

SF6 SWITCHGEAR

Pertemuan 07 - PST

GAS SF6

- stabil secara kimiawi
- tidak bersifat racun
- tidak mudah terbakar
- tidak berbau
- tidak berwarna

GAS SF6

- kekuatan listriknya 2-3 kali udara biasa.
- pada tekanan 3 atmosfer, kekuatan listriknya menyamai isolasi minyak.
- kemampuan memadamkan busur api (arc) lebih besar dari udara biasa.
- bersifat elektronegatif, molekulnya cepat menyerap elektron yg mengalir pada arc menjadi ion negatif berat yang lambat.

Proses Produksi Gas SF6

SF6 terbentuk dari reaksi kimia antara sulfur cair dan gas fluorine. Fluorine sendiri didapat dari elektrolisa asam hidroflorik (HF).

Proses Produksi Gas SF₆

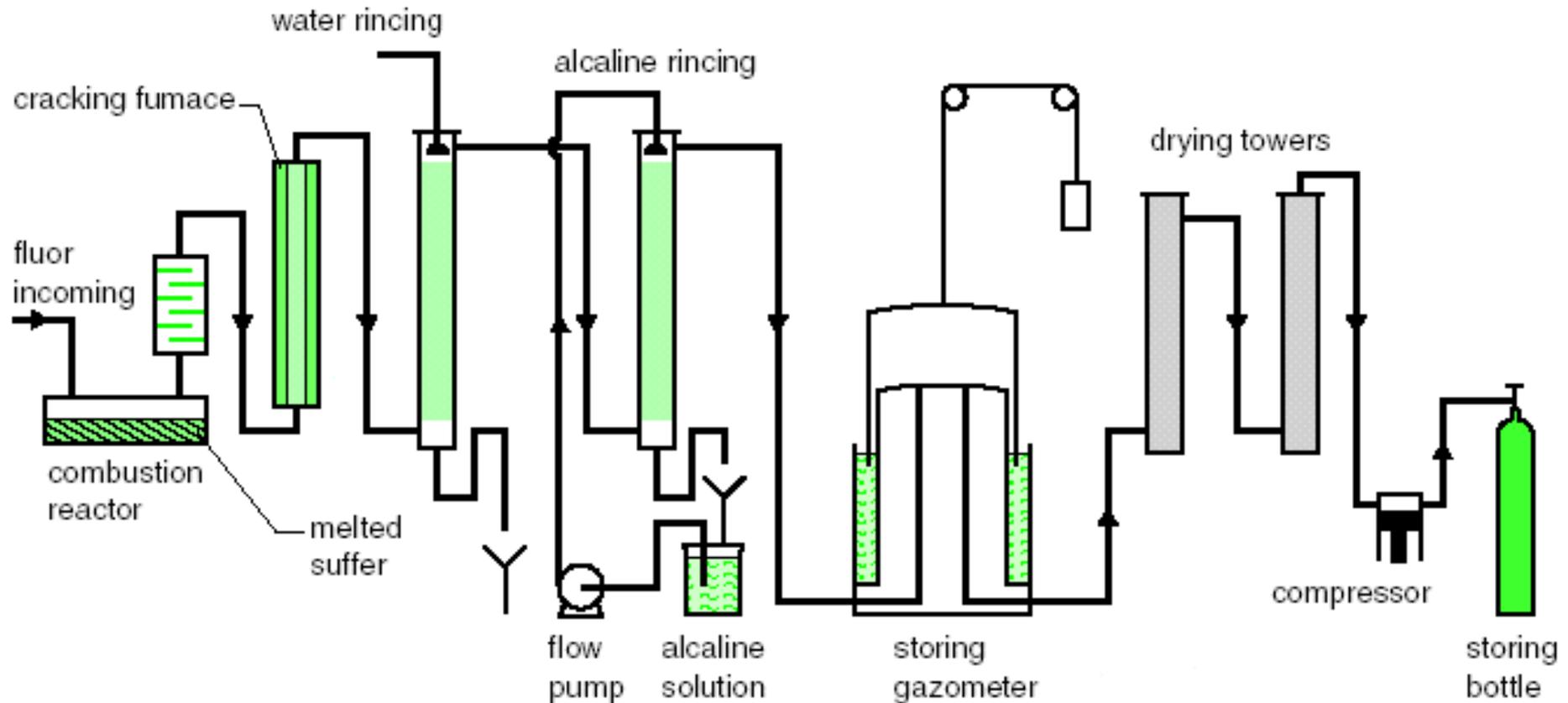


fig. 1 : process of SF₆ production by direct combination. The purification chain is necessary to obtain high purity gas. The quality of SF₆ for delivery is defined by IEC publication 376 which specifies the admissible concentrations of impurities.

Gas SF6 beracun ?

- Gas SF6 murni tidak beracun. Gas ini tidak berbahaya bila dihirup, komposisi hingga 20% oksigen dan 80% SF6 tidak berbahaya untuk dihirup.
- SF6 adalah 6 kali lebih berat dari udara, artinya SF6 dapat terkumpul di ducts kabel atau di bagian bawah tangki.

Penyebab bahaya pada kasus tertentu dikarenakan kekurangan oksigen, tapi bukan karena gas SF6 !!

Pengaruh terhadap lingkungan

- SF6 tidak mengandung klorin, sehingga tidak berpengaruh kepada lapisan ozon.
- SF6 dapat memantulkan radiasi panas dari bumi sehingga menimbulkan efek 'greenhouse', tapi konsentrasi gas ini sangat amat kecil dibanding gas lain seperti CO₂, dsb.

SF6 dapat dihancurkan ?

- **SF6 dapat dibersihkan dan digunakan lagi ('recycled')**
- **SF6 dapat dengan mudah dihancurkan (*bila sudah tidak digunakan lagi*) dengan cara dipanaskan dengan kapur menghasilkan zat yang tidak berbahaya**
- **kebijakan produsen peralatan listrik biasanya: *tidak boleh ada gas SF6 pun yang dilepas secara sengaja maupun tidak sengaja ke atmosfer saat peralatan dipasang, digunakan, hingga dibuang.***

Pemakaian SF6

- **Pada peralatan listrik, SF6 hanya digunakan pada sistem yang tertutup dan aman yang tidak menyebabkan kebocoran gas.**
- **Bila peralatan akan dibuka, SF6 dapat dikumpulkan dan daur ulang.**

Penggunaan Gas SF6

- Medium and High Voltage Switchgear
- Compact Gas Insulated Substation (GIS)
- Gas Insulated Transmission Line (GIL)
- Gas Insulated Transformers

SF6 Switchgear

- dapat indoor, outdoor, atau underground switchgear.
- membutuhkan sedikit tempat.
- tidak terpengaruh polusi dan faktor lingkungan.
- peralatannya umumnya dalam bentuk modul-modul.

Mekanisme open/close CB SF6

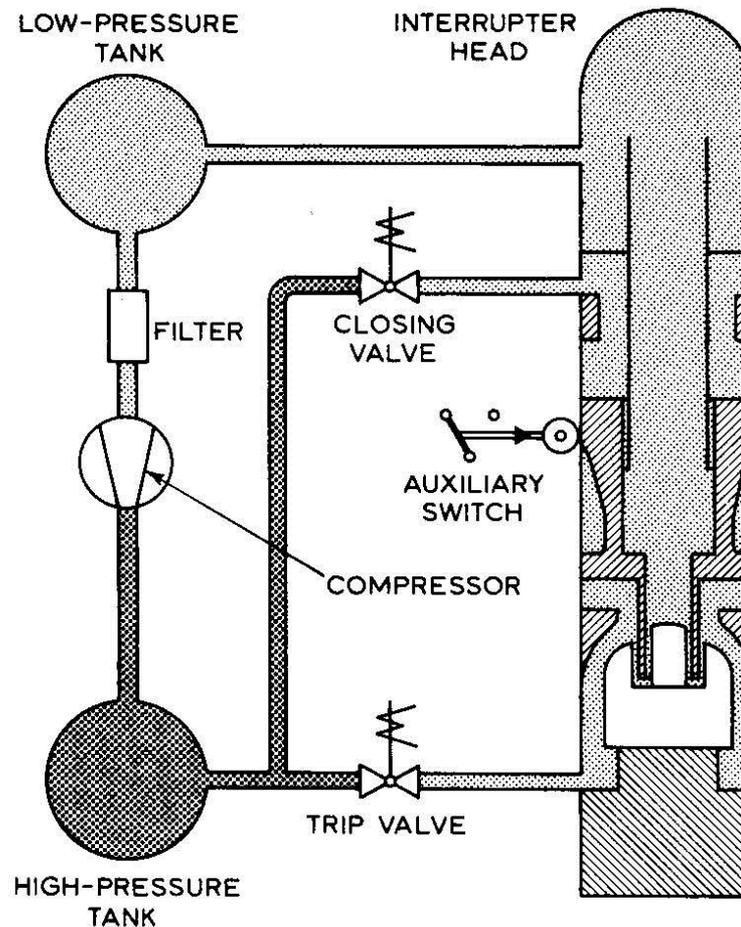


Figure 16.4. The closed gas system in the Siemens 'F' circuit-breaker, 10/30 kV. Contacts in closed position (courtesy Siemens (UK) Ltd.)

Pemadaman busur api

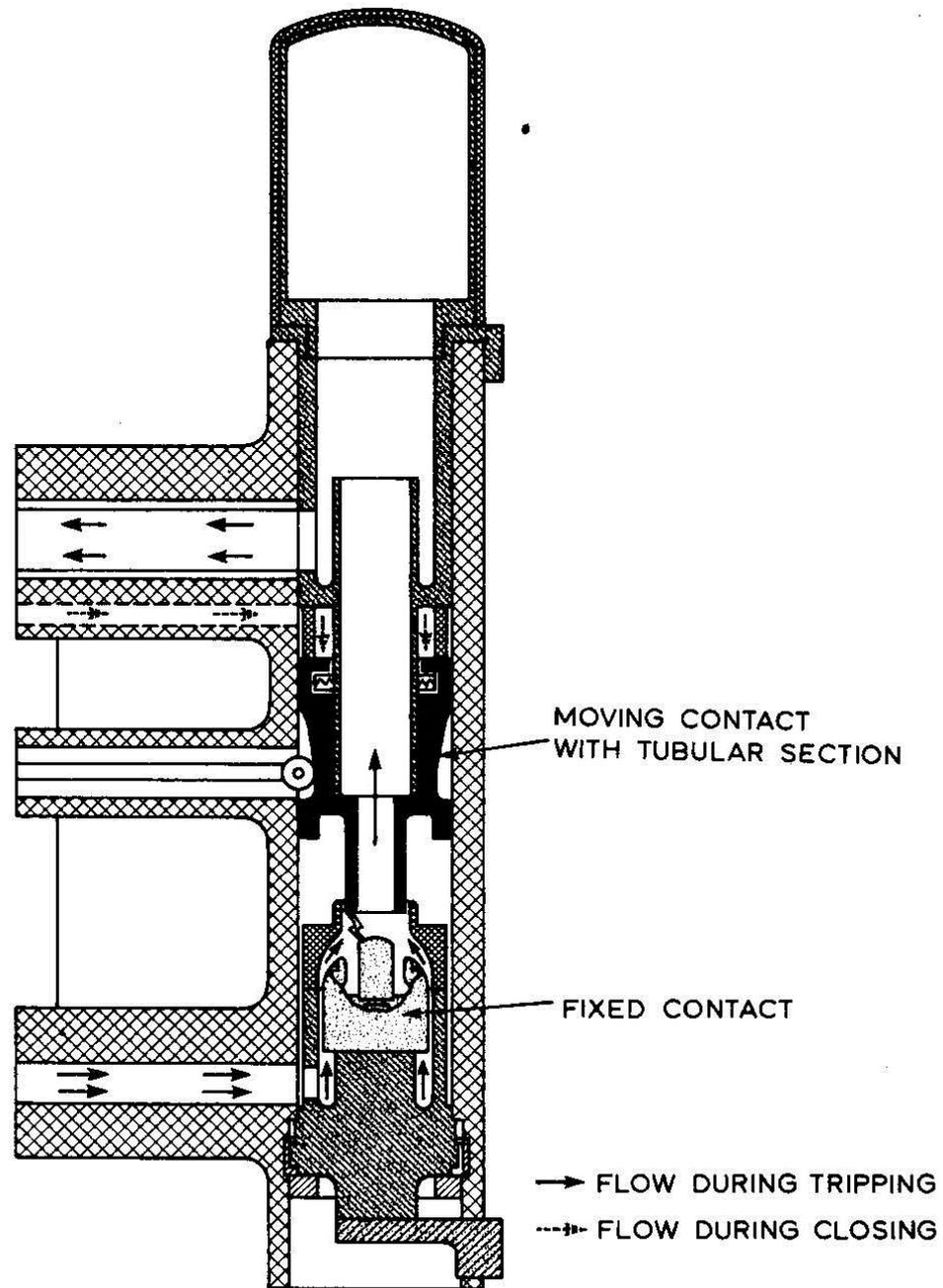
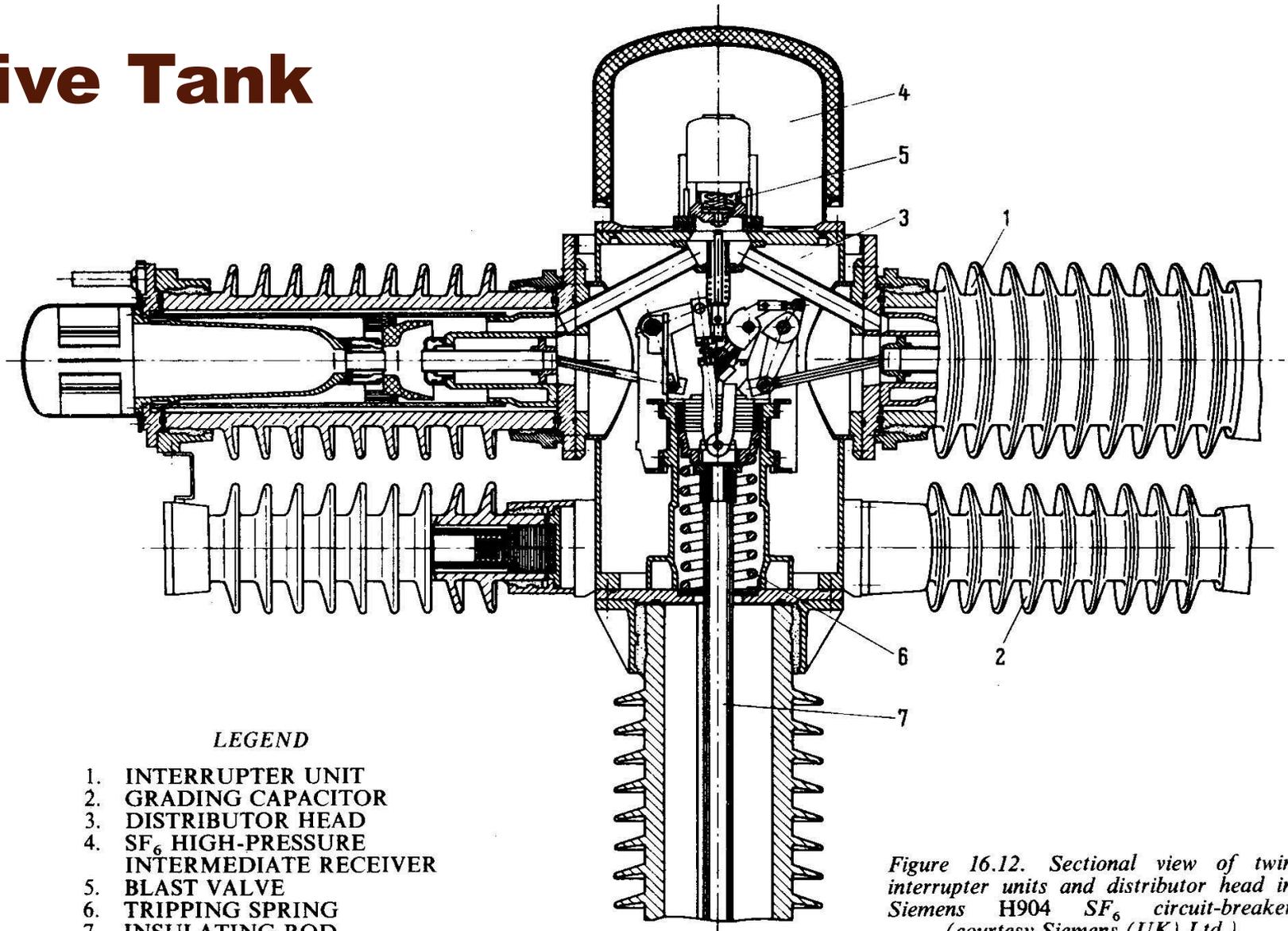


Figure 16.5. Interrupter unit with arc-quenching assembly (one pole) used in Siemens 'F' circuit-breaker. Contacts opening with an arc striking at the gap (courtesy Siemens (UK) Ltd.)

Live Tank



LEGEND

1. INTERRUPTER UNIT
2. GRADING CAPACITOR
3. DISTRIBUTOR HEAD
4. SF₆ HIGH-PRESSURE INTERMEDIATE RECEIVER
5. BLAST VALVE
6. TRIPPING SPRING
7. INSULATING ROD

Figure 16.12. Sectional view of twin interrupter units and distributor head in Siemens H904 SF₆ circuit-breaker (courtesy Siemens (UK) Ltd.)

Live Tank

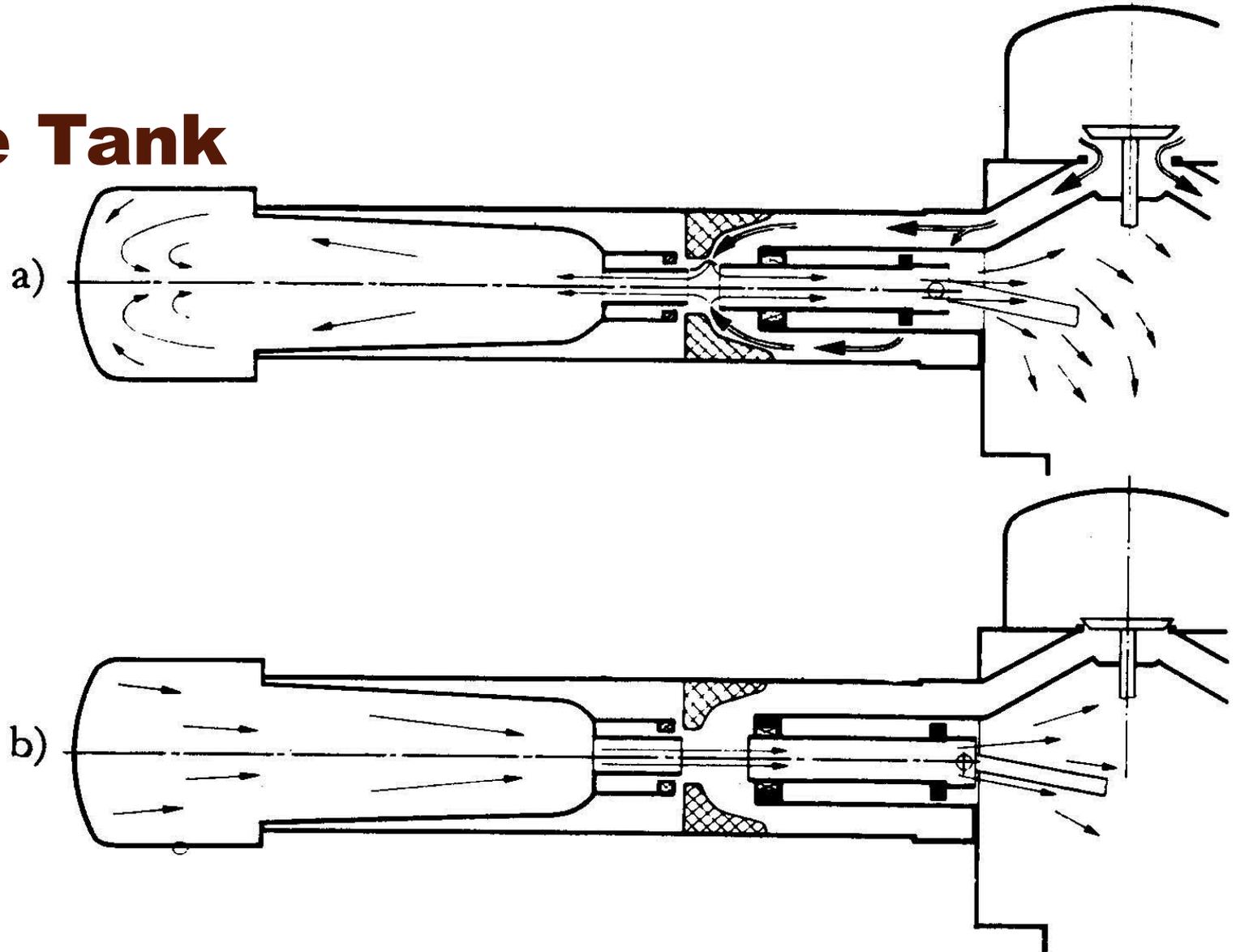


Figure 16.13. Schematic diagram of gas flow in the interrupter unit in the Siemens H904 SF₆ circuit-breaker. (a) During arc-quenching and (b) with arc extinguished (courtesy Siemens (UK) Ltd.)

Live Tank SF6 CB

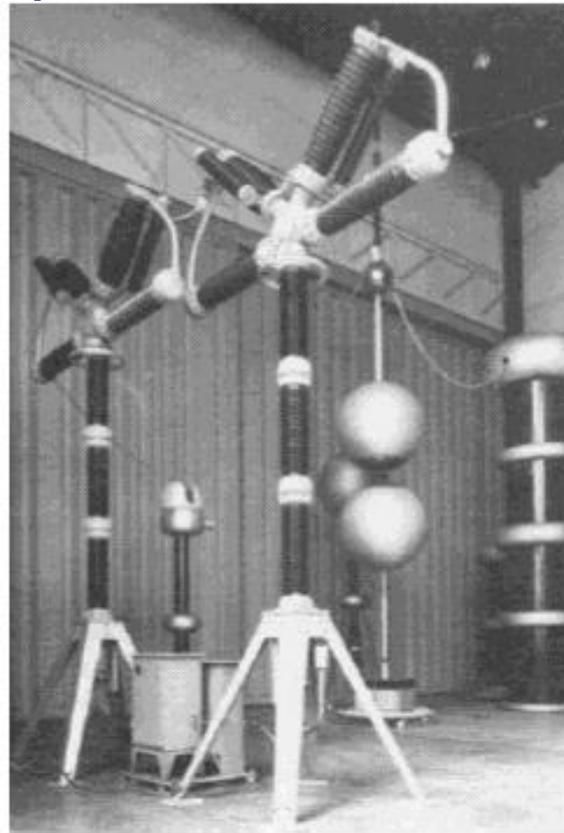


Fig. 3: pole of SF₆ puffer circuit-breaker with 4 breaks and closing resistors.
rated voltage = 525 kV; rated breaking current = 50 kA;
rated current = 3,150 A

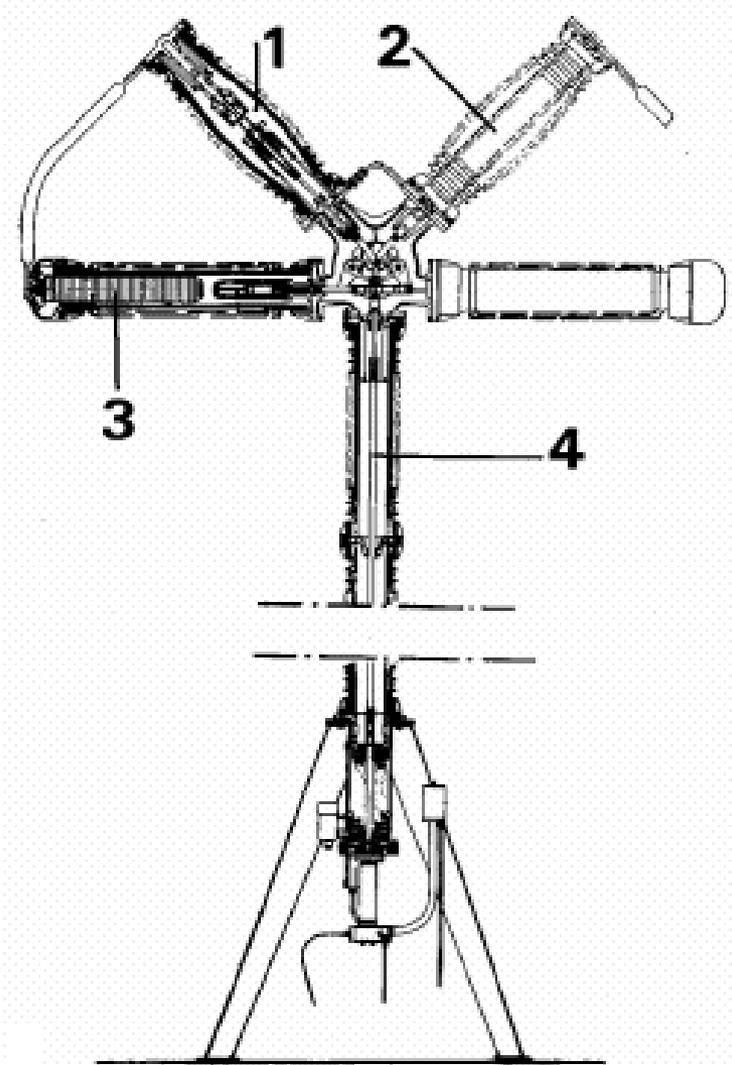


Fig. 1: sectional view of a pole unit of 525 kV circuit-breaker equipped with closing resistors.

1. break
2. grading capacitor
3. closing resistor
4. support insulator

Dead Tank

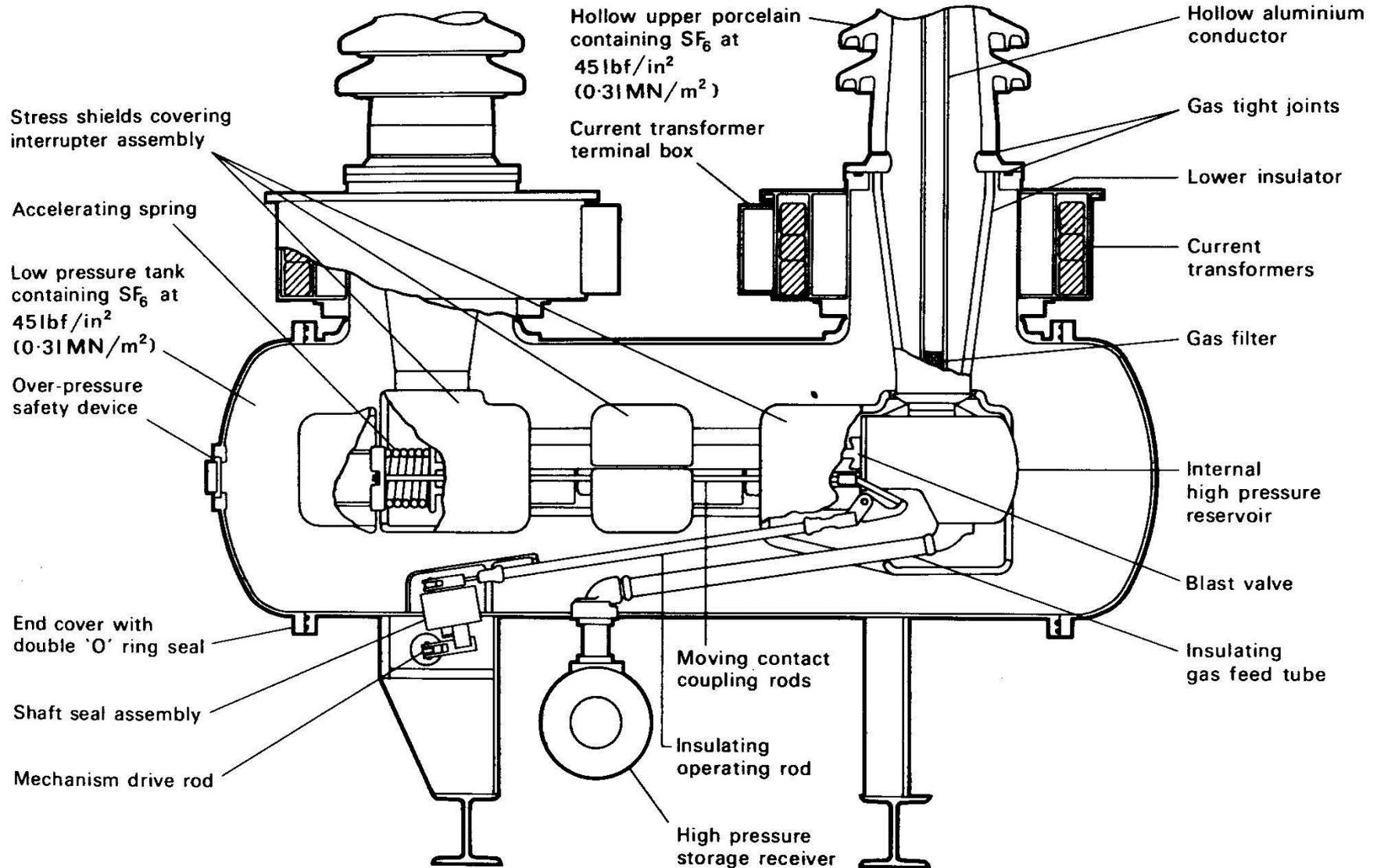


Figure 16.7. Sectional view of one pole of a 132 kV 5 000 MVA dead-tank SF₆ circuit-breaker (courtesy G.E.C. Switchgear Ltd.)

Sistem Gas SF6 CB

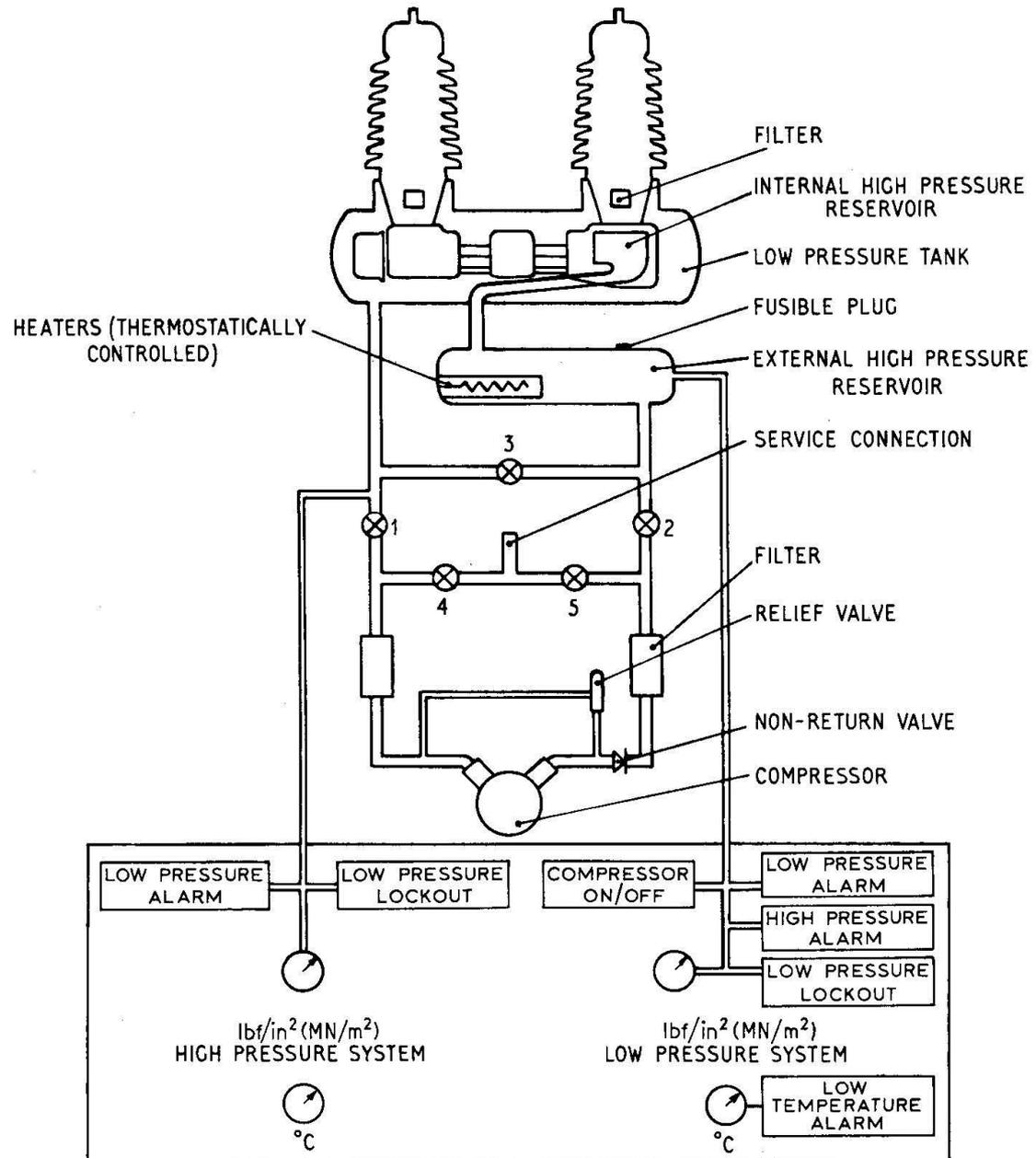


Figure 16.9. Schematic diagram of the closed-circuit gas system used in the SF_6 circuit-breaker shown in Figures 16.6 and 16.10 (courtesy G.E.C. Switchgear Ltd.)

SF6 SWITCHGEAR

SF6 akan menjadi teknologi tunggal dalam desai GIS dan CB.

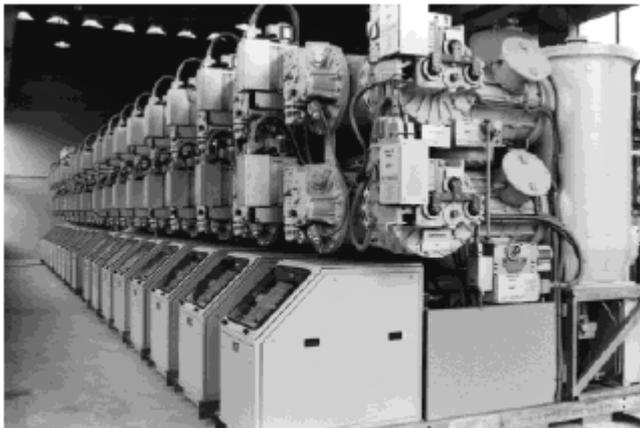


fig. 13 : GIS (Merlin Gerin)

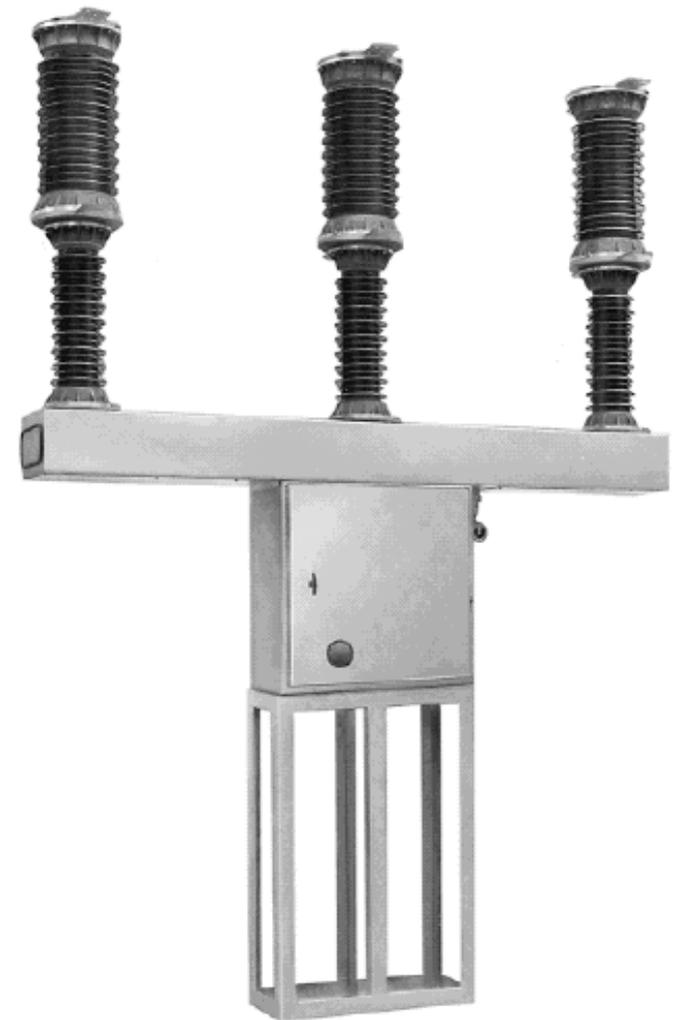


fig. 14 : circuit-breaker for HV substation equipment (SB6 circuit-breaker - Merlin Gerin).

Penanganan dan penggunaan Gas SF6

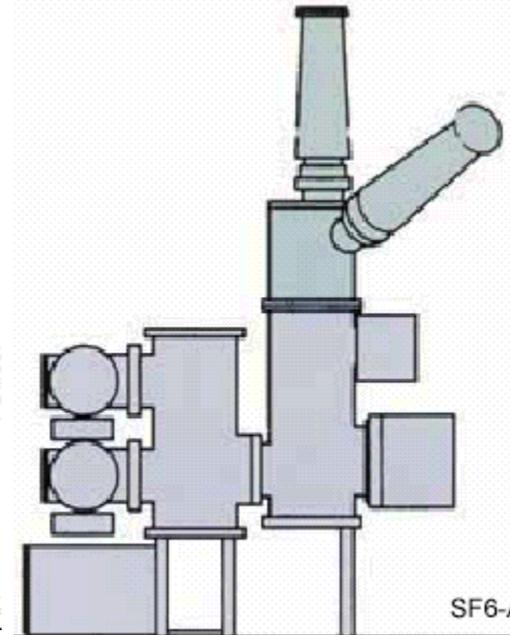
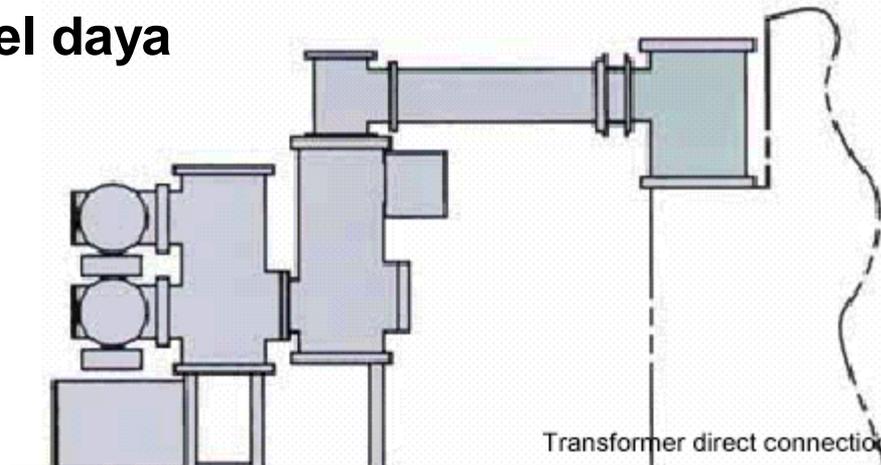
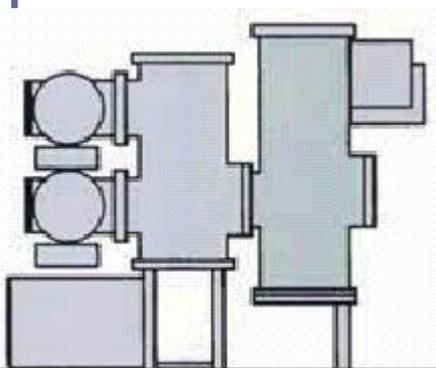
- Gas SF6 baru disuplai berbentuk cair tersimpan dalam tabung dengan tekanan 22 bar.

Kompatibilitas untuk berbagai terminasi

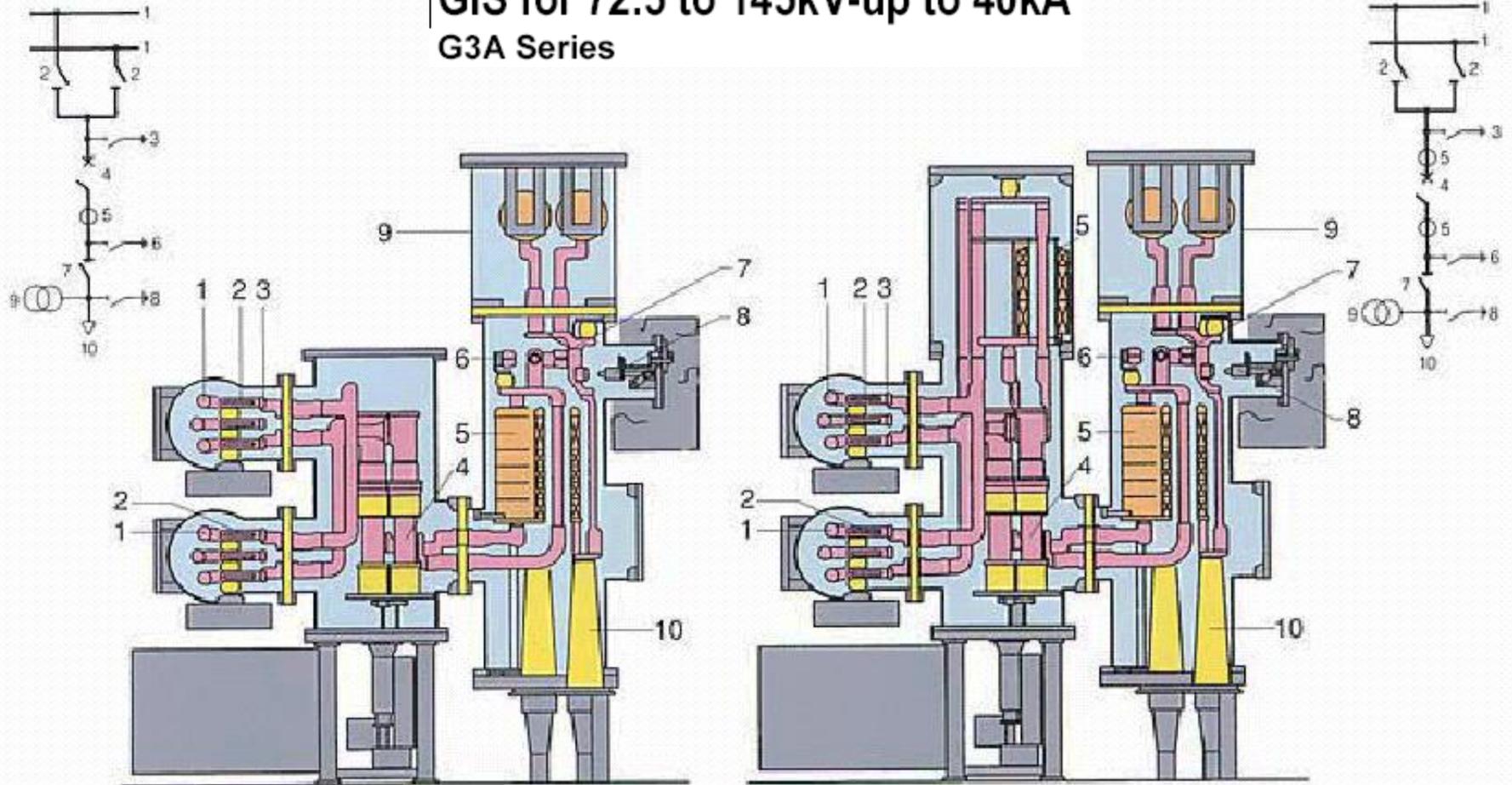
Hubungan ke udara terbuka

Hubungan ke transformer

Hubungan ke kabel daya



GIS for 72.5 to 145kV-up to 40kA G3A Series



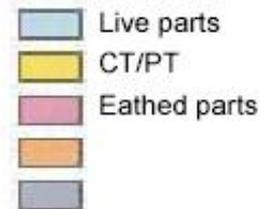
- 1: Busbar
- 2: Busbar disconnector
- 3: Maintenance earthing switch
- 4: Circuit breakers

- 5: Current transformer
- 6: Maintenance earthing switch
- 7: Disconnector
- 8: High speed earthing switch

- 9: Voltage transformer
- 10: Cable sealing end

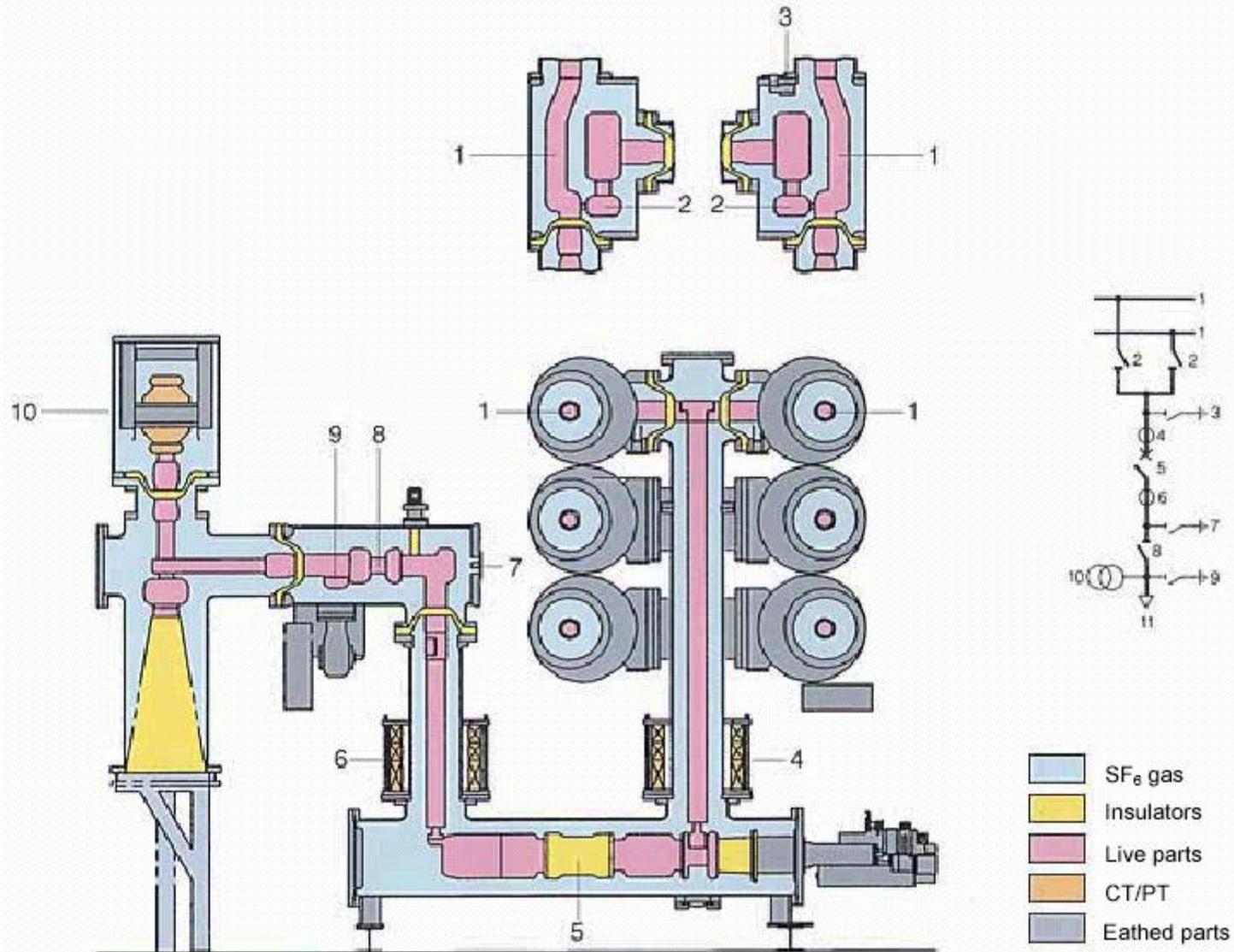
- SF₆ gas
- Insulators
- Live parts
- CT/PT
- Eathed parts

145kV GIS Sectional view of a bay with double busbar system



GIS for 170 to 252kV-up to 50kA

G1B Series



1: Busbar

2: Busbar disconnector

3: Maintenance earthing switch

4: Current transformer

5: Circuit breaker

6: Current transformer

7: Maintenance earthing switch

8: Disconnector

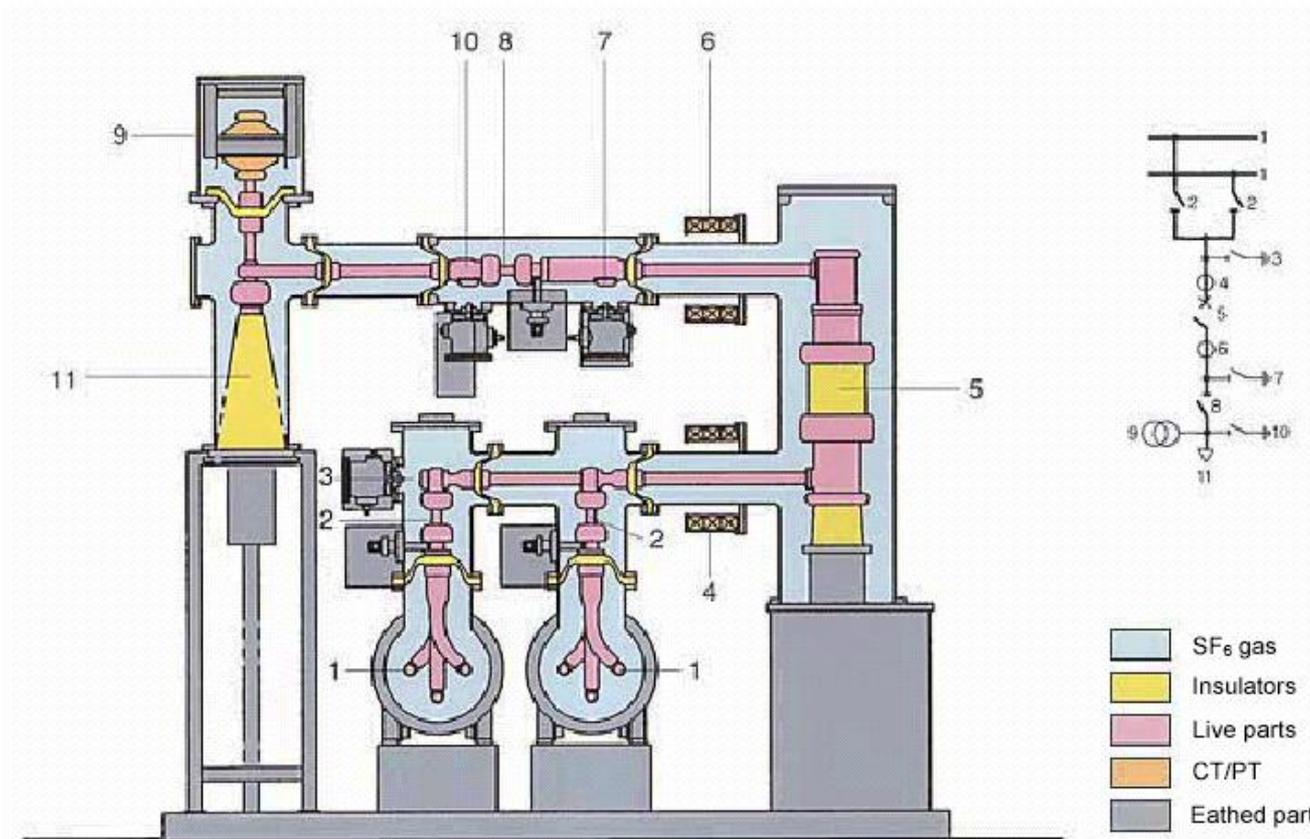
9: High speed earthing switch

10: Voltage transformer

11: Cable sealing end

GIS for 245 to 300kV-up to 63kA

G1C Series



- 1: Busbar
- 2: Busbar disconnector
- 3: Maintenance earthing switch
- 4: Current transformer

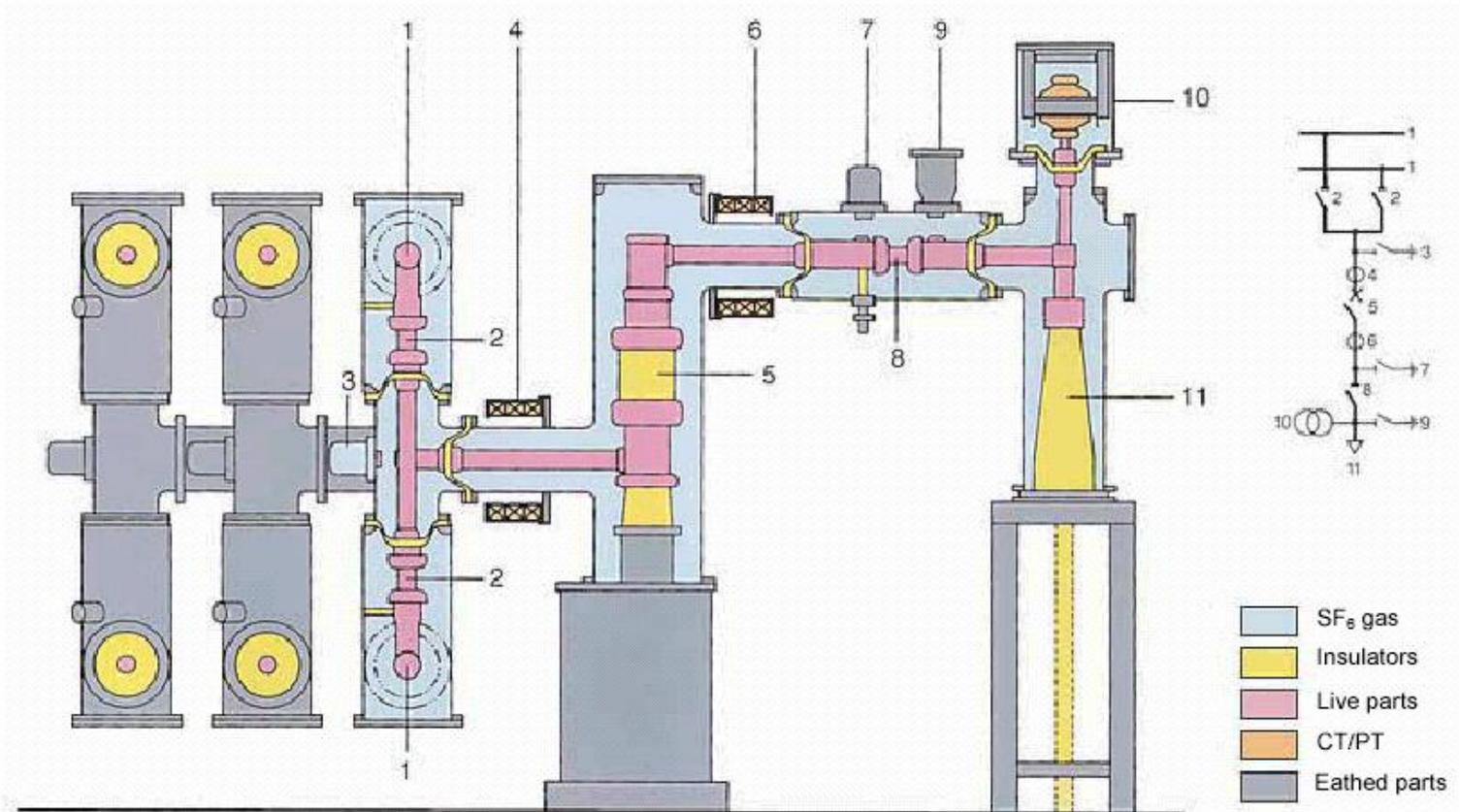
- 5: Circuit breaker
- 6: Current transformer
- 7: Maintenance earthing switch
- 8: Disconnector

- 9: Voltage transformer
- 10: High speed earthing switch
- 11: Cable sealing end

300 kV GIS Sectional view of a bay with double busbar system

GIS for 330 to 420kV-up to 63kA

G1D Series



- 1: Busbar
- 2: Busbar disconnector
- 3: Maintenance earthing switch
- 4: Current transformer

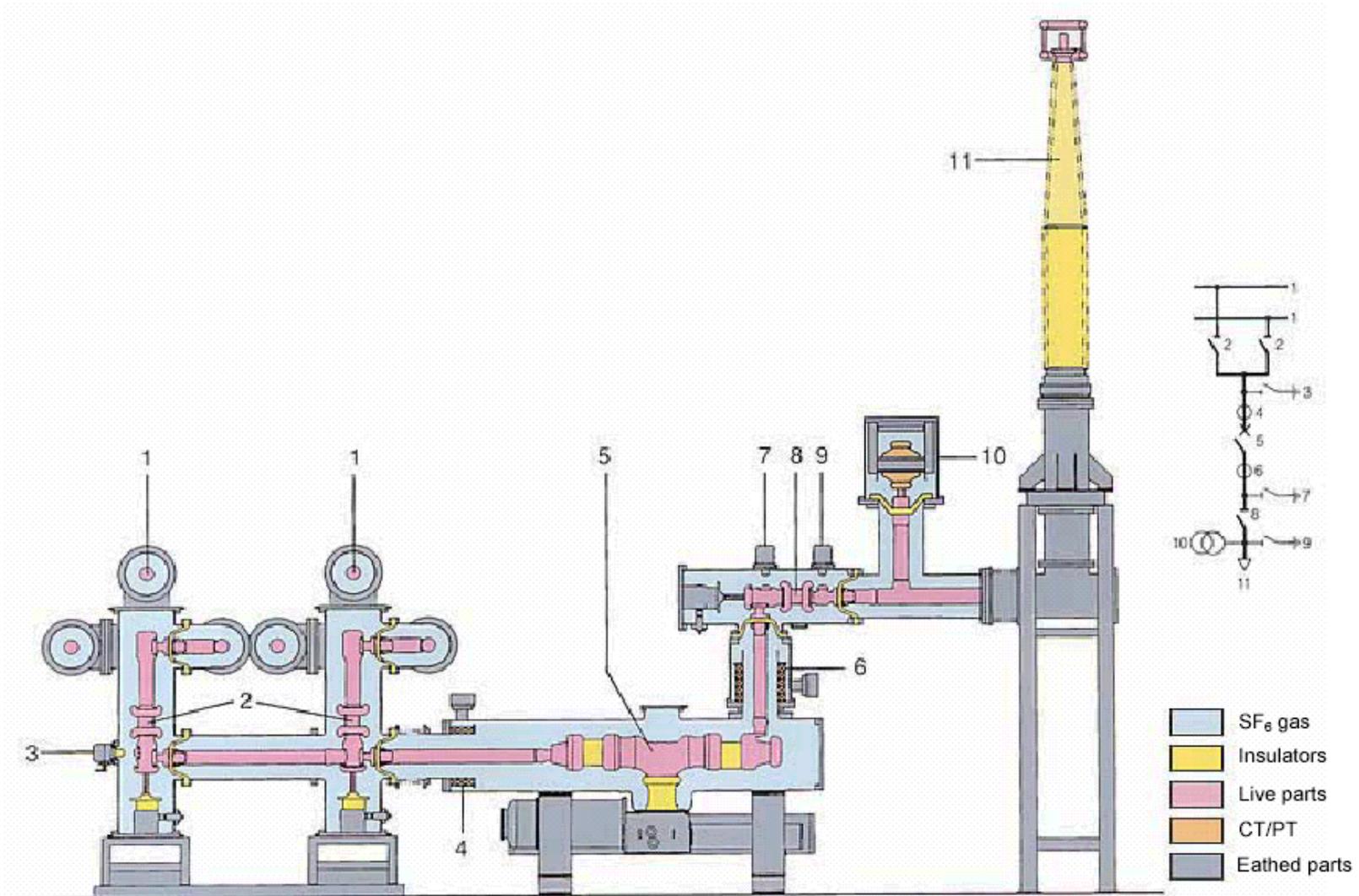
- 5: Circuit breaker
- 6: Current transformer
- 7: Maintenance earthing switch
- 8: Disconnector

- 9: High speed earthing switch
- 10: Voltage transformer
- 11: Cable sealing end

420 kV GIS Sectional view of a bay with double busbar system

GIS for 330 to 550kV-up to 63kA

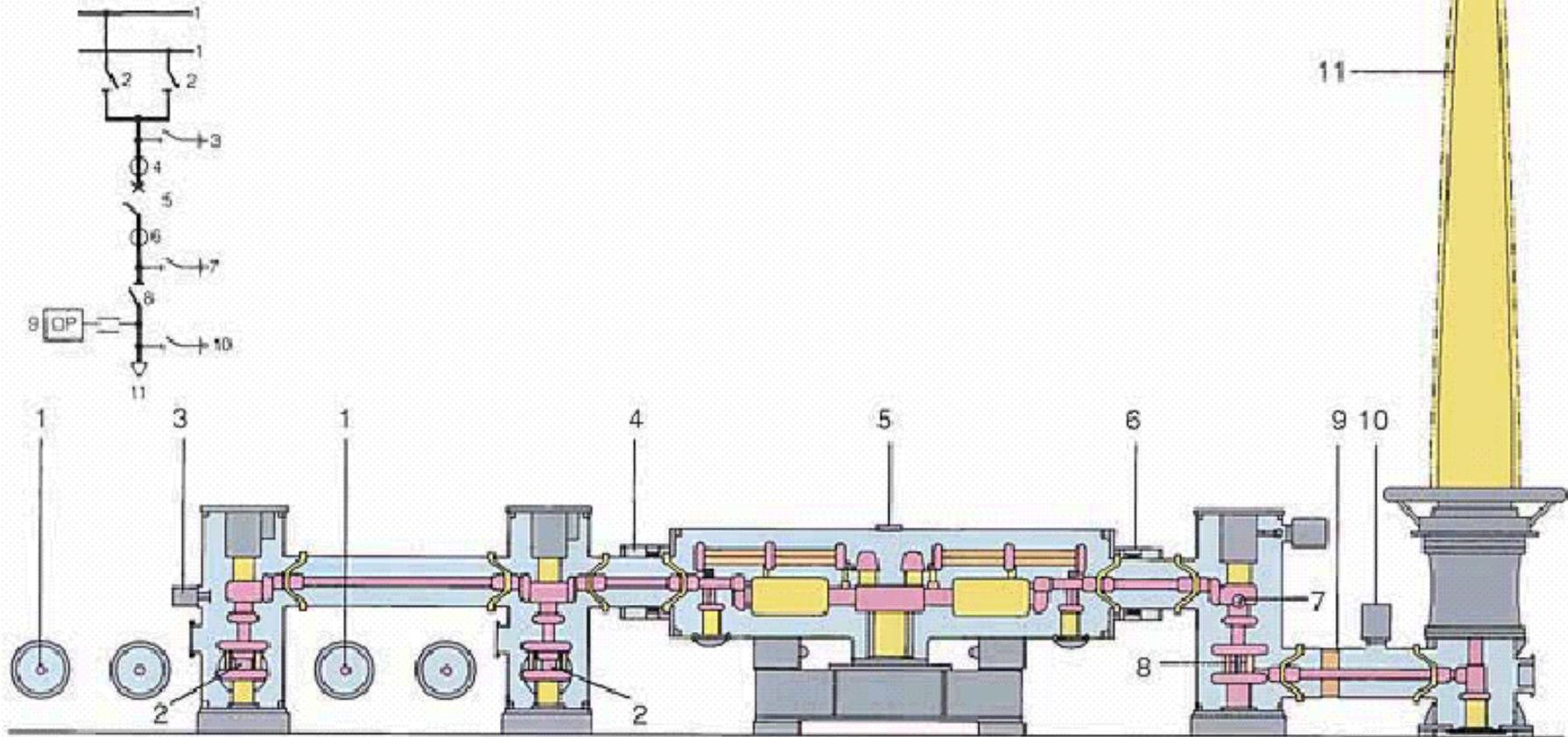
G1D Series



550 kV GIS Sectional view of a bay with double busbar system

GIS for 765 to 1,100kV-up to 50/63kA

G1E Series



- 1: Busbar
- 2: Busbar disconnector
- 3: Maintenance earthing switch
- 4: Current transformer
- 5: Circuit breaker
- 6: Current transformer
- 7: Maintenance earthing switch
- 8: Disconnector

- 9: Optical potential device
- 10: Earthing switch
- 11: Bushing

- SF₆ gas
- Insulators
- Live parts
- CT/PT
- Eathed parts

1,100 kV GIS Sectional view of a bay with double busbar system

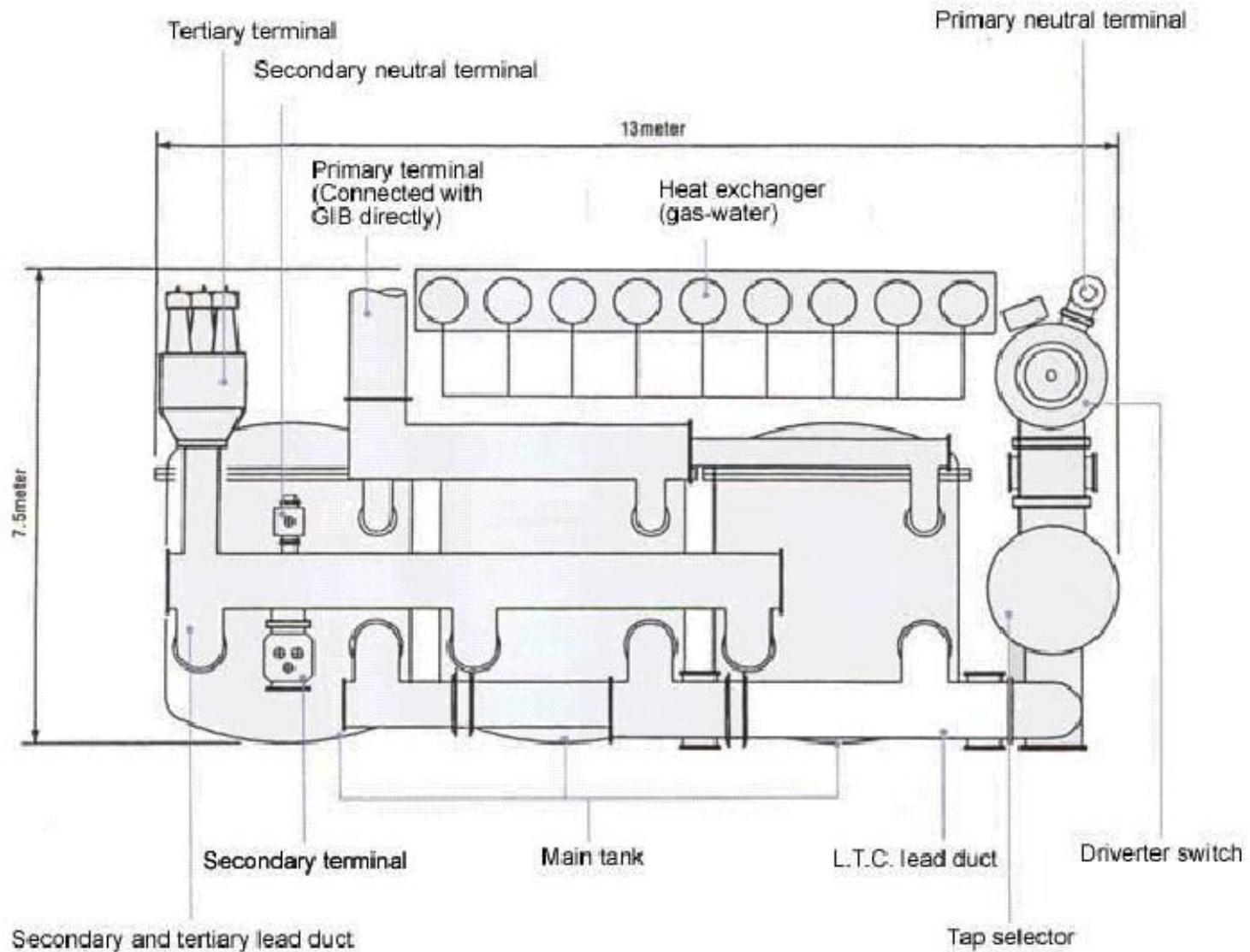
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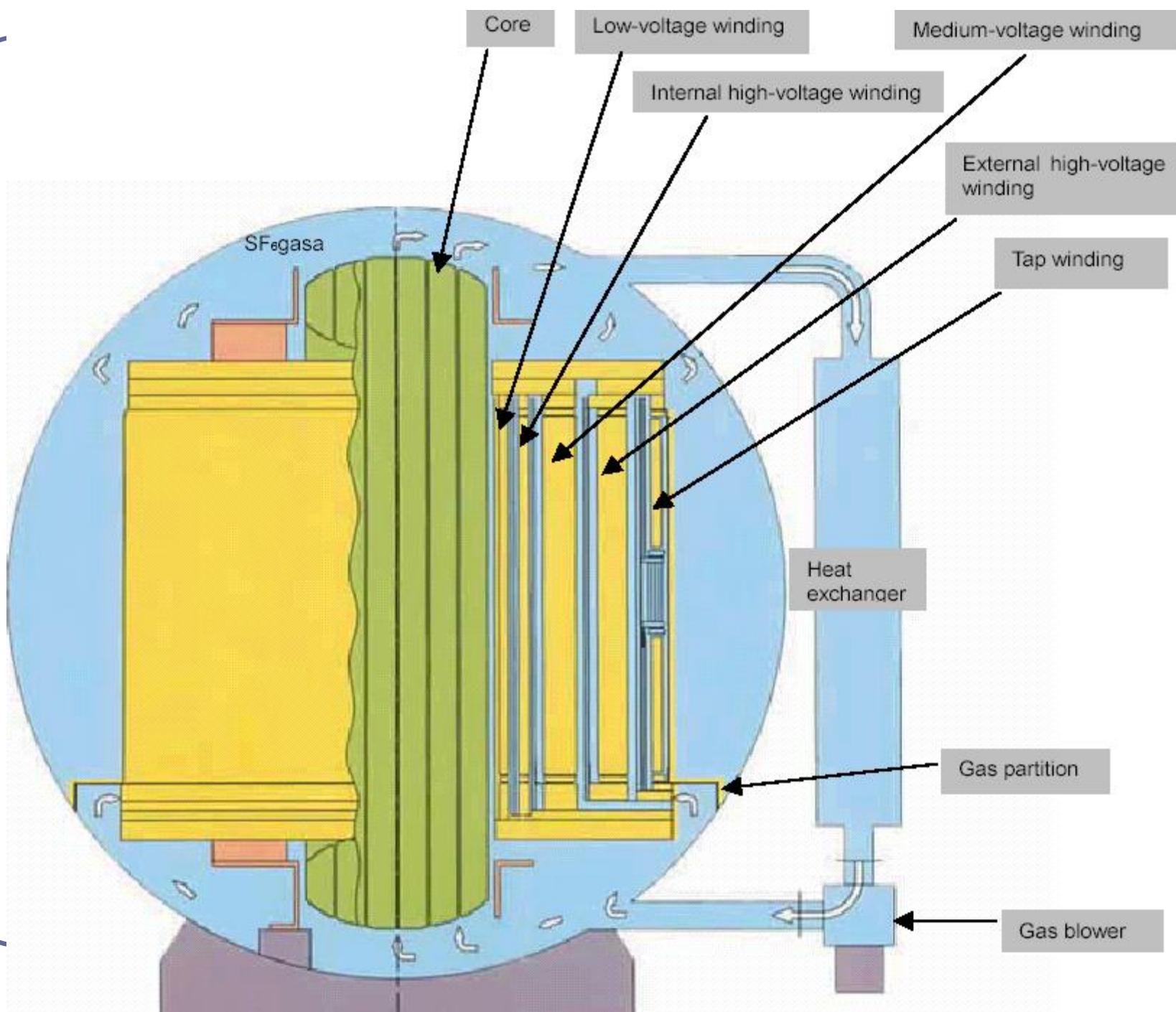
GAS INSULATED TRANSFORMER

- **Tidak mudah terbakar**
SF6 gas adalah media isolasi sekaligus pendingin
- **Tanki tidak dapat meledak**
Ketahanan tanki cukup menahan tekanan internal
- **Kompak**
Tinggi ruang trafo cukup 2 - 2,5 meter
- **Instalasi mudah**
Tidak perlu penyulingan minyak karena memakai SF6
- **Inspeksi dan perawatan mudah**
Inspeksi periodik hanya perlu memonitor tekanan gas SF6 saja

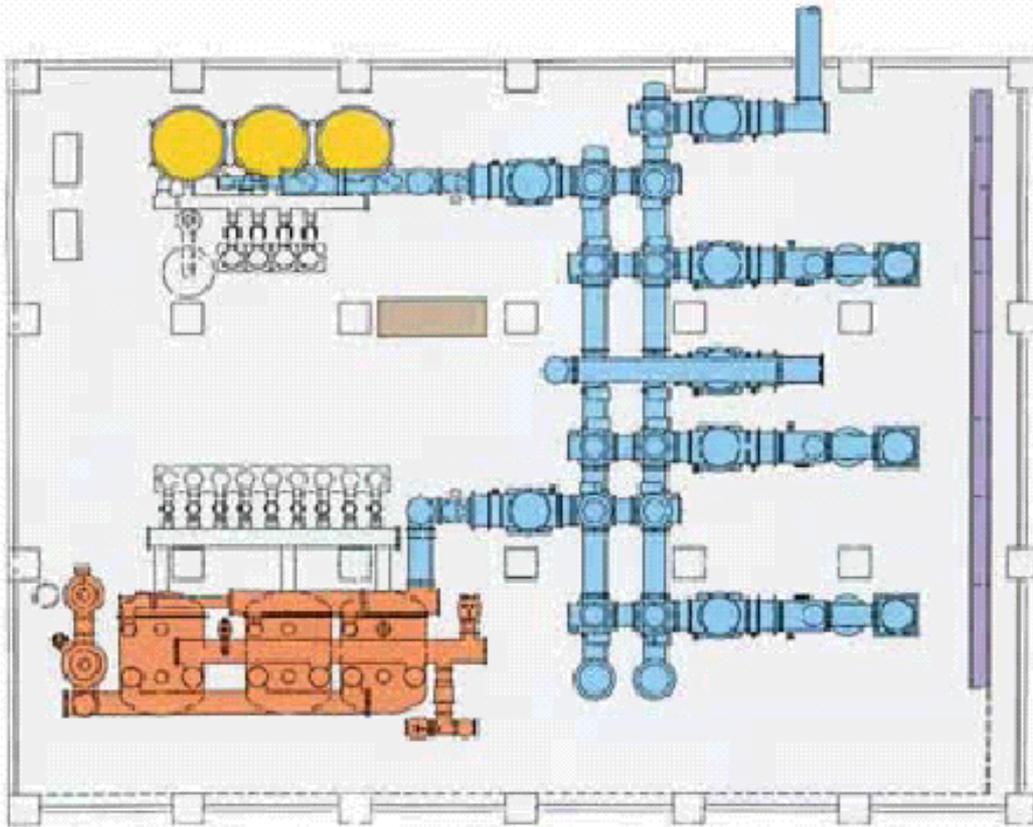


LAYOUT G.I.T.





CONTOH LAYOUT G.I.S.+G.I.T.



-  Gas insulated transformer
-  Gas insulated switchgear (GIS)
-  Gas insulated shunt reactor
-  Cooling system control panel
-  Protective relaying equipment

Tugas Kelompok

- Membuat PPT dan dipresentasikan berkelompok maksimal 15 menit (rekam video, bias pakai zoom, gmeet, aplikasi perekam yg lain).
- Pembagian topik dan kelompok presentasi :
- Pengertian dan Jenis-Jenis Gardu Induk 1-2
- Pengertian dan jenis-Jenis Bus Bar 3-4
- Transformator Daya 5-6
- Circuit Breaker (CB) dan Disconnecting Switch (DS). 7-8
- Current Transformer (CT) dan Potential Transformer (PT) 9-10
- Lightning Arrester (LA) dan CVT 11 – 12
- Gardu Induk Konvensional 13 – 14
- Gardu Induk GIS 15-16