

Substation Engineering: Gas Insulated Substations (GIS) & Hybrid GIS Substations (Part 3 of 4)

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Gas Insulated Substations (GIS) & Hybrid GIS Substations (Part 3 of 4)

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- Unit 6: Gas Insulated and Hybrid Substations

- GIS Layout Configurations
- Single Bus vs. Double Bus GIS
- Indoor vs. Outdoor GIS Installations
- Civil and Foundation Requirements
- Introduction to Mixed Technology Switchgear (MTS / Hybrid GIS)
- Components of a Hybrid GIS
- Advantages and Applications of Hybrid GIS

GIS Layout Configurations

- Just like AIS, GIS can be configured in any standard bus scheme
- Common schemes: Single Bus, Double Bus, Double Breaker, 1.5 Breaker
- The modular nature of GIS allows 3D stacking of phases to save space
- Phase arrangement can be single-phase enclosed (UHV) or three-phase enclosed (up to 170kV)
- Routing of control cables and gas piping must be integrated into the layout

Single Bus vs. Double Bus GIS Layout

Single Bus GIS:

- Extremely compact and simple
- Lower cost, but requires shutdown of the bay for busbar maintenance

Double Bus GIS:

- Features two parallel gas-insulated busbars running horizontally
 - Disconnectors connect the bay to either Bus 1 or Bus 2
 - Allows maintenance flexibility without dropping load

Space Optimization Techniques

- GIS allows for creative spatial arrangements
- Underground Substations: Entire substations built below city parks or commercial buildings
- Multi-story Substations: Cable terminations in the basement, GIS on the ground floor, transformers outside
- Vertical Stacking: Busbars can be stacked vertically to reduce building footprint
- Integrated control cabinets directly on the GIS modules

Indoor vs. Outdoor GIS Installations

Characteristic	Indoor GIS	Outdoor GIS
Weather Protection	Excellent	Exposed to sun, rain, snow
Building Cost	High (Requires civil structure)	Low (Only foundations)
Maintenance	Easy (climate controlled)	Harder (dependent on weather)
Visual Impact	Low (looks like a building)	Moderate (industrial look)
Corrosion Risk	Minimal	Higher (requires special coatings)

Civil and Foundation Requirements

- GIS imposes highly concentrated loads on floors
- Floor tolerances must be exceptionally flat (typically $\pm 2\text{mm}$ per meter)
- Modules must align perfectly to prevent stress on cast resin spacers
- Embedment plates are poured into the concrete floor to weld or bolt GIS frames
- Overhead cranes are mandatory in GIS buildings for installation and maintenance

Introduction to Hybrid GIS

- Also known as Mixed Technology Switchgear (MTS)
- Combines the compactness of GIS with the simplicity of Air Insulated Substations (AIS)
- Circuit breakers, disconnectors, and CTs are gas-insulated
- Busbars and connections between bays remain air-insulated
- Provides a 'best of both worlds' solution

Features of Mixed Technology Switchgear (MTS)

- Highly integrated modules (Breaker, CT, VT, Isolators in one tank)
- Bushings protrude from the tank to connect to overhead air-insulated buses
- Completely factory assembled and transported as a single unit
- Plug-and-play installation minimizes on-site work
- Common market products: PASS (ABB/Hitachi), HIS (Siemens)

Hybrid GIS Substation Layout

Unlike full GIS, Hybrid GIS requires standard air clearances between bays
However, the bay depth is drastically reduced
Replaces 4 or 5 separate AIS components with 1 MTS module
Reduces bay footprint by approximately 50-70% compared to full AIS
Ideal for replacing aging AIS bays within the same property boundary

Advantages of Hybrid GIS

- Space Savings: 60% reduction over AIS
- Cost Effective: Cheaper than full GIS, no building required
- Reliability: The most critical component (breaker) is protected in SF6
- Fast Installation: Pre-assembled and tested
- Clear demarcation of isolation: Air-insulated disconnects provide visible open points

Comparison: AIS vs GIS vs Hybrid GIS

Metric	AIS	Hybrid GIS (MTS)	Full GIS
Space Required	100%	40-50%	10-25%
Capital Cost	Low	Medium	High
Installation Time	Weeks	Days	Weeks (plus building)
Environmental Vulnerability	High	Low	Zero
Gas Inventory (SF6)	None/Low	Moderate	High

Typical Applications for Hybrid GIS

- Brownfield Expansions: Adding new bays to a constrained existing AIS yard
- Rapid Substation Deployment: Emergency replacements or fast-track industrial projects
- Seismic Zones: Lower center of gravity than AIS components
- Mobile Substations: Mounted on trailers for temporary power restoration

Summary

- GIS layout design leverages 3D stacking to fit massive power capacity into small buildings
- Civil requirements for GIS are extremely tight to ensure mechanical integrity
- Hybrid GIS (MTS) combines SF6-insulated components with air-insulated busbars
- Hybrid GIS cuts footprint by 50% while avoiding the high costs of full GIS
- MTS is ideal for upgrading existing substations and fast-track deployments

Next Lecture Preview

- GIS and Hybrid GIS (Part 4 of 4)
- Testing and Commissioning of GIS
- High-voltage dielectric testing on site
- Partial Discharge (PD) measurement techniques (UHF and Acoustic)
- Lifecycle maintenance and SF6 gas handling procedures