

Design Experience with Clean Air insulation for switchgear and equipment

A3 PS 2

SF₆ alternatives - Q7

The filling pressure of equipment with natural-origin gases is often above 1 MPa. Is there any experience or an estimate on the long-term leakage or other lifetime limiting mechanisms, including mechanical damage, deformation of internal parts, e.g., vacuum interrupters at 0 MPa?

SIEMENS
ENERGY

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Example - Long term experience with high pressure air insulated GIS

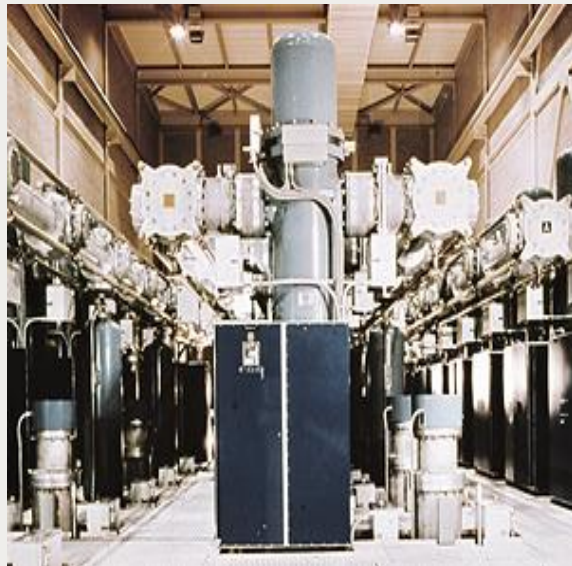
1970

First HV GIS with air-insulation

Type: BISEP GIS

170 kV/ 50 kA with air-blast CB & air-insulation

References: 88 bays (8 Subs.)
Alblasserdam, Netherlands



Group Discussion Meeting

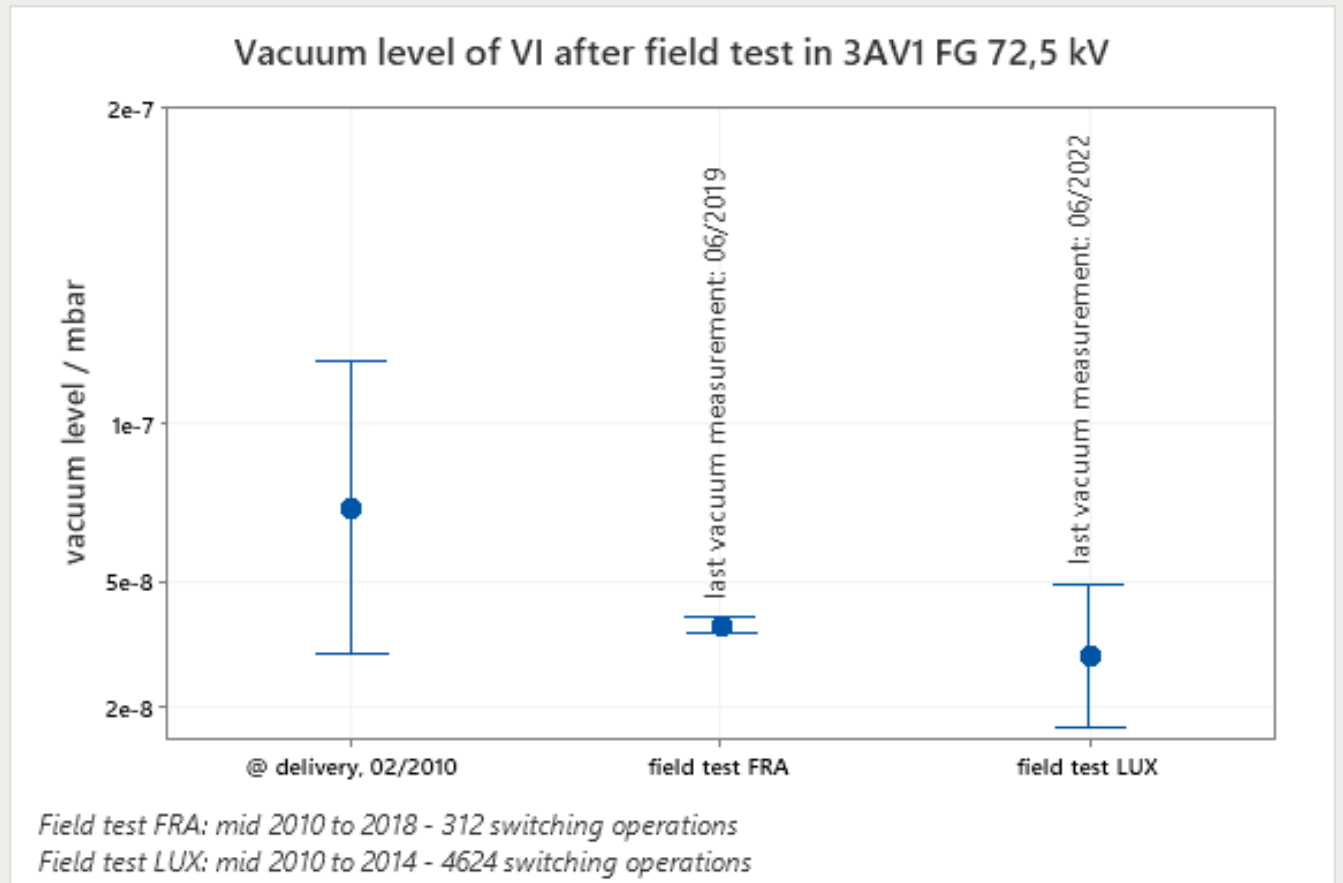
Technical data

- 88 bays commissioned between 1970...1980
- Most of them still in service, retrofit program 2004...2016 focus on CB
- Controlled pressure system, no humidity filter applied
- Rated current 2500 A up to 4000 A (Busbar)
- Bay size 1050 x 3300 x 13000 (W x H x D)
- Single-phase enclosures out of casted and welded aluminium
- **Filling Pressure: 1,8 MPa for insulation**
- **MTBF of 830 bay-years (considered 1970 – 2022)**

1. **Up to now no negative effects in the air insulation or damages of parts due to the high pressure**
2. **Air is a long-term stable insulation medium and proven for GIS**
3. **Safe operation guaranteed for the user**

Vacuum measurement of installed HV vacuum interrupter after operation

- 72,5 kV vacuum CBs were investigated after 4 – 8 years in service and up to 4624 switching operations
 - Vacuum interrupters are hermetically sealed
 - In operation the vacuum level is constant
- No leakage of HV vacuum interrupters were detected



Recent experience with design of switchgear and equipment with Clean Air (CA) insulation

- For GIS < 420 kV and live-tank circuit breakers filling pressure comparable to SF₆ equipment.
 - For gas-insulated switchgear and gas-insulated busducts ≥ 420 kV slightly higher filling pressures compared to SF₆ are considered and covered by switchgear design.
 - 420 kV VT, CT and Combi IT were introduced with CA filling pressures of 1,25 MPa to ensure the same footprint and tech. parameters as SF₆ design by reinforced housing design.
 - Explosion proof VT design with the highest protection class II and protection stage 2 according to IEC 61869. Internal arc test with an arc current of 80 kA, 0,3s succeeded.
 - For circuit breaker application with vacuum interrupter (VI) technology the capability of the VI to withstand the pressure is proven and is a key design factor for the CB.
- For all CA applications tightness measurements as part of type tests, accord. IEC (after mech. endurance type tests, high and low temp. test, temp. rise test) prove leakage rates similar to SF₆ equipment.



420 kV VTs: Comparison of Clean Air (blue) and SF₆ (green)

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