PARIS SESSION 2024

# Study Committee B3
# Substations & Electrical Installations

A Special Reporter's perspective

cigre
For power system expertise

# Introduction

- B3 Scope
- Special Report preparation
- Summary of the Paris 2024 General Discussion Meeting

# SC B3 Scope

- CIGRE Substation Study Committee B3 is responsible for activities that cover the design, construction, maintenance, and management of substations and the electrical installation in power stations, excluding generators.
- The aim is to bring value to the engineering community by highlighting state-of-the-art practices, establishing recommendations, and reporting best practices.
- The major objectives of B3 are to facilitate technical guidance, which enables the electrical supply community to increase reliability and availability, encourage cost effective engineering solutions, manage environmental impact, support effective asset management and encourage the adoption of appropriate technological advances in equipment and systems to achieve these objectives.

# The Special Report

- Review of all the papers accepted by the Study Committee in response to the published Preferential Subjects
- Prepared by a team of Special Reporters selected by the Study Committee Chairperson.
- Set of Questions are synthesised from the submitted papers.
- Published in May/June ahead of the Paris General Discussion Meeting (GDM).
- Paper authors and conference delegates are invited to provide written responses to the questions, which are discussed in the Paris session.

# Preferential Subjects 2024

**PS1 - Challenges & new solutions in T&D substation design and construction for energy transition:**

- Design impacts on substations from on-offshore wind, PV, hydrogen, small modular reactors, EV charging infrastructure, etc.
- New functions in substations (energy storage, synchronous compensators, etc.).
- HV-MV DC substation and GIS/GIL application for a DC network.

**PS2 - Return on operational experiences for substation management:**

- Challenges of managing assets: Initiatives to strengthen resilience, reliability and security, best practice and end-of-life management considering sustainability aspects.
- Lessons learned from operational experience from SF6 alternatives solutions, digital transformation solutions and digital substation.

# The B3 Special Report review process

| Preferential Subject | Number of papers reviewed | Number of Special reporter Questions | Authors Topics |
|---|---|---|---|
| Preferential Subject 1: Challenges & new solutions in T&D substation design and construction for energy transition:<br>• On-Offshore wind, PV, Geothermal, etc.<br>• Energy Storage, Hydrogen, Synchronous compensators, etc.<br>• GIS/GIL application for DC network. | 18 | 4 | • New Substation Concepts.<br>• Distribution Grid Parks<br>• Modular & Containerised solutions<br>• Developments in GIS technology<br>• Digitalisation in the substation environment |
| Preferential Subject 2: Sustainability Management Challenges in Substations<br>• External drivers for substation intervention such as resilience, reliability, security of supply, life expectancy coordination, etc.<br>• SF6 alternatives and emission management, Circular economy of materials such as reuse, reduce, recycle.<br>• New set of skills for new technologies, Knowledge transfer and high standards of education in engineering skills | 47 | 6 | • Safe by Design<br>• Digitalisation in Substations<br>• Substation Asset Health Metrics<br>• GIS Performance and Service Continuity<br>• Introduction of SF6 alternatives<br>• Substation Resilience<br>• Implementing Sustainability |

# B3 2024 Special Report questions

| Preferential Subject 1 | Preferential subject 2 |
|---|---|
| PS1.1 Is the philosophy of clustering new connections and technologies into a Distribution Grid Park or similar being considered elsewhere? What are the emerging key substation standardisation factors (e.g. voltage, rating, acceptable technologies etc..) | PS2.1 What efforts and concepts are being applied, including the Distribution Substation sector, to ensure the safe and reliable rollout of new infrastructure, taking into considerations limited experience of new technology and the limited engineering resource pool? |
| PS1.2 Is there any return on experience to date, regarding the compact design and maintenance requirements for containerised and modular H&D applications (e.g. EV charging infrastructure, BESS, distribution substations etc..) | PS2.2 With regard to new resources and skills, how prepared is the Energy sector to manage the impact that Digitalisation and Net Zero will place on it. Is this a threat or opportunity to the skills gap within the sector? |
| PS1.3 How is the use of SF6 alternative gases going to impact on the GIS design philosophy and utility GIS ownership perspective (e.g. extensions, accessibility, gas handling, interpreting test results, etc..) | PS2.3 The application of Asset Health Indices to lead assets is quite well practiced, but how are aspects associated with the substation infrastructure and services to support the primary equipment assessed and considered? Is there information from the SCADA that can be used to help identify these issues? |
| PS1.4 How are utilities addressing the combined risks of innovation and digitalisation while at the same time significantly expanding their networks to accommodate net zero? | PS2.4 What strategies are being considered by utilities and solution providers to manage the lead time issues associated with the procurement and construction of new bays or substations? |
| | PS2.5 What strategies are being implemented to aid the transition away from SF6? Is there an emerging direction regarding the re-use of GIS with an alternative or replacing the GIS in its entirety? |
| | PS2.6 A key aspect of resilience and sustainability is the ability to cater and absorb change. Should utilities be constructing substations ahead of need and create the network, or should they be more reactive and expand as the need appears? What are utilities doing in this respect? |

# Special Report 2024

- Provides a summary and critique of the submitted papers against the Study Committee's preferential subjects.
- Executive summary of 65 papers from 23 countries
- Introduces further questioning – inviting the authors and readers to submit responses to be presented in the General Discussion Meeting in Paris
- 10 prepared questions

2024 Paris Session

B3 - 00

SPECIAL REPORT FOR STUDY COMMITTEE B3
(Substations and electrical installations)

M.M. OSBORNE, M. McVEY
Special Reporters
K. KAWAKITA B3 Chair and S. NGUEFEU Secretary

CIGRE Substation Study Committee B3 is responsible for activities, which cover the design, construction, maintenance and management of substations and the electrical installation in power stations excluding generators. The aim is to bring value to the engineering community through highlighting state-of-the-art practices, establishing recommendations and reporting best practices.

The major objectives of B3 are to facilitate technical guidance, which enables the electrical supply community to increase reliability and availability; encourage cost effective engineering solutions, manage environmental impact, support effective asset management and encourage the adoption of appropriate technological advances in equipment and systems to achieve these objectives.

Substations are integral parts of the power system and central to the safe, reliable transmission and distribution of power by providing access to the network, fault isolation, and facilitating expansion. This is evident worldwide as energy networks adapt to meet the challenges placed on them.

The Preferential Subjects (PS) for the 2024 Session are:

**PS1 Challenges & new solutions in T&D substation design and construction for energy transition:**

- Design impacts on substations from on-offshore wind, PV, hydrogen, small modular reactors, EV charging infrastructure, etc.
- New functions in substations (energy storage, synchronous compensators, etc.).
- HV-MV DC substation and GIS/GIL application for a DC network.

**PS2: Return on operational experiences for substation management:**

- Challenges of managing assets: Initiatives to strengthen resilience, reliability and security; best practice and end-of-life management considering sustainability aspects.
- Lessons learned from operational experience from $SF_6$ alternatives solutions, digital transformation solutions and digital substation.
- New competencies for new technologies, knowledge transfer methods and high standards of education in engineering skills.

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# Paris 2024 B3 Activities

34 Regular Members
1 Additional Members
9 Observer Members
= 44 total

Mon Aug 26: A2/A3/B3/D1 **Workshop**, "Driving T&D substations and equipment towards ZERO emissions" -- 514 attendees

Tues Aug 27: **Tutorial,** "Guidelines for SF6 end-of-life treatment of T&D equipment (>1 kV) in substations" Maik Hyrenbach -- 56 attendees

Tues Aug 27: **Poster Session** -- 1091 attendees

Wed Aug 28: **Group Discussion** – 65 papers from 23 countries

- 895 attendees at Auditorium
- xx prepared contributions; xx spontaneous contributions or Sparkup chat

Thu Aug 29: 61st Annual **Study Committee Meeting** -- Room 353

xx attendees; xx countries represented; plus 13 on-line participants

# General Discussion Meeting

**Wed 25th August 2024**

- 895 participants over the day
- There was a total of 50 contributions addressing the 2 preferential subjects, 14 for PS1 and 35 for PS2
- Contributions were received from 16 different countries.
- The NGN Showcase presentation Keisuke Murakita (Japan)
    - ‘Substation Insulation coordination design review following actual accident due to direct multiple lightning strikes.

# General Discussion Meeting - Headlines

## $SF_6$ Alternatives

- Legislation impacting the longer-term use of $SF_6$ is in different stages around the world, with a lead being taken in Europe through the F-Gas regulations, pushing for the use of much lower GWP materials in the next decade. This is very progressive, providing there are viable alternatives available to facilitate the Net Zero transition.
- Currently, $C_4$-FN alternatives are being considered as an alternative to use in unmodified GIS, whereas dry air alternatives do require a modified design of equipment and interruption to provide a suitable alternative.

## Modularity and containerised solutions

- Growing in popularity to speed up construction and deliverability.
- While this advocates less site resource and specialisms during construction, it probably requires utilities to consider different ways of working and possibly more departure from their in-house technical standards and practices.

# General Discussion Meeting - Headlines

## Digitalisation

- Digitalisation is impacting every part of our lives and it is no different for the substation sector. Whether in the design phase,
- IEC 61850 protection and automation or in the latter stages of asset life where data analytics are required to facilitate asset intervention drivers. Furthermore, it is underpinning the industry knowledge capture and synthesis for Engineers of the future.
- A constant thread running through all of these applications is the need to support and integrate these tools into the enterprise asset management, which requires different skills and support to implement and maintain.

## Clustering

- The challenges in meeting net zero ambitions and maintaining security of supply.
- solutions to meet the demand at distribution level of RES generation and power electronic applications.
- methodology being applied to improve network access for renewable generation.

# GDM publications

## Daily Summary

- short summary of the daily logistics

## General Report

- comprehensive summary of the GDM and each prepared contribution
- 15 page report

## CIGRETV

- news media channel included many short interviews and articles with all the CIGRE Study Committees and attendees

DISCUSSION MEETING SUMMARY

Study Committee B3

(Substation and electrical installations)

*Wednesday 28th August 2024*

**Chair: Koji KAWAKITA**

**Secretary: Samuel NGUEFEU**

**Special Reporters: Mark OSBORNE (PS1) & Mark MCVEY (PS2)**

**1. INTRODUCTION**

CIGRE Substation Study Committee B3 is responsible for activities that cover the design, construction maintenance, and management of substations and the electrical installation in power stations, excludin generators. The aim is to bring value to the engineering community by highlighting state-of-the-art practice establishing recommendations, and reporting best practices.

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The session covered a broad scope of issues, and all the preferential subject criteria have been address some degree, highlighting the following key themes:

- The challenges in meeting net zero ambitions and maintaining security of supply.
- The impact of SF6 alternatives on substation construction and operation.
- Modularity and containerisation – solutions to meet the demand at distribution level generation and power electronic applications.
- Impact of Digitalisation across all aspects of the substation lifecycle.

**2. RUNNING OF THE MEETING**

The session was attended by 895 participants over the day. There was a total of 50 contributions the 2 preferential subjects, 14 for PS1 and 35 for PS2 including 1 NGN Showcase. Contributions we from 16 different countries.

The NGN Showcase presentation was given in Preferential Subject 2 by NGN member Keisu (Japan) on the 'Substation Insulation coordination design review following actual accident multiple lightning strikes.

GENERAL REPORT FOR SC B3

SUBSTATIONS & ELECTRICAL INSTALLATIONS

Wednesday 28th August 2024

Chairperson: Koji KOWAKITA
Secretary: Samuel NGUEFEU
Special Reporters: Mark OSBORNE (PS1), Mark MCVEY (PS2)
Sparkup moderator Caterina TOIGO

INTRODUCTION

CIGRE Substation Study Committee B3 is responsible for activities, which cover the design, construction, maintenance and management of substations and the electrical installation in power stations excluding generators. The aim is to bring value to the engineering community through highlighting state-of-the-art practices, establishing recommendations and reporting best practices.

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This report summarises the presented contributions, in response the Special Reporter Questions in the B3 Special Report. The prepared responses to each question can be seen in Appendix A.

Contributions from the audience were also facilitated through the Sparkup application, which allowed questions to be asked and responded to online. This triggered vital and constructive discussions occurred during the meeting, and 70 spontaneous contributions, questions, and comments were recorded. The Sparkup content is summarised in Appendix B.

This year the CIGRETV news media channel was widely employed and included many short interviews and articles with all the CIGRE Study Committees and attendees, including B3. Links to these articles can be found here.

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# Preparing for Paris 2026….

**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, Substation LCA and SF6 transitions.

**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 Centers, Reliably and Safely

# New B3 Working Groups….

**WG B3.68: Experience of Offshore Substation (OSS) operation and maintenance.**

- Convenor Simon WADDINGTON and B3 Chair are still welcoming experts

**WG B3.69: Process Requirements for Commissioning and Inspection of AIS and GIS.**

- Convenor Simon BECKER.
- TC approval expected shortly.

**WG B3.70: Substations Improvements to Support Black Start Capability.**

- Convenor Crina Miana COSTAN.
- ToR submitted to the TC for comments.

**A3/B3 UK Liaison Meeting**

- 15th-16th Jan 2025, University of Manchester