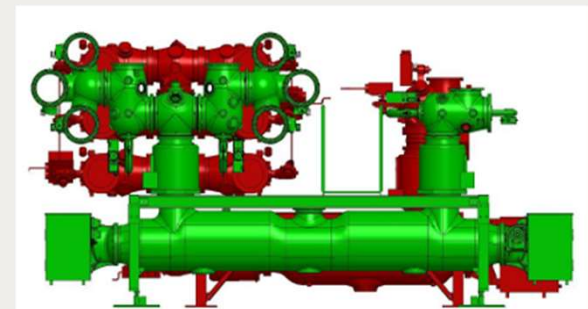
- Impact of renewable generation, solars, wind turbines on T&D equipment
- Impact to inverter based new technologies on T&D Equipment
- Impact of energy storage including batteries, hydro pump storage, hydrogen
- Network development and stress that may impact T&D equipment
- Environmental and severe weather condition impact on T&D equipment
- Sustainability in the whole lifecycle of T&D equipment
- Digitalisation and automation of T&D equipment



Main Technical Directions – Focus of WGs in SC A3

SC-A3 Preferential Subject for 2024:

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



Main Technical Directions – Focus of WGs in SC A3

SC-A3 focus has been driven to:

- **SF6 alternative equipment and projects**

The following WGs were created to address this subject:

- **WG A3.41** - Current Interruption in SF6 free Switchgear (TB 871, 2022)
- **JWG B3/A3.59** - Guidelines for SF6 end-of-life treatment of T&D equip. in S/S (TB 914 - 2023)
- **JWG A3/B3.60** - User guide for non-SF6 gases and gas mixtures in Substations – 2021
- **JWG B3/A3** - Guidelines for in Substations considering the carbon footprint evaluation (2023 -TIR)

Update on progress of SF6 alternatives (since CIGRE Paris 2022)

- Many new project on SF6-free MV and HV ≤ 145 kV
- 145kV and 420kV DTCTB (C4-FN/CO₂) available, 245kV scheduled for 2025
- 145kV DTCTB (Vacuum interrupter) available, 245kV scheduled for 2025
- 420kV SF6-free GIS under construction, 245kV scheduled for 2025
- 3M announced stop in production of NOVEC gasses from 2026
- EU and CARB, F-gas regulation voted
-  **NO REGULATION ON “F” GASES IN AUSTRALIA**

Medium voltage (<52 kV)	High voltage (>52 kV)	
Switchgear medium (with / without vacuum)	Interruption medium	Electric insulation
N ₂ / O ₂ (or dry air)	CO ₂ / O ₂	CO ₂ / O ₂
C5-FK / O ₂ / N ₂	C4-FN / CO ₂	C4-FN / CO ₂
C4-FN / CO ₂	C4-FN / CO ₂ / O ₂	C4-FN / CO ₂ / O ₂
N ₂ / O ₂ / CO ₂	Vacuum technology	N ₂ / O ₂
		C4-FN / N ₂ / O ₂

Legislation and Regulations

F-gas regulation - decision was made on 05/10/23			
(a) kV ≤ 24 (b) $24 < \text{kV} \leq 52$ (c) $52 < \text{kV} \leq 145$ (d) kV > 145			
Decision / Publication	Commission 05.04.2022	Parliament 30.03.2023	Council 05.04.2023
Prohibition	GWP > 10	All F-gases	GWP > 10
Further alternatives in case no bidders	GWP < 2000 / SF ₆ (a), (b), (c), (d)	GWP < 1000 (c), (d)	GWP < 2000 / SF₆ (a), (b), (c), (d)
Ban date (a), (b), (c), (d)	2026 2030 2028 2031	2026 2028 2028 2031	2026 2030 2028 2032
Obligations F-Gases* C4-FN, C5-FK	Reporting	Same as SF ₆	Reporting & Certification
Ban of Export	No	Yes	No
Service exemptions	No	Repair	Repair, Expansion

 SF₆-gas regulation – In place in CA and being implemented by other states
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January 2022 CARB SF₆ regulation effective (Law)

1) SF₆ and F-gases with GWP > 1 reporting

2) SF₆ phase-out according Table 2

Table 2. Phase-Out Dates for SF₆ GIE with Voltage Capacity > 38 kV

Voltage Capacity (kV)	Short-Circuit Current Rating (kA)	Phase-Out Date
<u>38 < kV ≤ 145</u>	< 63	January 1, 2025
	≥ 63	January 1, 2028
<u>145 < kV ≤ 245</u>	< 63	January 1, 2027
	≥ 63	January 1, 2031
<u>≥ 245</u>	All	January 1, 2033

Recent publications

WG number	Name of the Publication	Publication details
WG A3.41	Current Interruption in SF6 free Switchgear	TB 871 - 2022
JWG B3/A3.80	Design, test and application of HVDC Circuit Breakers	TB 873 - 2022
JWG B3/A3.59	Guidelines for SF6 end-of-life treatment of T&D equipment in Substations	TB 914 - 2023

Upcoming publications

Technical Brochures under completion/review:

WG number	Name of the Publication	Publication details
WG A3.40	Technical requirements & testing recommendations for MVDC switching equipment	TB (Q1, 2024)
WG A3.42	Failure analysis for recent incidents of AIS instrument transformers	TB (Q1, 2024)

Green Books progress:

- “Switching Equipment” (update to existing GB) – The first draft is expected in December 2024

Tutorials and webinars

Year	Date	Type	Title
2021	09/02/2021	WBN025	Shunt Reactor switching: Theory and practice
2022	31/12/2022	Tutorial	Field experience with vacuum switching devices
2022	31/12/2022	Tutorial	SF6 alternatives for transmission and distribution substations and their switchgear
2023	23/01/2023	WBN041	The fundamentals of current interruption in SF6 and its alternative
2023	03/09/2023	Tutorial	Measurement of harmonics and Impact of high frequency transients on instrument transformers
2023	07/03/2023	Tutorial	Innovations & trends in transmission and distribution equipment
2024	25/01/2024	WBN	How Internet of Things (IoT) is Changing Electrical Utilities

Most webinars are available at e-cigre.org as recordings

Next planned activities: See Event calendar at cigre.org

Active WGs and JWGs

Ongoing WGs:

- WG A3.39 – Applications and field experience with Metal Oxide Surge Arresters – 2017 (2023)
- WG A3.40 – Technical Requirements and Testing Recommendations for MV DC switching equipment – 2018 (2023)
- WG A3.42 – Failure analysis of recent AIS Instrument Transformer incidents – 2018 (2023)
- WG A4.43 – Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems – 2018 (2023)
- WG A3.45 – Method for identification of frequency response characteristic of voltage measurement systems – 2019 (2023)
- WG A3.46 – Generator Circuit Breakers: review of application requirements, practices, in-service experience and future trends – 2019 (2023)
- JWG A3/A2/A1/B1.44 – Consequence of HV Equipment exceeding highest system voltages – 2019 (2023)
- JWG B4/A3 – 86 Fault Current Limiting Technologies for DC Grids – 2020 (2022)
- JWG A3/B3.60 – User guide for non-SF6 gases and gas mixtures in Substations – 2021 (2024)
- WG A3.47 – Lifetime Management of Medium Voltage Indoor Switchgear – 2021 (2024)
- WG A3.48 – 4th CIGRE Reliability Survey on T&D Equipment – 2022 (2025)

New works / planned

New approved WGs (2023)

WG/JWG/TF	Number	Title	Convener Name (Location)
WG	A3.49	Aging effects on accuracy class of Instrument Transformers	Rroberto Tinarelli (Italy)
WG	A3.50	On-site calibration and verification of the accuracy of instrument transformers	Paollo Mazza (Italy)
WG	A3.51	Requirements for HV T&D Equipment operating under Abnormal Weather Conditions	Santosh Kumar Annadurai (India)
JWG	C4/A3/B2/B4.75	Guide to procedures for the creation of contamination maps required for outdoor insulation coordination	Massimo Marzinotto (Italy)

Proposed by other SCs

WG/JWG/TF	Number	Title	Convener Name (Location)
WG	C4.76	Overvoltage protection in switching inductive devices with vacuum circuit breaker	Frank Richter (Germany)
JWG	B3/A3 (under proposal)	Guidelines for Life Cycle Assessment in Substations considering the carbon footprint evaluation	Akshaya Prabakar (Netherlands)

News from Central office

Many digital tools will be updated/introduced

- e-cigre
- Session Page
- WG management
- Session Registration Platform

2023 Events

- March 2023, Symposium, Muscat, Oman
- May 2023, Colloquium – Birmingham, United Kingdom
- September 2023, Symposium – Cairns, Australia

Events after 2023

- August 2024, CIGRE Paris Session, France
- April 2025, Colloquium – Tel-Aviv, Israel
- June 2025, Colloquium – Tokyo Japan

Australian Panel AU A3 - T&D Equipment

The AU A3 Panel

- Continues to grow
- Currently 27 members, 5 new representatives (2 x NGN) in the last year
- Seeking for representatives from Standard Australia

The AU Panel has representatives from both AU and NZ

Considerable activity throughout both countries:

- Reduction of life cycle costs, placing more emphasis on reliability, monitoring and increased life expectancy
- Decarbonisation, renewable generation projects
- Transition to SF6 alternative equipment, considering trail projects
- Energy storage, batteries, hydro pump, hydrogen

Increase involvement of AU NGN members in panel activities



Australian Panel AU A3 – T&D Equipment

Topics of interest raised during 2022/23

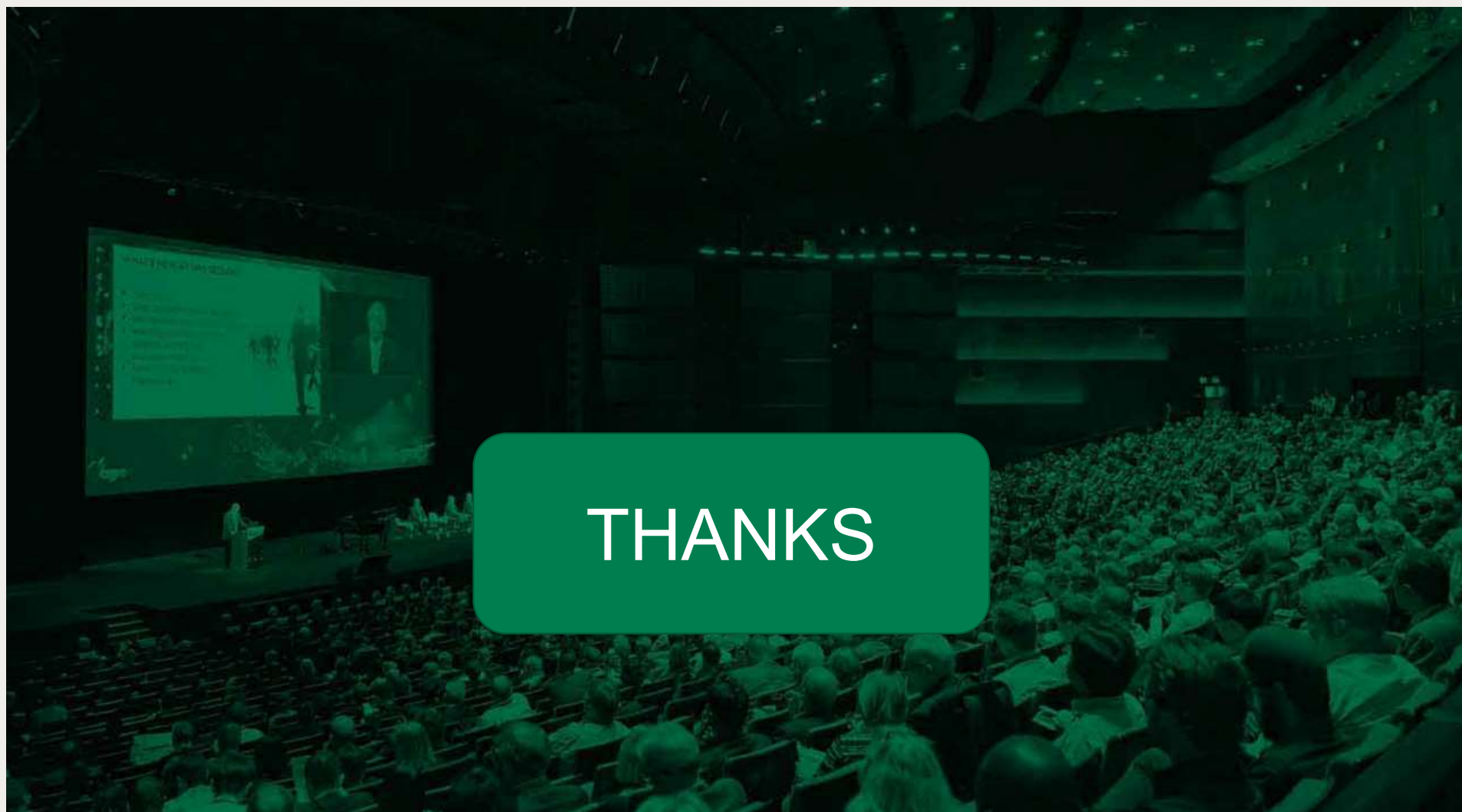
- Lifecycle management and life extension of the existing equipment
- Equipment condition monitoring, new methodologies/tools
- Condition assessment and diagnostic
- SF6 gas leak mitigation strategy
- Medium Voltage switchgear lifetime management
- Innovative technologies to reduce total cost of ownership and foster the energy transition
- Renewable energy, solars, wind turbines, hydrogen
- Energy storage, Batteries, Hydro Pump Storage
- Transition to SF6 free equipment, trial projects with SF6 alternatives
- Application of control switching, including impact on network operation



Australian Panel AU A3 – T&D Equipment

AU A3 Members currently on Working Groups

WG/TF Number	WG/TF Title	AU Rep
WG A3.42	Failure analysis of recent AIS Instrument Transformers incidents	W. Pepper
WG A3.43	Tools for lifecycle management of T&D switchgear based on data from condition monitoring systems	A. Maheshwari, C. Antoun
WG A3.46	Methods of identification of frequency response characteristics of voltage measurement systems	S. Elphick
WG.A3.47	Lifetime Management of MV Switchgear	A. Maheshwari (WG Convenor)
WG A3.48	4 th CIGRE Reliability Survey on T&D Equipment	W. Pepper
WG A3.49	Aging effects on accuracy class of Instrument Transformers	D. Pita, M. Burns



THANKS