

Study Committee B3

Substations and Electrical Installations

Paper ID – 1082

First F-gas-free and climate-neutral insulated 420 kV GIS busducts installation at TransnetBW

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Motivation

- Favourable timing to test a new SF₆ alternative, as this pilot project is part of a large infrastructure project (reconstruction of Daxlanden Substation)
- Gaining own experience with an SF₆ alternative, that contains only atmospheric natural origin gases
- Saving of around 60 % of the entire SF₆ quantity of this project, by replacing it in the GIBs with a total length of 4000 m

Selection of the SF₆ alternative

- Gas handling: reduced complexity compared to SF₆, without special precautions in normal operation and in the event of an incident
- GWP = 0 (TransnetBW requirement: GWP < 1)
- The selected alternative enables a climate-neutral operation beyond 2050 as well

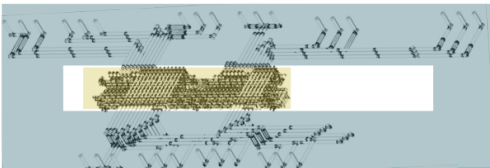
420 kV F-gas-free GIB technical data

- | | |
|-------------------------------------|-------------|
| • Highest voltage of equipment | 420 kV |
| • Rated frequency | 50 / 60 Hz |
| • Rated short time current / Time | 63 kA / 3s |
| • Rated BIL | 1425 kV |
| • Rated SIL | 1050 kV |
| • Power frequency withstand voltage | 650 kV |
| • Rated continuous current | 5000 A |
| • Rated peak withstand current | 170 kA |
| • Ambient temperature | -50...+40°C |

Conclusion

- The SF₆ saving potential of the GIB is very high. At the same time, the risk failure of such modules is rather low.
- Onsite testing of SF₆-free equipment through pilot projects is necessary in order to gain field experience with the new technologies and their handling.
- The replacement of SF₆ by gas mixtures of natural gases is safer concerning the future regulation changes.
- TransnetBW will keep on installing and testing SF₆-free equipment based on atmospheric natural gases for GIS and AIS from all prequalified suppliers.

New substation Daxlanden after rebuild

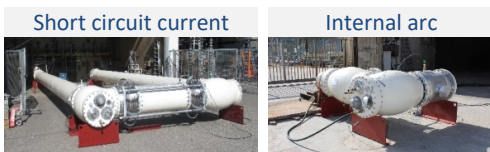
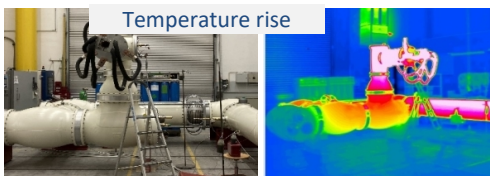
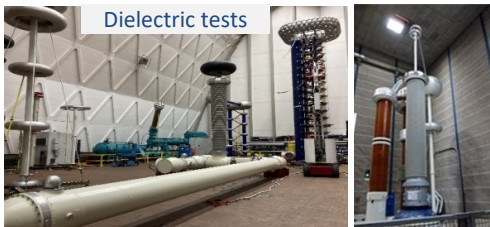


Low-emission conventional 420 kV-GIS

F-gas-free

*Only the GIS-C1 is shown as an example. The GIS-C2 is executed identically

Exemplary type tests impressions



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Clean Air operational experiences

The positive operating experience and increasing installations show that Clean Air is suitable for replacing SF₆ as an insulating gas up to 420 kV.

With Clean Air the same reliability and MTBF can be expected as with SF₆ equipment. In fact, no major failures have been recorded so far.



Exemplary Clean Air installations

First life tank CB with vacuum interrupter and Clean Air were installed already in 2010. Meanwhile LT, DT, Instrument Transformers and GIS are installed worldwide in all climatic zones.



Design overview of the 420 kV GIB

To ensure the dielectric performance the dimension and pressure of Clean Air is increased in comparison to SF₆. The related bursting type tests were successfully passed.



Busducts comparison	SF ₆	Clean Air
Tightness in % pro year	< 0,1	< 0,1
Filling pressure rel. at 20 °C in MPa	0.56	1.08
Gas weight in kg/m	3,5	3,3
GWP _{System} in t CO ₂ -eq. / 100 m	26.460	0

Clean Air gas handling

Clean Air enables much simpler, safer and faster gas handling!

Evacuation	Filling / Storage
<ul style="list-style-type: none"> - Vacuum pump for air & clean air - Storage and reuse not necessary - Clean Air is a commodity with multiple suppliers worldwide 	<ul style="list-style-type: none"> - Filling from bottles (tool supplied) - Storage w/o special requirements
Gas quality <ul style="list-style-type: none"> - After filling, only gas humidity (dew point -20°C). - Gas mixture remains stable, no gas composition checks 	Handling after arc fault <ul style="list-style-type: none"> - Decomposition O₃ & NO_x, natural degradation up to a few days. - The plant building is ventilated, cleaning with vacuum cleaners (simple personal protection measures)
Leakage detection <ul style="list-style-type: none"> - After installation with helium similar to factory - During service on individual modules with leak spray 	Recycling <ul style="list-style-type: none"> - No special requirements - Gas is released into the environment after operation (via filter after arc fault)

Life cycle assessment (LCA)

- With Clean Air the CO₂ footprint is significantly lower, the materials have a marginally influence
- In a CO₂-neutral economy only the gas remains climate-impacting as the needed energy will be generated by renewables without any CO₂ emissions
- Hence, Clean Air enables climate-neutral power grids without CO₂ compensation

LCA CO₂ Footprint according ISO 14040¹⁾



1) own evaluation for 100 m 420kV GIB length 2) depends significantly on the electricity mix