

CIGRE Key Take Away 2026

SC B3 substations and electrical installations



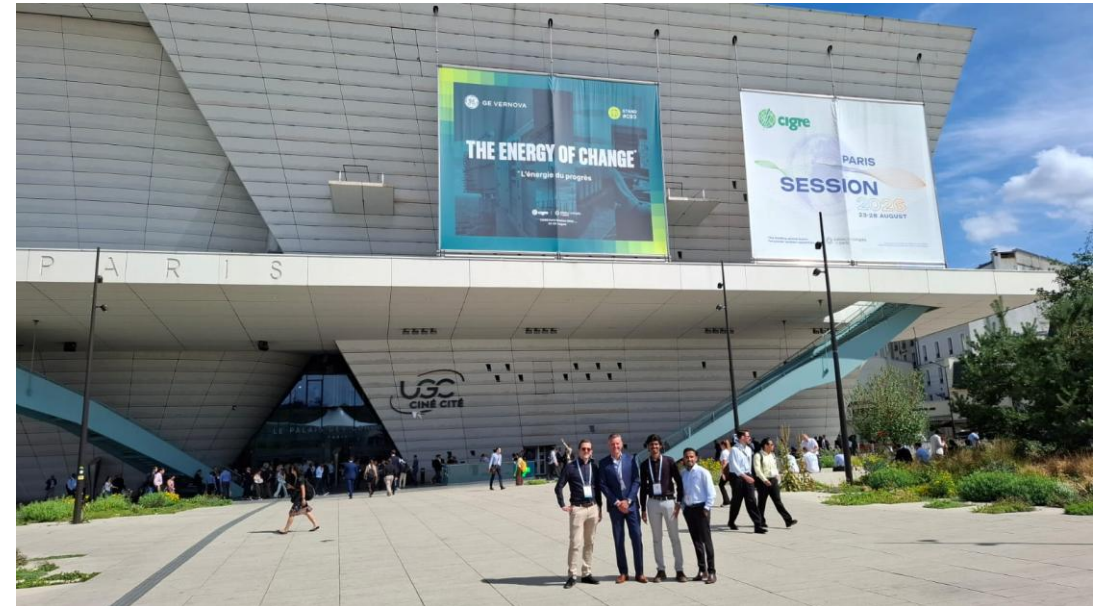
Robert Vosse – Duurzaam Energie Perspectief

New NSC Chairs!

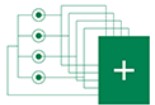


Today's presentation

1. Promo CIGRE and publications
2. Program Paris Sessions
 - a) Papers/Poster session
 - b) Group Discussion Meeting
 - c) Workshops / Tutorial
 - d) Study Committee meeting
 - e) Exhibition



WHY JOIN CIGRE



1000+
Technical
brochures



Free downloads
of **14000+**
technical
publications



Collaborate
with experts



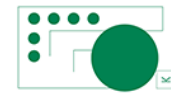
Access
perspectives
and peers from
across the globe



Save on the
Paris Session



Contribute to the
energy transition



60+ In country
and regional CIGRE
organisations



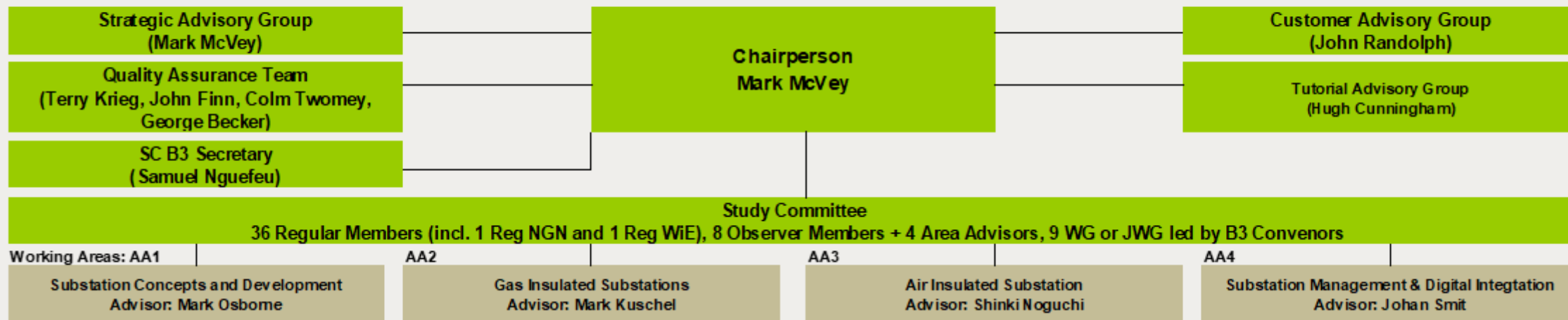
6 Editions of
ELECTRA per year







Study Committee B3 Organisational Structure - after completion of 2026 TB publication plan

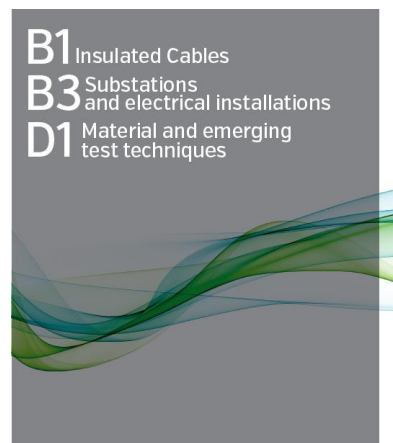


B3 Publications 2025-2026

CIGRE member free download from
e-cigre (<https://e-cigre.org/>)



No.	WG	Title	Convener
957	B1/B3/D1.79	Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends	Cornelis PLET (NL)
986	B3.61	Risk and asset health based decision making in existing substations	Jan BEDNARIK (IE)
993	B3/A3.60	User Guide for Non-SF6 Gases and Gas Mixtures in Substations	Piet KNOL (NL)
997	B3.52	Neutral Earthing Method Selection and Earth Fault Handling for Substations in the Distribution Networks	Theodor Connor (DE)
999	B3/D2.62	Lifelong Supervision and Management of Substations by Use of Sensors, Mobile Devices, Information and Communication Technologies	Nicolaie FANTANA
1000	B3.56	Application of 3D technologies in substation engineering works	Eduard KONIG (SA)



Recommendations for dielectric testing of HVDC gas-insulated cable connection assemblies

TECHNICAL BROCHURES
February 2025 - Reference 957



Risk and asset health based decision making in existing substations

TECHNICAL BROCHURES
May 2025 - Reference 986



User Guide for Non-SF₆ Gases and Gas Mixtures in Substations

TECHNICAL BROCHURES
July 2025 - Reference 993



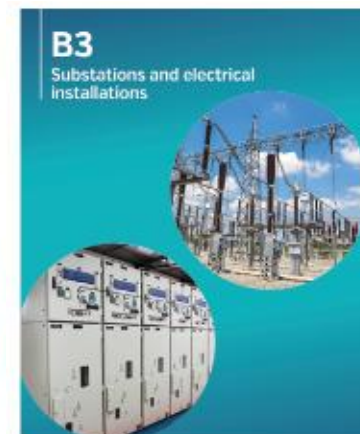
Neutral Earthing Method Selection and Earth Fault Handling for Substations in the Distribution Networks

TECHNICAL BROCHURES
August 2025 - Reference 997



Lifelong Supervision and Management of Substations by Use of Sensors, Mobile Devices, Information and Communication Technologies

TECHNICAL BROCHURES
August 2026 - Reference 999



Application of 3D technologies in substation engineering works

TECHNICAL BROCHURE
August 2026 - Reference 1000

2. Program B3 CIGRE Paris Sessions

Date	Time	Program
Mon, August 24	16:00-18:00	<u>B3 Tutorial (B3.56)</u> : “Application of 3D Technologies in Substation Engineering Works”
Tue, August 25	08:30-10:30	<u>A3/B3/D1 Joint Workshop</u> : “SF ₆ replacement and alternatives”
Tue, August 25	10:30-12:30	<u>A3/B3/B5 Joint Workshop</u> : “Digitalization of Switchgear and Substations: Implementation experience and integration with the Protection World”
Wed, August 26	08:30-10:30	<u>B3.70 Workshop</u> : “Substation Knowledge Management Powered by AI & AR/VR”
Wed, August 26	10:30-12:30	<u>B3.69 Workshop</u> : “Substation Commissioning/Inspection Experiences and Lessons Learned”
Wed, August 26	14:30-18:00	<u>B3 Poster Session</u>
Thu, August 27	08:45-18:00	<u>B3 GDM</u>
Fri, August 28	09:00-18:00	<u>(63rd) B3 Annual Meeting</u>



Poster/Paper Session

Study Committee B3

Proces from Paper to Poster

- 3 preferential subjects
- 85 papers (one NL)
- 23 countries

PS1 Innovative Concepts, Designs and Operation Experience in Substations:

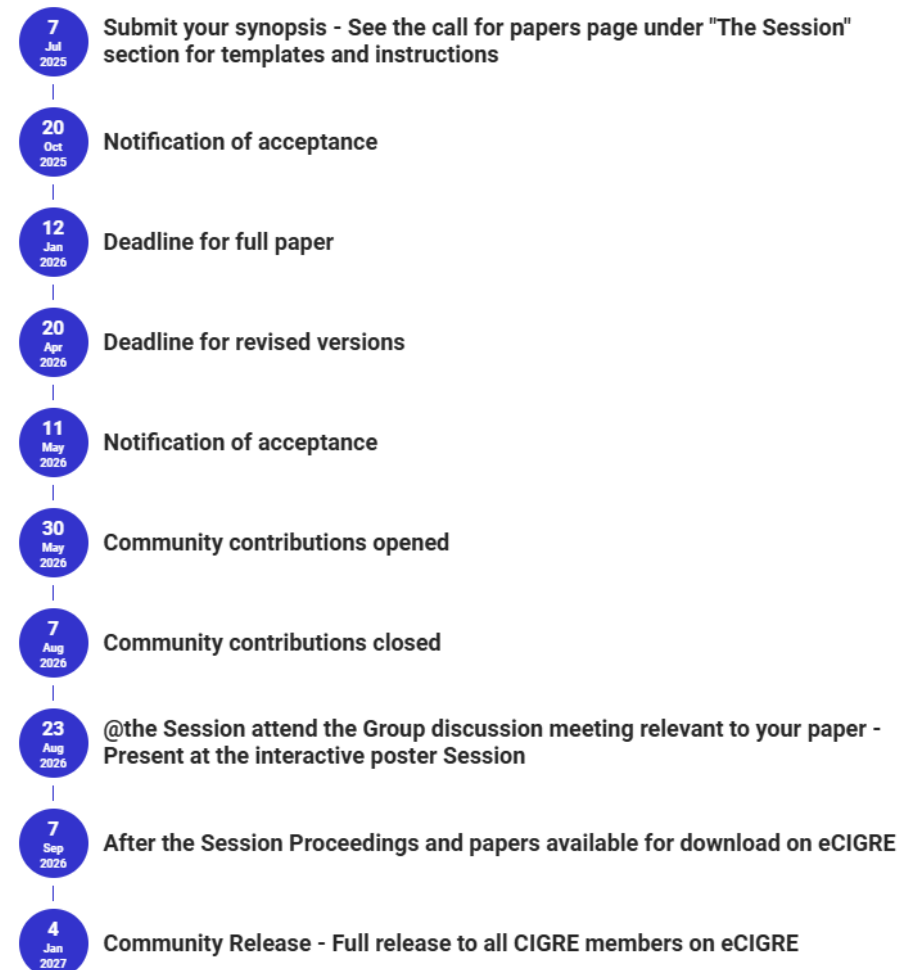
- Experience with Digital design, Training Tools Using 3D Software, AI and Machine Learning
- Modular Substations and Prefabricated Material Design Methods for all Voltage Classes
- Operational Experience with Renewable Substations for Onshore and Offshore UHV or HVDC

PS2: Life Cycle & Asset Management in Substations:

- Monitoring, Diagnostics and Testing Equipment to Improve Energy Efficiency and Functionality to Reduce Carbon Footprint as well as Improve Resiliency
- Substation Up-Rating, Upgrading Experience and Operation Concepts
- Asset Management Strategies Including Optimised Maintenance and Substation LCA

PS3: Impacts of Grid Transformation and New Reliability Threats in Substations

- Physical Security Designs and Experience for Substations
- Substation Designs, Upgrades and Concepts to Mitigate Severe Weather effects
- Experience Building Substations to Connect Large Customers such as Data Centres, Reliably and Safely

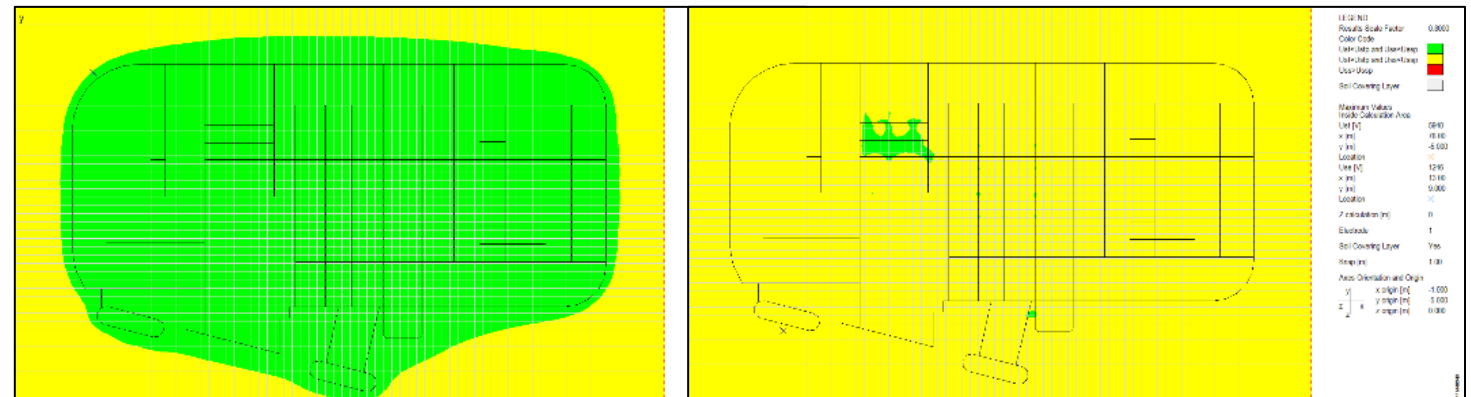


Paper key trends

- Increasing focus on **substation resilience**, to address the impact of network growth as the industry accommodates the decarbonisation agenda.
- The progression of **SF₆ alternatives across all levels of switchgear**. This is also supplemented with an increased focus around decarbonisation in the construction and operational phases.
- Uptake of **modularity** and ambition for more **standardisation** in the substation sector to meet the construction ambition across the industry.
- The increasing exposure and growth in substation related **digital applications**, across all stages of the substation life-cycle.

PS1: Innovative Concepts, Designs and Operation Experience in Substations (#32 papers)

- The grounding and earthing studies show that Ground Potential Rise (GPR), touch and step voltages, and transferred potentials are strongly influenced by lightning impulses, soil ionization, seasonal freezing or drying, industrial congestion, and complex subsurface structures. (10164, 10748, 11030, 12309)
- VFTO and TEV in GIS highlighting this dynamic perspective to EHV/UHV (765 kV) substations. (10542)
 - On-site measurements
 - EMT simulations
 - Mitigation measures



Summer – Compliant Earthing Areas

Winter – Compliant Earthing Areas

PS1: Innovative Concepts, Designs and Operation Experience in Substations (#32 papers)

- The grounding and earthing studies show that Ground Potential Rise (GPR), touch and step voltages, and transferred potentials are strongly influenced by lightning impulses, soil ionization, seasonal freezing or drying, industrial congestion, and complex subsurface structures. (10164, 10748, 11030, 12309)
- VFTO and TEV in GIS highlighting this dynamic perspective to EHV/UHV (765 kV) substations. (10542)
 - On-site measurements
 - EMT simulations
 - Mitigation measures

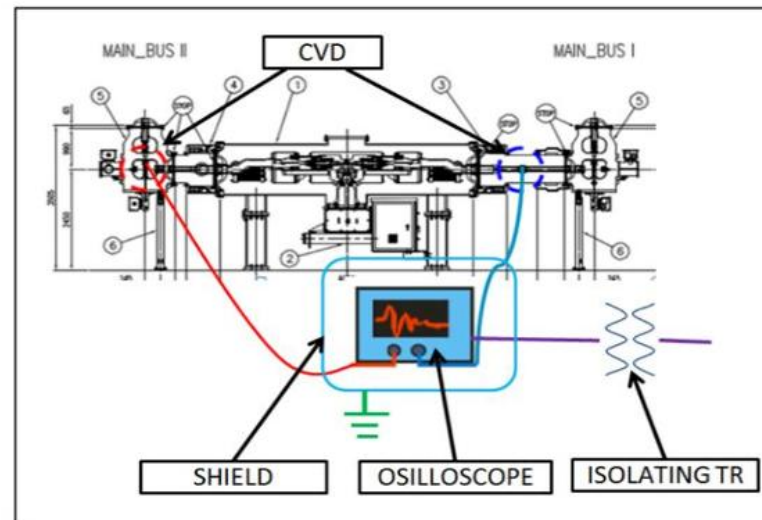


Figure 2 : VFTO measurement arrangement using CVD sensors in 765 kV GIS

PS1: Innovative Concepts, Designs and Operation Experience in Substations (#32 papers)

- Resilience is not solely a matter of component robustness! (12279)
- Main developments: Data driven, AI supported and lifecycle-oriented methodologies (BIM, GeoBIM, Digital Twins, Generative Design, AI and robotics). (10389, 10438, 10443, 10445, 10692, 10684, 10808, 10834, 10877, 11300, 11302, 11616, 12059, 12057, 12207, 12272 and 12635)
 - Digitalization is progressing rapidly,
 - AI and robotics are still largely in the exploration.

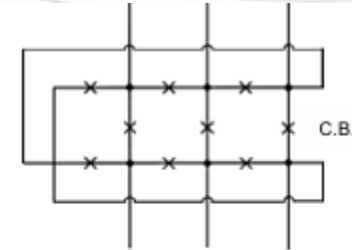


Figure 1a: Moebius-Strip configuration with 6 feeders, single line

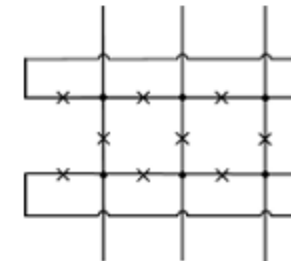


Figure 1b: Crossed-Ring configuration with 6 feeders, single line

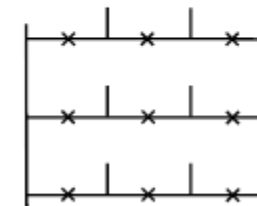


Figure 1c: Breaker-and-a-Half configuration with 6 feeders, single line

PS1: Innovative Concepts, Designs and Operation Experience in Substations (#32 papers)

- Resilience is not solely a matter of component robustness! (12279)
- Main developments: Data driven, AI supported and lifecycle-oriented methodologies (BIM, GeoBIM, Digital Twins, Generative Design, AI and robotics). (10389, 10438, 10443, 10445, 10692, 10684, 10808, 10834, 10877, 11300, 11302, 11616, 12059, 12057, 12207, 12272 and 12635)
 - Digitalization is progressing rapidly,
 - AI and robotics are still largely in the exploration.

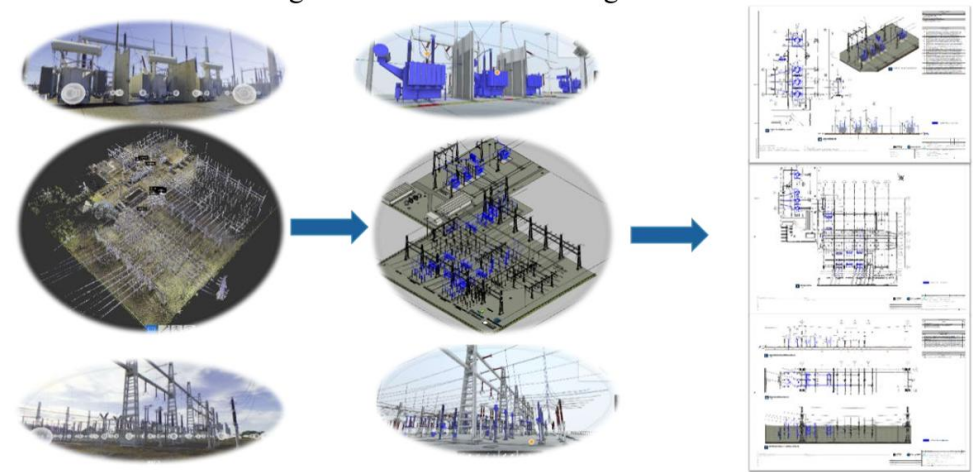


Figure 10 - GeoBIM Models as a Baseline for Engineering Design

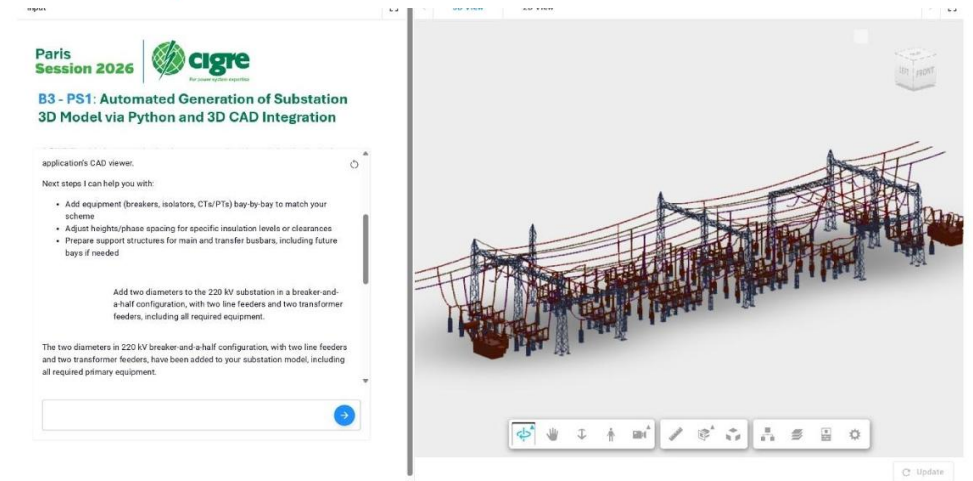


Figure 4 - Application Output for the Prompt "Add two diameters to the 220 kV substation in a breaker-and-half configuration, with two-line feeders and two-transformer feeders, including all required equipment."

PS2: Life Cycle & Asset Management in Substations (#37 papers)

- Managing the substation carbon footprint!
- Japan considers a more wider reaching LCA over 80yrs taking into account an entire GIS (275kV) and AIS (77kV) substation. (10839)
 - Potential emission reduction 26% at GIS and appr. 60% at AIS.
- Application of machine learning to determine distribution substation (24kV) reliability based on surface PD measurements using non outage remote measurements. (11425)

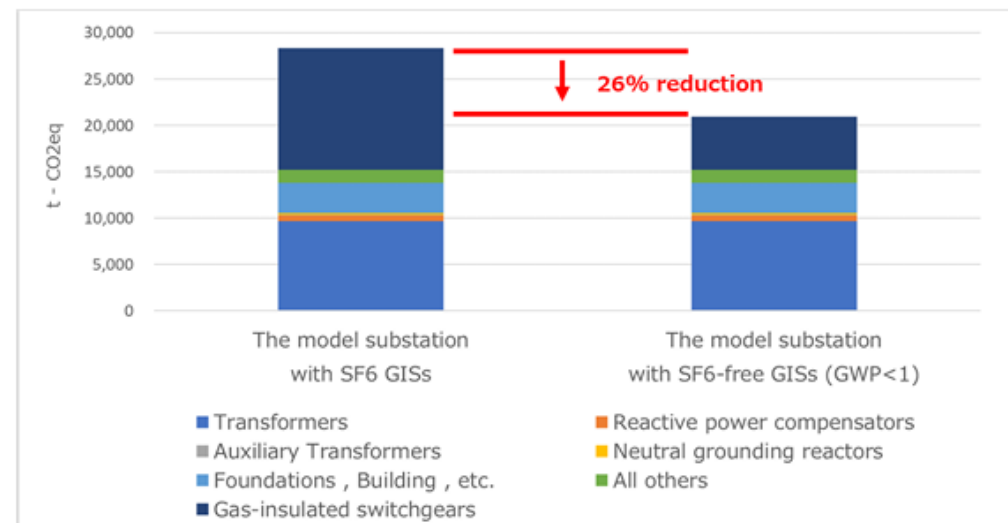


Figure 6 - The estimated LC-CO₂eq reduction by employing SF₆-free GISs with an alternative gas GWP<1

Table 2 – Reduction measures and their effects at the substation level

No	Reduction measure	Reduction rate	Reduction amount (t-CO ₂)
①	Service-Life-extension (50 → 80 years) of transformers through overhaul	18.6 %	321
②	Use of low-carbon steel	3.4 %	59
③	Use of low-carbon concrete	14.7 %	253
④	Use of transformers with rapeseed-oil insulation	3.6 %	61
⑤	Use of green aluminum	0.2 %	3
⑥	Introduction of electric vehicles	10.6 %	182
⑦	Use of SF ₆ -free circuit breakers (dry-air VCBs)	12.2 %	211

PS2: Life Cycle & Asset Management in Substations (#37 papers)

- Return on experience from early deployments of C4-FN SF₆ free alternative gas in 420 kV GIS in Scotland (10738)
- Operational performance of 72/84kV equipment in Japan which has successfully been operating since 2006 using VCB and dry-air insulated in so called cubicle type GIS at low pressure. Higher voltage applications using this combination are being developed with 245kV and 550kV applications in mind. (10837)
- Retrofill activity in UK on GIS up to 420kV and GIL up to 550kV. SF₆ removal, through using a gas mixture with N₂, O₂ and C4-FN with a GWP reduction of 99% for 420 kV GIS (12281)
- Mitigating SF₆ leakage in Australia and the Netherlands (10351 & 10278)



PS2: Life Cycle & Asset Management in Substations (#37 papers)

- Few papers: Spares and resilience
 - Denmark: Focussing on strategic components in an offshore substation (11959)
 - India: FMECA and implementation of an asset health and risk framework (10483)
 - Japan: Collaborative framework between utilities and OEMs because of replacement peak (10840)
 - Germany: Highlights the impact that spares management, maximizing GIS asset resilience and availability (12392)

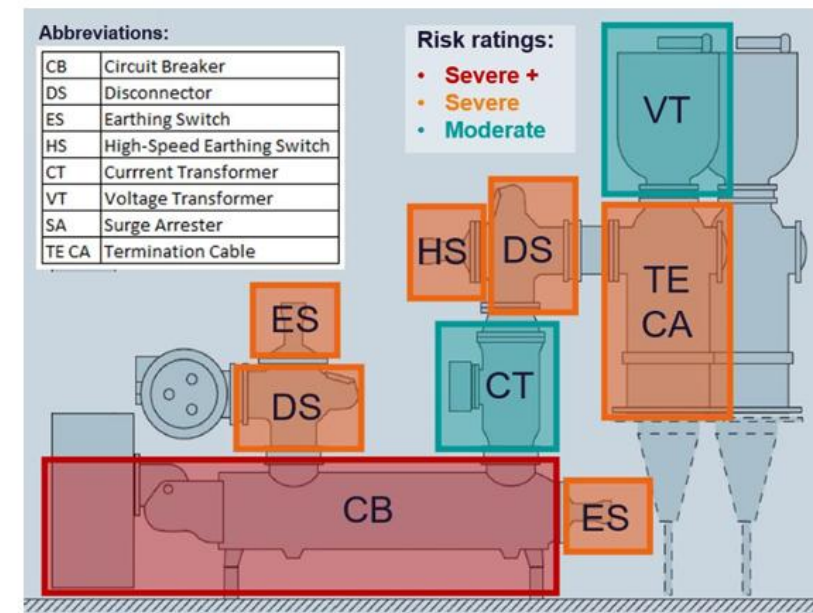


Figure 4 - Typically used switchgear modules (functions) with abbreviations in symbolic representation of a switchgear bay, includes exemplary technical risk ratings

PS3: Impacts of Grid Transformation and New Reliability Threats in Substations (#18 papers)

- BESS (Battery Energy Storage Systems) (10339, 12643)
- Offshore wind project in India. Combining shunt reactors and STATCOMs at both onshore and offshore substations, to compensate capacitive reactive power. (Paper 10546).
- Mobile substations, including Modular and Temporary Mobile Substations (TMS), aimed at enabling the accelerated connection of new customers and supporting grid restoration following major outages (10749 and 11078).
- Extreme weather conditions are becoming an increasingly significant design challenge. Heatwaves, flooding, extreme wind loads, wildfires, and similar events are driving a shift in design philosophy from purely standards-based approaches toward more risk-based design methodologies. (11074, 10882, 11101, 11314 & 11350)



10749
B3 Substations and Electrical Installations
PS3 Grid transformation and new reliability threats

Temporary Mobile Substations: A Solution for Modern Grid Expansion Challenges

Boris GUREVICH*
ComEd
USA
boris.gurevich@comed.com

Sean FITZGERALD
ComEd
USA
sean.fitzgerald@comed.com



ID-11078
B3 SUBSTATIONS AND ELECTRICAL INSTALLATIONS - Full Papers
B3 PS3 – Grid transformation and new reliability threats
Substations and Electrical Substation

Mobile Substations : Rapid Response Solutions for Reliability Threats

Francesco CARACCI
HITACHI ENERGY
Grid-eXpand Mobile
Center of Competence
ITALY
Francesco.Caracci@hitachienergy.com

Claudio SPELLA
HITACHI ENERGY
Grid-eXpand Mobile
Center of Competence
ITALY
Claudio.Spella@hitachienergy.com

Group discussion meeting

Study Committee B3

August 27th

Group discussion meeting

- Special report -> 15 questions (5 per PS)
- While asset management has traditionally been driven by **reliability** and **cost** considerations, the focus is increasingly shifting towards the **resilience** of the electricity system.
- Digitalization is no longer optional.
- AI adoption is still in its early stages.
- Experiences with obsolete components and how reverse engineering and additive manufacturing can help address these challenges.



Workshops / Tutorial

Study Committee B3

24 – 26 August 2026

Workshops / Tutorials

- **Tutorial - Study Committee B3 - Beyond Visualisation - The 3D Digital Transformation of Substation Engineering**
- **Workshop - A3, B3 & D1 - SF6 replacement and alternatives / eventually digitalisation**
- **Workshop - Study Committee B3 - Substation Knowledge Management Powered by AI&AR/VR**
- **Workshop - Study Committee B3 - Process for Commissioning and Inspection of Air Insulated Substations (AIS) and Gas Insulated Substations (GIS)**

Workshops / Tutorials

- Tutorial - Study Committee B3 - Beyond Visualisation - The 3D Digital Transformation of Substation Engineering
- **Workshop - A3, B3 & D1 - SF6 replacement and alternatives / eventually digitalisation**
- Workshop - Study Committee B3 - Substation Knowledge Management Powered by AI&AR/VR
- **Workshop - Study Committee B3 - Process for Commissioning and Inspection of Air Insulated Substations (AIS) and Gas Insulated Substations (GIS)**
 - **WG B3.69**

Workshop - A3, B3 & D1 - SF6 replacement and alternatives / eventually digitalisation



- Independent industry documents on SF6-free equipment
- SF6-free switchgear crosses the EHV bar
- Three main technologies
- Less focus to LCA studies
- Regulatory status overview
- Ecodesign for sustainable product regulation
- PFAS restriction proposal

Workshop SF ₆ replacement and alternatives Organised by CIGRE SC A3, B3, D1 August 25, 8:30-10:30, Room 342AB, Palais des Congrès, Paris		
1	Introduction	
	René Smeets	Moderator Overview of present and past CIGRE activities on SF ₆ free equipment NL
2	Panellists' presentations (10 minutes each)	
	Presenter	Subject Affiliation
	Nina Støa-Aanensen (A3)	Status of SF ₆ -free station equipment Regulatory status in EU SINTEF Energy, NO
	Shenli Jia	Regulatory and product status in China Sichuan University, CN
	Karla Trost	Regulatory status in North America, Japan, Korea G&W Electric, US
	Guilhem Blanchet	ENTSO-E's perspectives ENTSO-E representative
	André Lathouwers (B3)	TSO decision criteria Tennet TSO, NL
	Karsten Juhre (D1)	Lifetime performance assessment studies CIGRE SC D1 representative
3	Plenary discussion with audience	
	Martin Kriegel	Facilitator CH



Workshop - A3, B3 & D1 - SF6 replacement and alternatives / eventually digitalisation

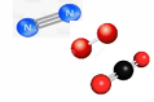
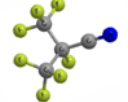


- Independent industry documents on SF6-free equipment
- SF6-free switchgear crosses the EHV bar
- Three main technologies
- Less focus to LCA studies
- Regulatory status overview
- Ecodesign for sustainable product regulation
- PFAS restriction proposal

SF₆-free equipment, *Status per 25.08.26

MV, CB / LBS = medium voltage switchgear, circuit breaker / load break switch
LT = live-tank
DT = dead-tank
GIS = gas-insulated switchgear
GIL / GIB = gas-insulated lines / busbars



	INSULATION	INTERRUPTION	GWP	VOLTAGE*	APPLICATION
 SF ₆	SF ₆		24 300	12 – 1 200 kV	MV / LT / DT / GIS
Natural-origin gases  N ₂ O ₂ CO ₂	N ₂ / O ₂ , solid	VACUUM	0	10 - 252 kV	MV CB / LT / DT / GIS
	N ₂ / O ₂	N ₂ / O ₂	0	420 kV	MV LBS, ≤ 24 kV
	O ₂ / CO ₂		<1	72 – 420 kV	GIB / GIL
	CO ₂		1	12 – 40 kV	LT
Fluoronitrile-based  C ₄ F ₇ N + natural-origin gases	C ₄ F ₇ N / AIR	VACUUM	300 - 750	10 - 40 kV	MV LBS
		C ₄ F ₇ N / AIR			
	C ₄ F ₇ N / CO ₂ / O ₂		300 - 750	72 – 550 kV	Distr / LBS / GIS
	C ₄ F ₇ N / CO ₂		300 - 750	145 kV	LT / DT / GIS
	C ₄ F ₇ N / N ₂		> 500	1 000 kV	GIS
			300 - 750	420 kV	GIB / GIL

Workshop - A3, B3 & D1 - SF6 replacement and alternatives / eventually digitalisation



- Independent industry documents on SF6-free equipment
- SF6-free switchgear crosses the EHV bar
- Three main technologies
- Less focus to LCA studies
- Regulatory status overview
- Ecodesign for sustainable product regulation
- PFAS restriction proposal





Study committee meeting

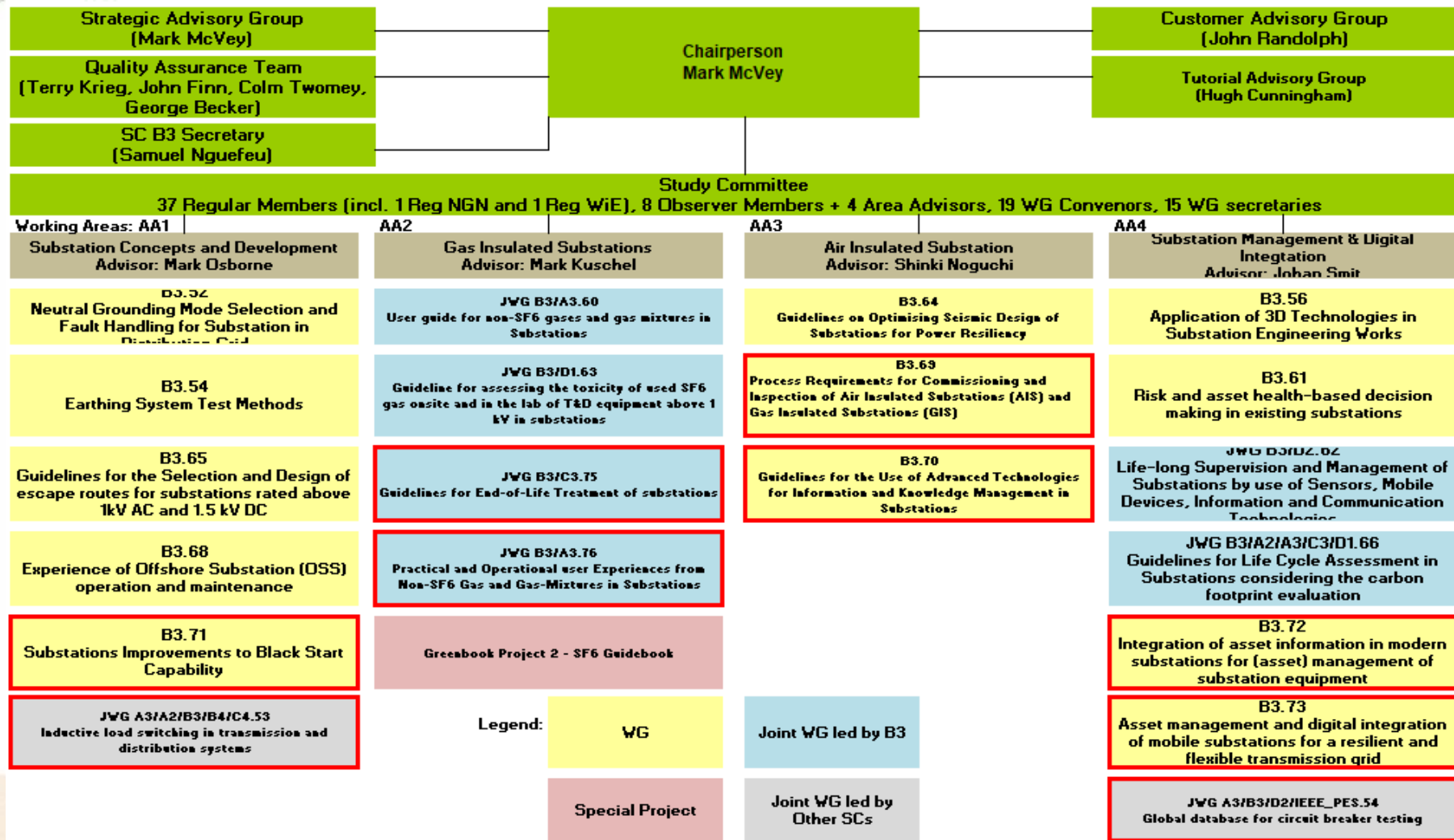
Augustus 28th

Jaarvergadering B3

- Members update
- Chair, Advisory & WG Reports
 - New WG TOR
- Technical presentations
- Relevant B3 events
 - CIGRE Symposium in Heidelberg, Germany, on April 26 – 30, 2027
 - B3 & A3 Joint Colloquium, Tokyo JP. 25-29 Oct 2027
 - Symposium in Bangkok, Thailand on 8-11 November 2027
- Paris Session 2028
-



Jaarvergadering B3



Jaarvergadering B3 (preferential subjects 2028)

PS 1: Global Trends in Substation Standardization

- Accelerating end-to-end substation delivery from concept to commissioning, while maintaining lifecycle reliability and maintainability
- Future-ready substations for network growth, electrification, and data center integration
- Standardization of modular, prefabricated, and scalable substation solutions, including their operation, maintenance, and long-term support

PS 2: Managing Substation Sustainability, Resilience & Availability

- Resilient substation design, auxiliary systems, and organizational preparedness for evolving grid requirements and extreme threat events
- Digital substations: optimized design, lifecycle support, outage management, and operational recovery
- Sustainable asset management through lifecycle optimization, best practices, and lessons learned from operation and major events

PS 3: Trends in Substation Design, Commissioning & Operations

- Key changes shaping modern substation design and operational practices, including evolving grid requirements, climate and environmental challenges, societal expectations, and emerging technologies
- Future skills and competencies for commissioning and operations engineers in response to new technologies, requirements, and threats
- Workforce and process development through advanced technologies (e.g., digital tools, AI, robotics, physical AI, and VR or AR) together with training, knowledge transfer, and the evolution of engineering processes, manuals, guidelines, and standards

Thank you

Join the Paris Session in 2028!!