Jessica Ponce de Leon, Gas Insulated Switchgear, Power Products, ABB Switzerland

Gas Insulated Switchgear

Concept Design for Service Continuity in GIS

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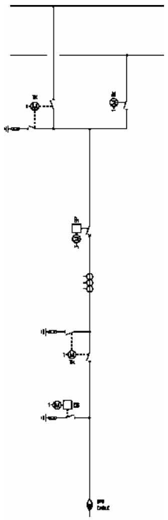
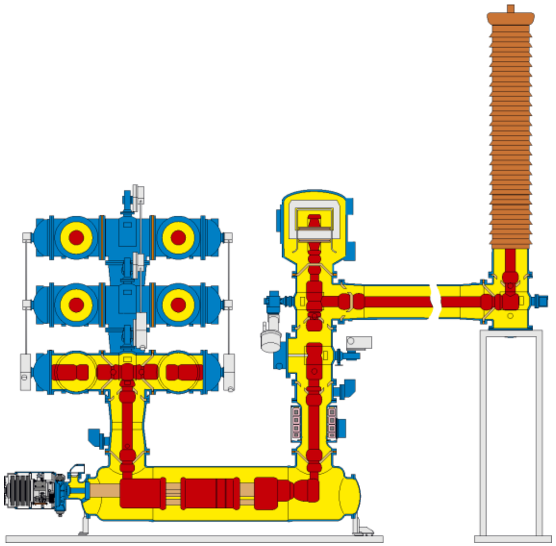
Gas Insulated Switchgear
What is a GIS?





- Usual substation components arranged in
  - Metal enclosures (Aluminum or steel)
  - Insulated with gas (SF_6) at high pressure
  - Components which are segregated into independent gas zones for operational flexibility.
- High reliable equipment and system
- **Assures availability during**
  - **Maintenance**
  - **Repair**

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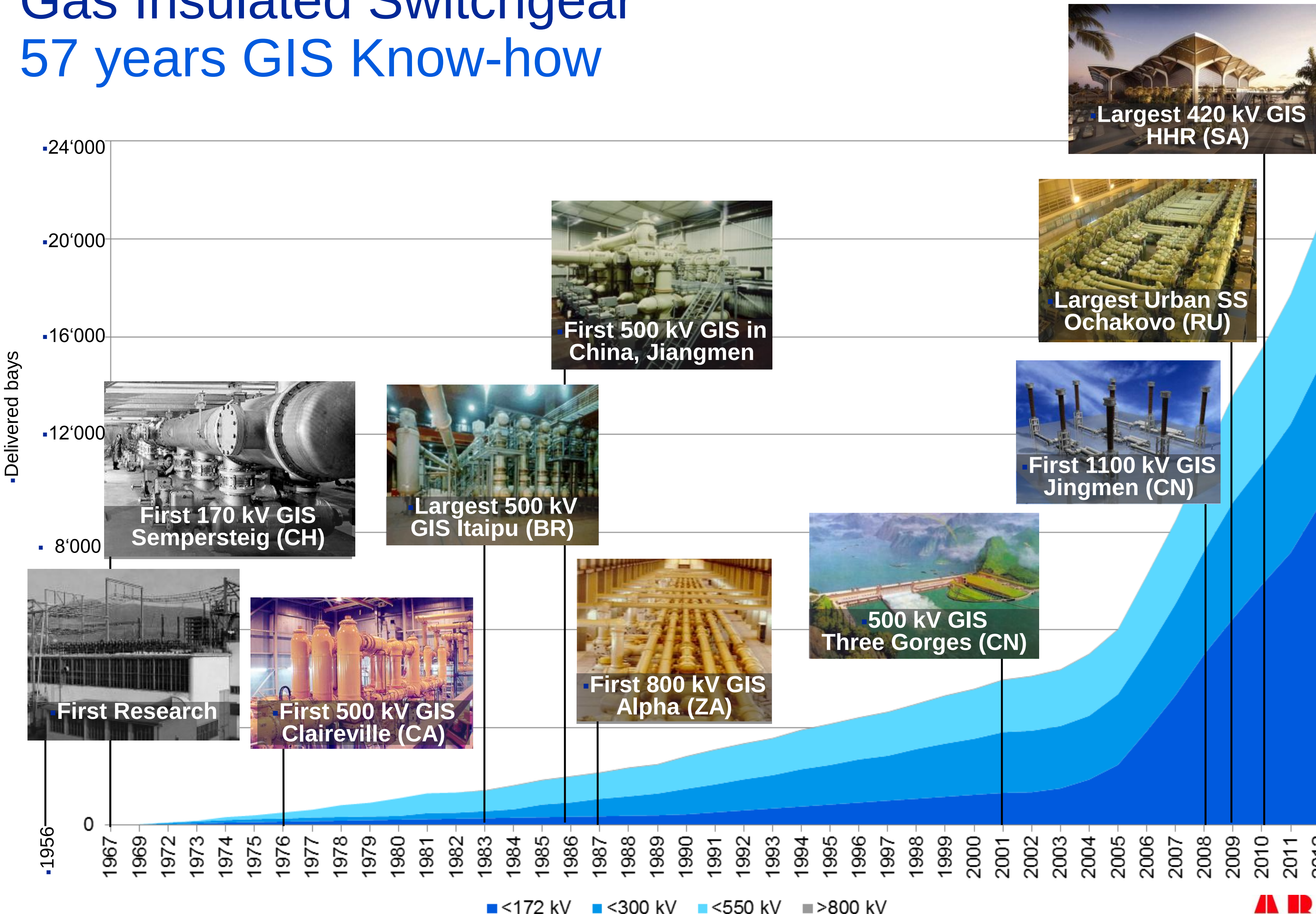
Gas Insulated Switchgear
Benefits - Serving today's megatrends

- Low space requirement
- Low environmental impact
- Low Life Cycle Costs
- High energy efficiency
- High safety level
- High quality standard

Gas Insulated Switchgear
57 years GIS Know-how



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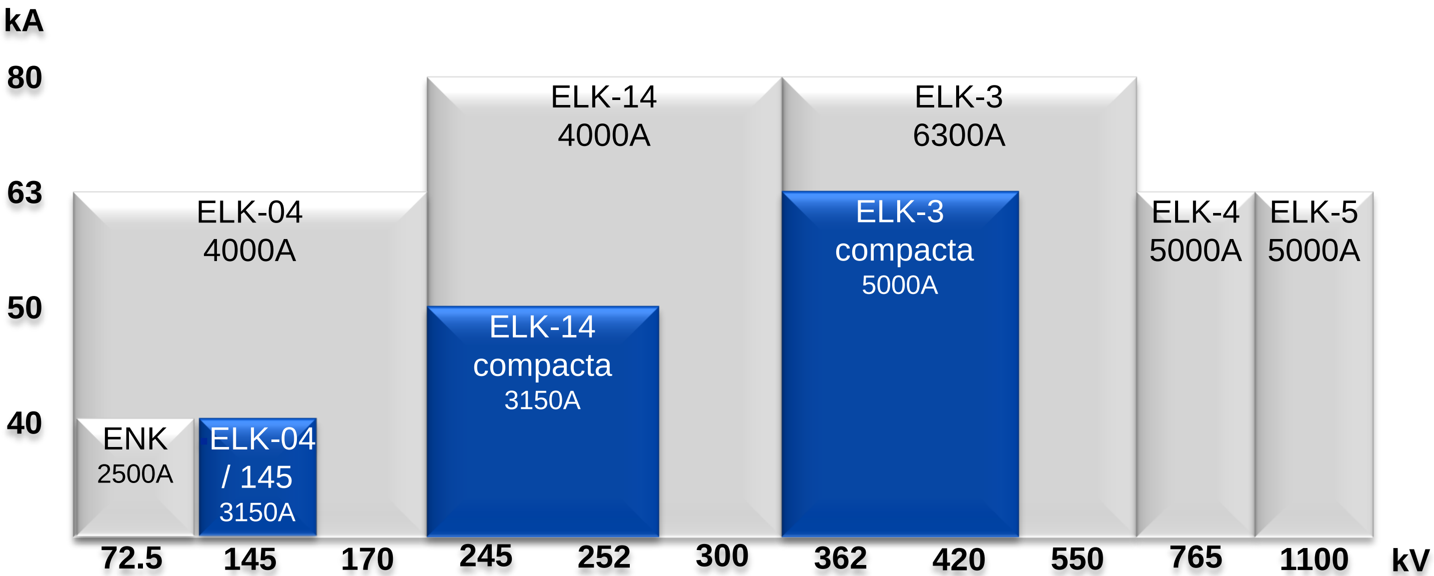
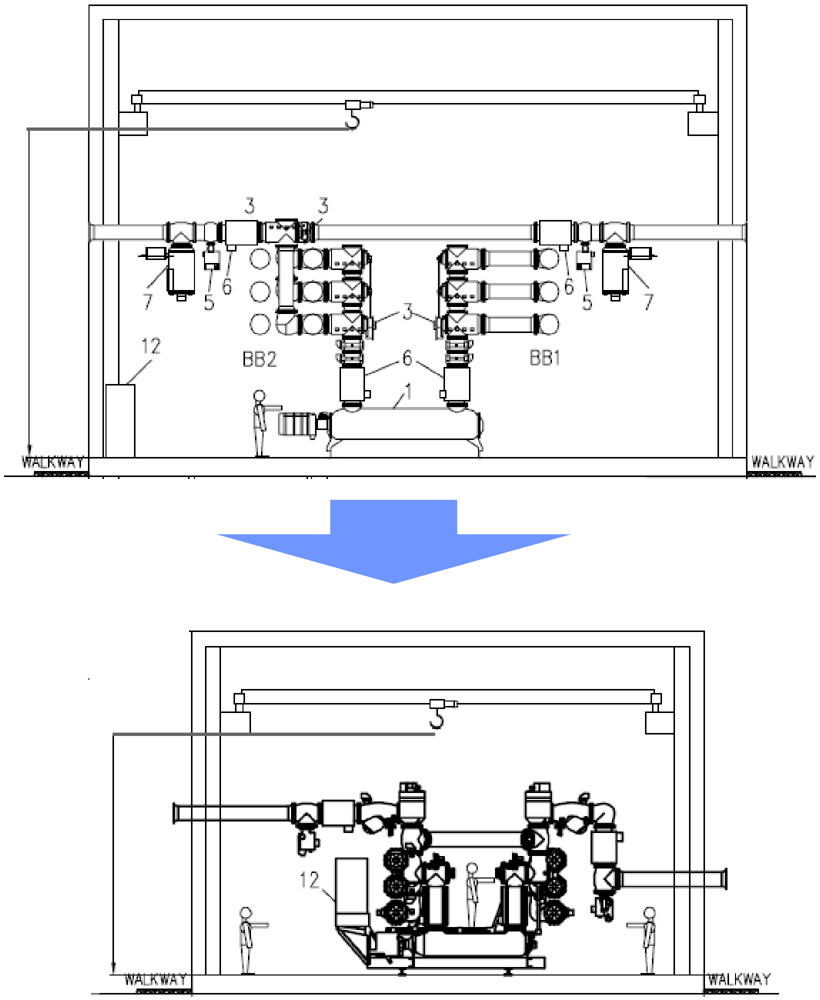
Gas Insulated Switchgear
Applications

Gas Insulated Switchgear
Product Portfolio - Technical Data



Gas Insulated Switchgear
Most compact portfolio



- **Dimensions** reduced by 45%
  - Building cost reduction
  - Reduced steel structures
- **Weight** reduced by: 25%
  - Building cost reduction
  - Reduced steel structures
  - Reduced transportation emissions
- **SF_6 gas** reduced by: 40%
  - Ready for future environmental regulations

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Service continuity in GIS
IEC 62271-203 ed 2.0 – Annex F

Background:

- More than 30 years of GIS experience
- Reliability of GIS is generally good
- Maintenance and failures can cause long outages
- Bad experience with some GIS designs
- Users wanted to have recommendations in IEC standard regarding Service Continuity

Service continuity in GIS
Factors

- Single line diagram
- Gas compartment
- Isolating link
- Physical arrangement of components
- Facilities for dismantling
- Design of partitions
- Provisions for onsite dielectric testing
- Necessity of on-site dielectric testing
- Provisions for future extensions
- Availability of spare parts

In order to achieve required service continuity the following factors may be considered among others:

- Single line diagram (number of busbars, sequence of feeders, number and position of disconnectors…)
- Gas compartment: partitioning, configuration and design, number of gas compartments, additional gas buffer compartments
- Additional isolating links…
- Physical arrangement of components
- Facilities for dismantling
- Design of partitions: whether the design allows or disallows working in a compartment with the adjacent under full pressure. In addition working conditions and procedures are to be considered in order to avoid injuries to persons or damage to partitions.
- Provision for on-site dielectric test (GIS and interfaces)
- Necessity to carry out on-site dielectric tests after maintenance or repair
- Provision for future extensions: buffer gas compartments, appropriate disconnect facilities for extensions without de-energization of complete GIS
- Availability of spare parts, tools and skilled staff

Service continuity in GIS
Partitioning

In order to achieve required service continuity the following factors may be considered among others:

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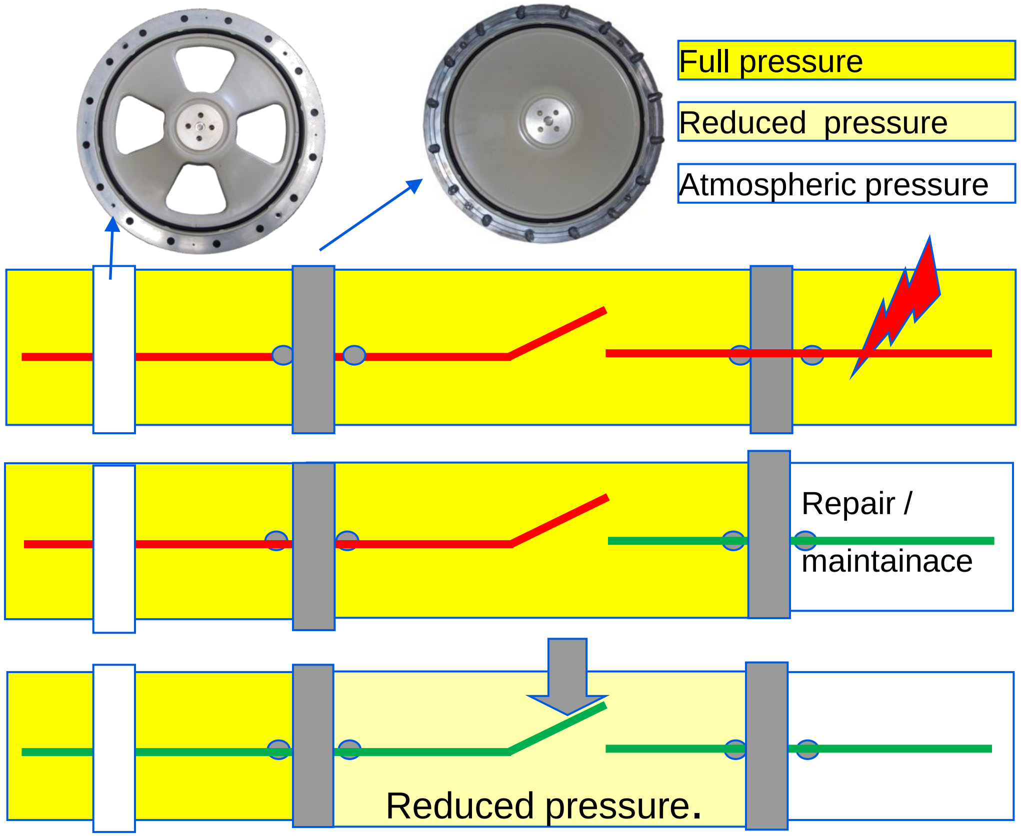
Partitioning concept
Safety rules have to be considered



Degass the compartment.. safety rules would prohibit working on one side of pressurised gas barrier which has been exposed to an arc…

..and therefore pressure will have to be reduced in the adjacent compartment ; meaning……

Consequence = Reduced pressure means reduced dielectric withstand capability of the gas compartment…..

Service continuity in GIS
Impact of GIS partitioning on service continuity

Examples of how partitioning of GIS may affect service continuity are given below.

> In some arrangements the two busbar-disconnectors are separated by only one partition. In Figure F.101, the consequences of the removal of the gas compartment partition at 'A' requires both busbars of a double busbar substation to be isolated, with the loss of all feeders on that section of busbar for the duration of the repair.

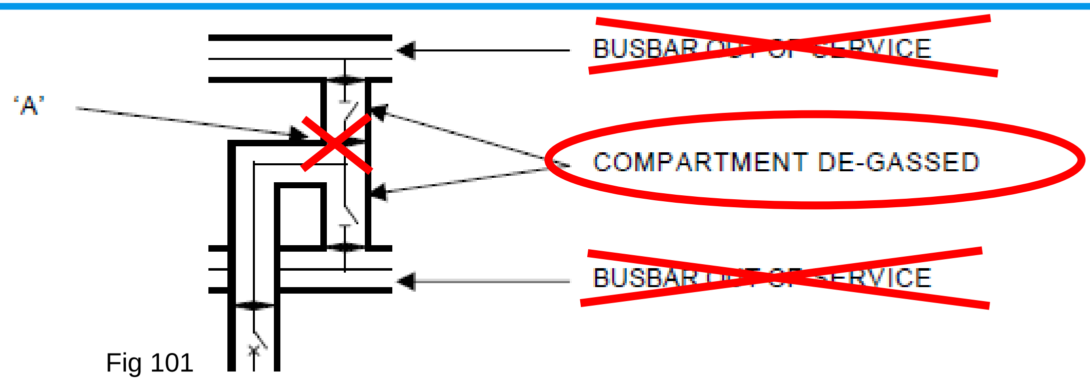
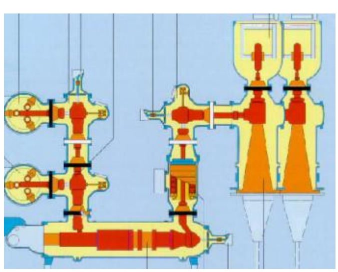
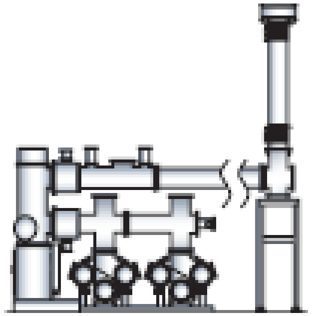
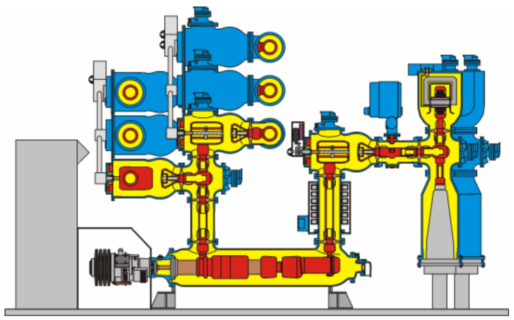


Fig 101

Different solutions of different manufacturers:

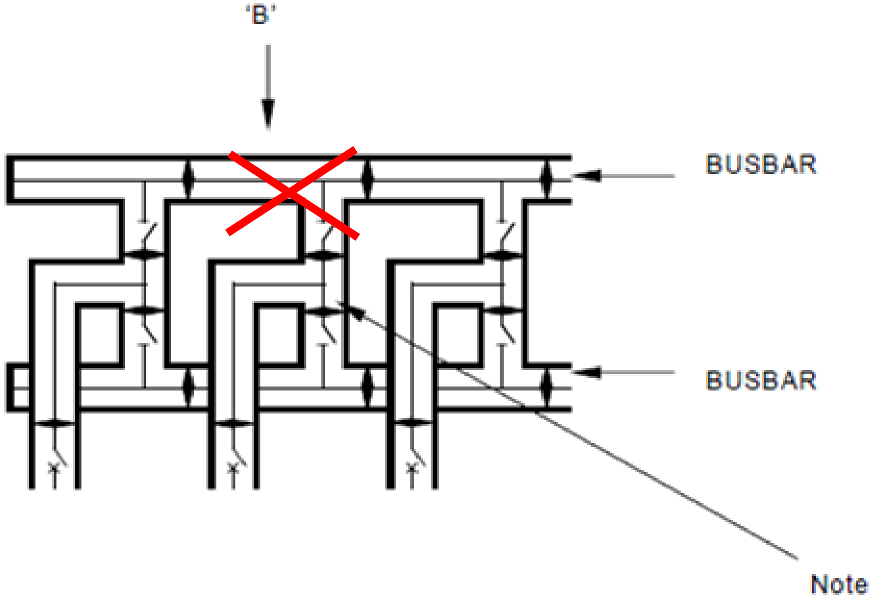






Service continuity in GIS
Impact of GIS partitioning on service continuity

In Figure F.102 the removal of the disconnector, including its partitions, at 'B' requires the compartments of the adjacent disconnectors to be de-gassed. This causes the loss of the associated feeders for the duration of the repair.



Service continuity in GIS
Impact of GIS partitioning on service continuity

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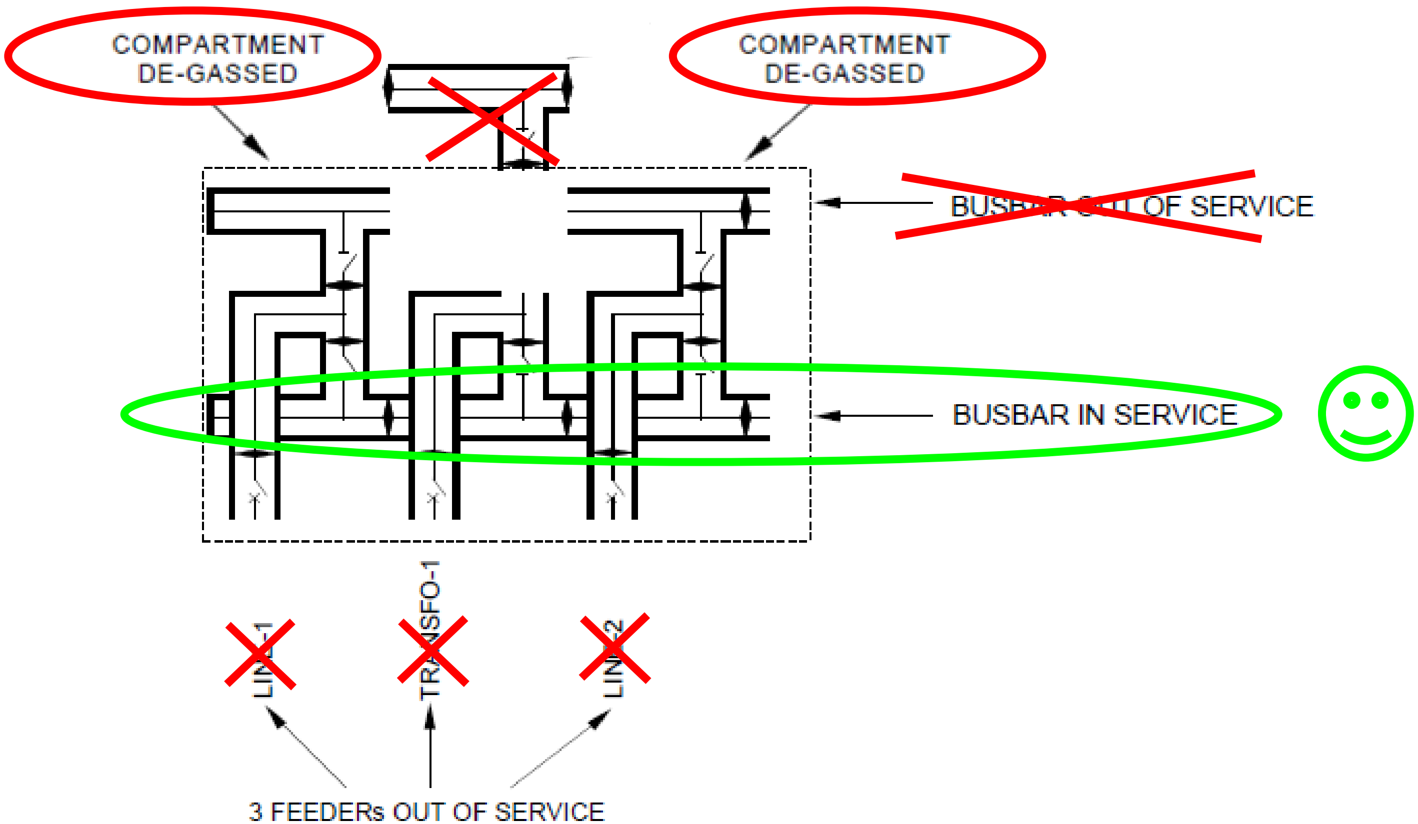
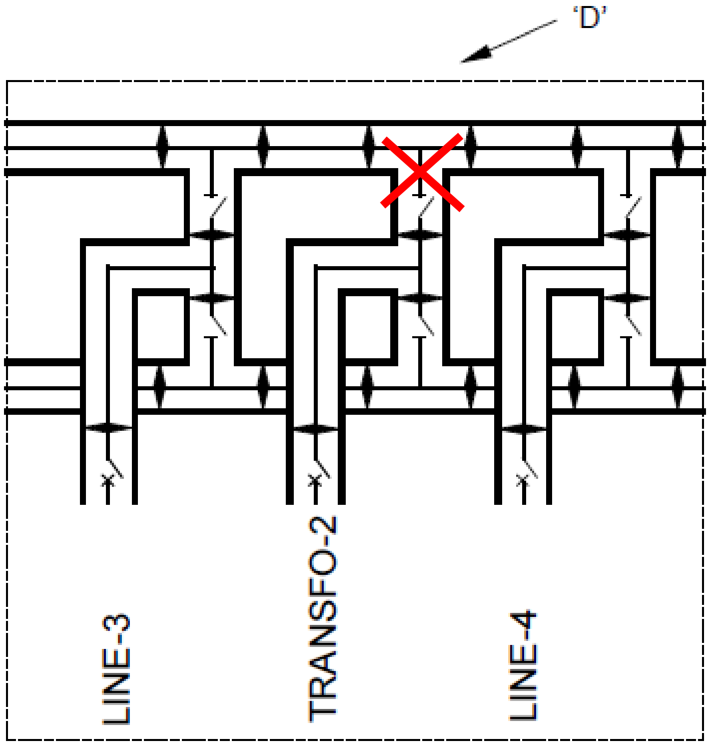
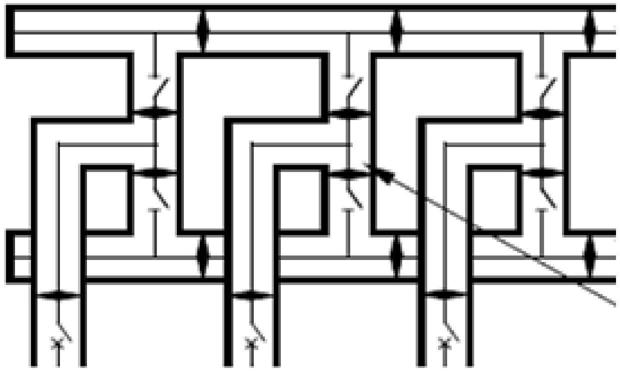


NOTE If working adjacent to a pressurised partition is not allowed an outage of the second busbar could be needed also.

Service continuity in GIS
Impact of GIS partitioning on service continuity

In the case study, the removal of the disconnector at ‘D’ in SECTION-3 requires only the outage of the faulty feeder and not of the adjacent feeders. See Figure F.6.





Service continuity in GIS
Impact of GIS partitioning on service continuity

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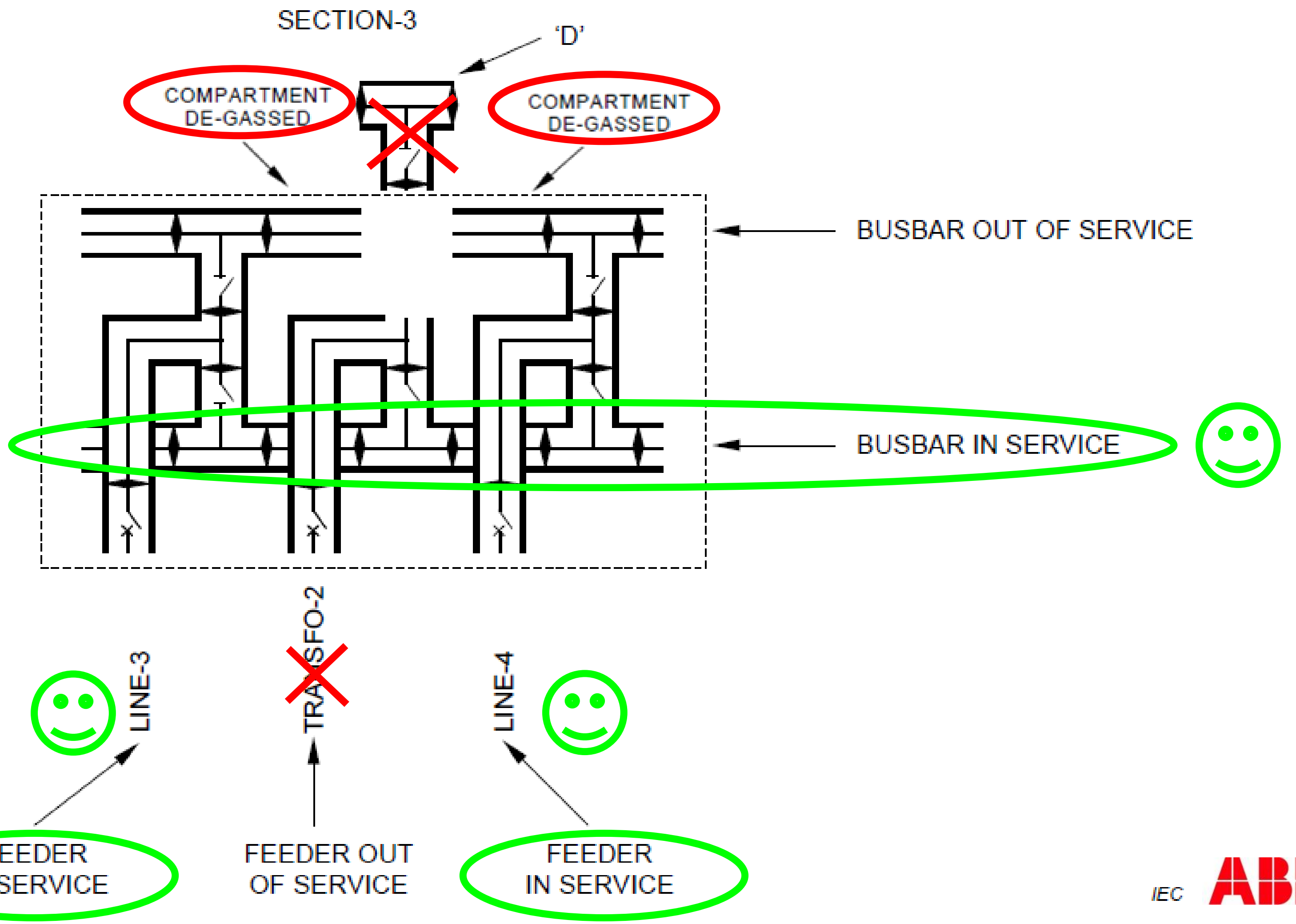
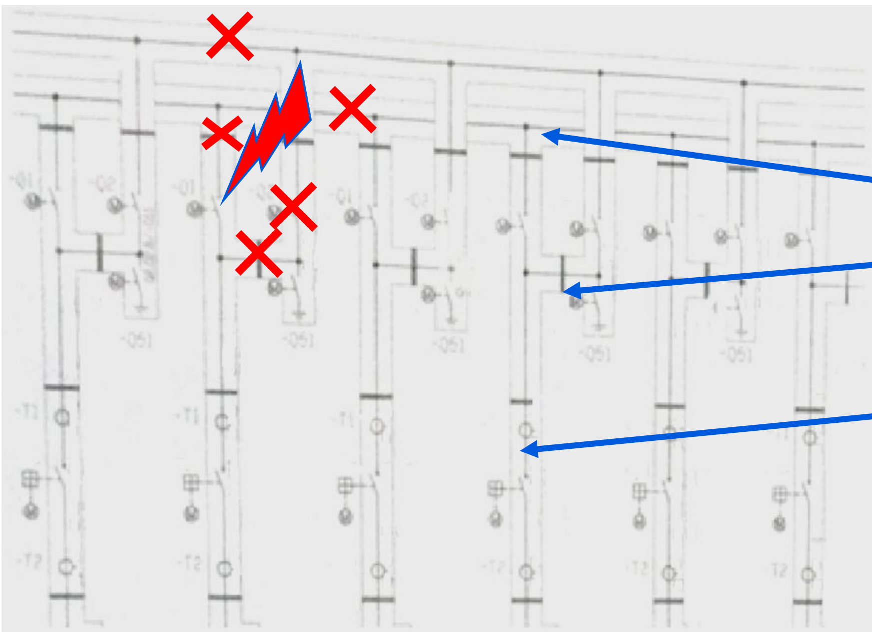


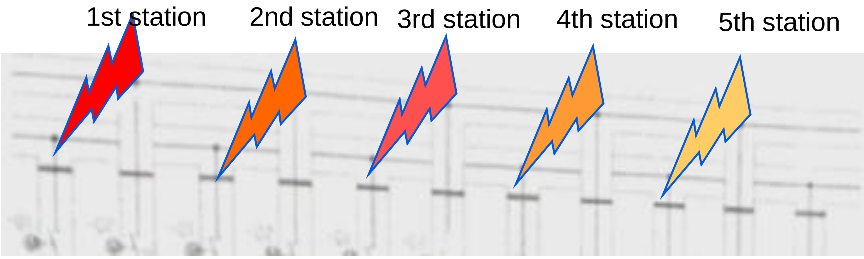
Lets take test !

DBB Switchgear. Observations & consequences ?



An ABB Substation example from the 60th

Internal arc



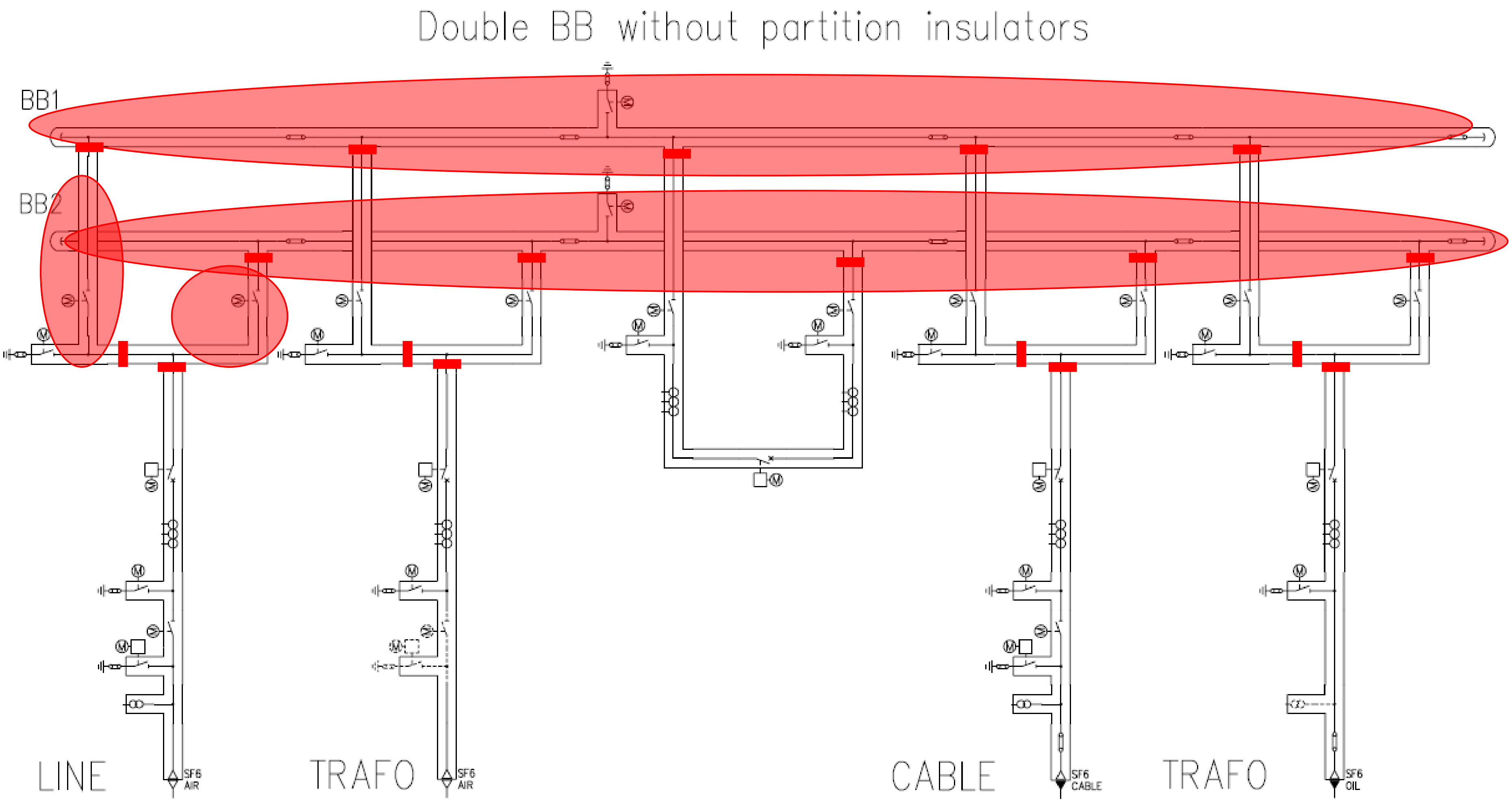
Observations

- No bay-wise gas segregation
- No buffer compartment between both busbar disconnectors
- CTs inside CB compartment

Consequence:

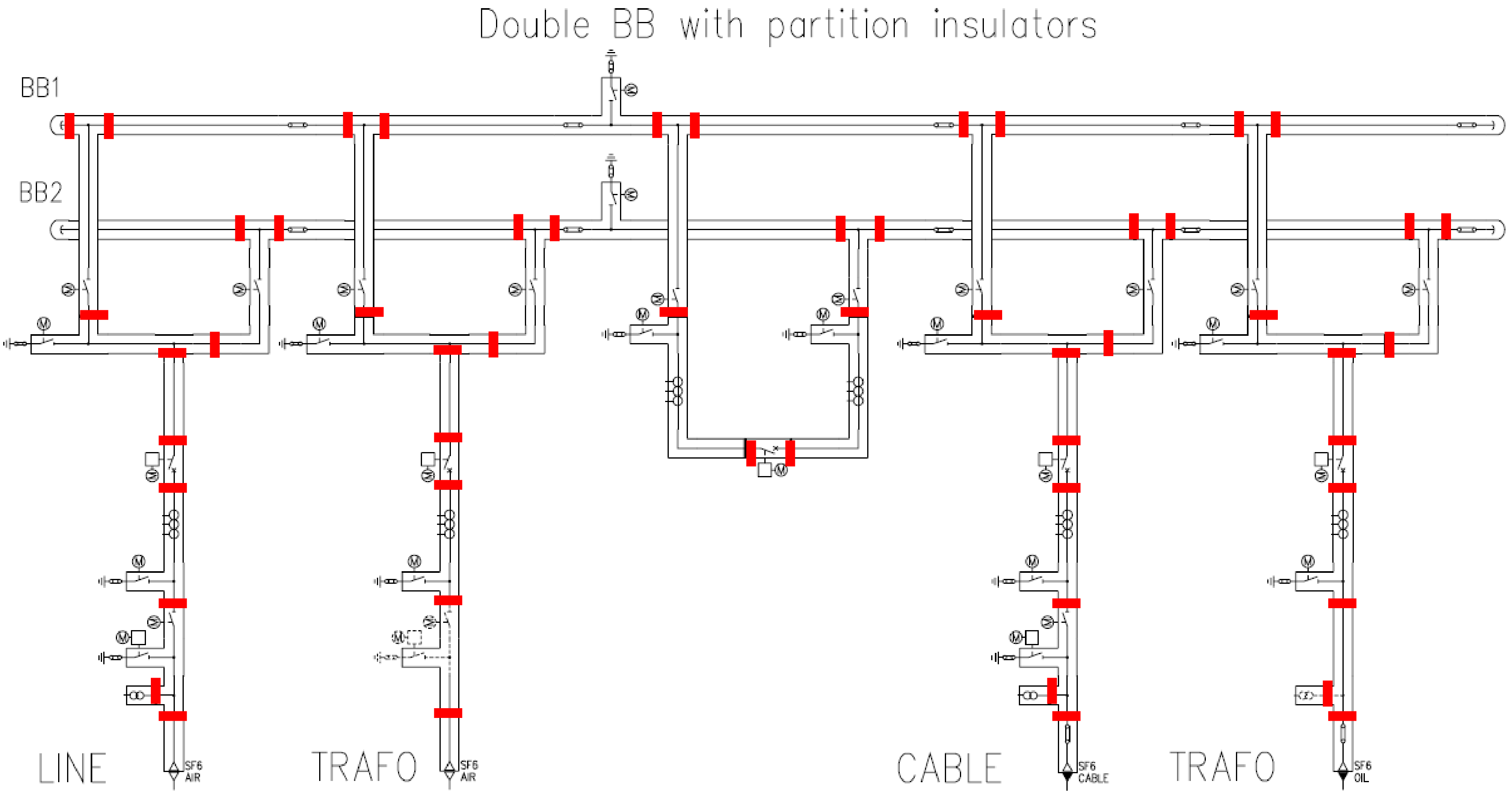
- Failure in one BB disconnector will lead to a complete shutdown of the substation.
- Failure in a busbar, will cause
  - long repair time
  - big environment impact

Arrangements and Configurations
Double Busbar Scheme – Negative example



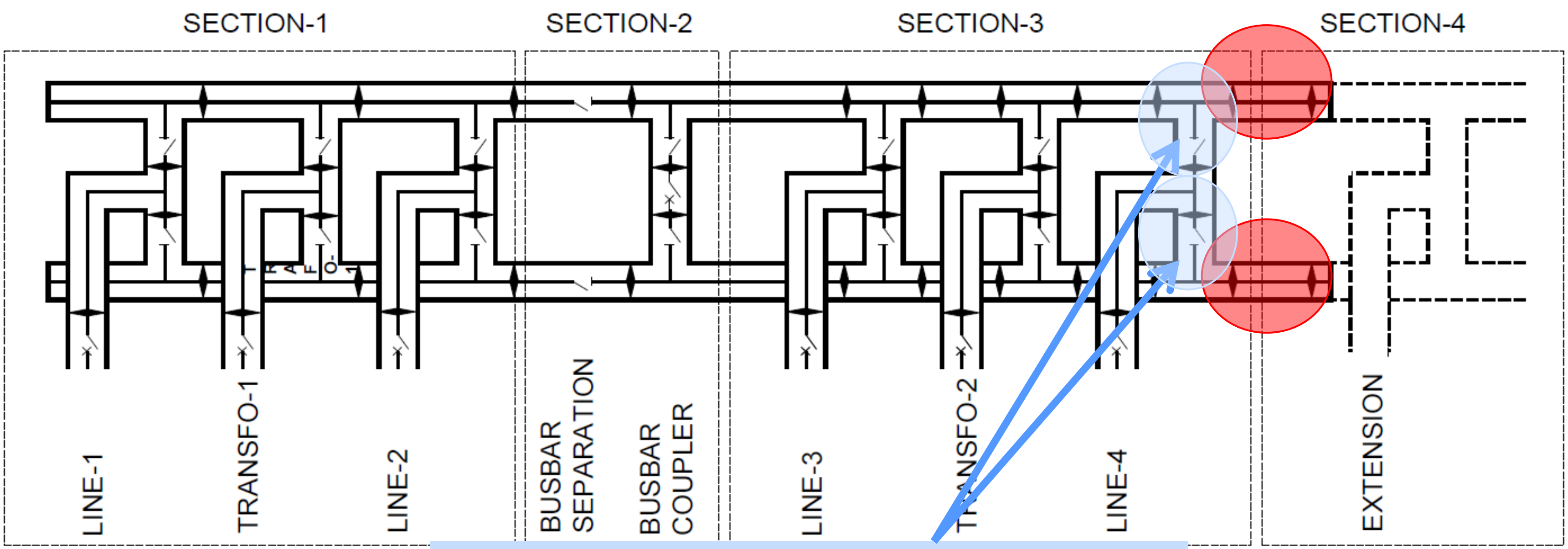
- Critical gas-zones

Arrangements and Configurations
Double Busbar Scheme – Positive example



Service continuity in GIS
Extensions

In the example the substation has a total number of six feeders, four line and two transformer feeders. The busbars are divided by a busbar separation and linked with a coupler. A future extension is planned at the right side of the substation.



Buffer compartments to avoid de-gassing of disconnector compartments and loss of Line 4

Figure F.3 – … cheme

Service continuity in GIS
Users define the requirements on service continuity

It is the responsibility of users to define a strategy of maintenance relatively to the impact on service continuity and, it is the responsibility of manufacturers to design and define partitioning in order to fulfil users need.

The service continuity requirements should achieve an appropriate balance between equipment cost and the criticality of the substation in the user's network.

The user may define some general statements that allow a quantitative assessment of the service continuity during maintenance, repair or extension. The following general statements are given as examples:

– At least one line- and transformer-feeder must remain in service during maintenance and repair

– Maximum one busbar and one feeder permitted out of service during maintenance and repair

– The power flow must be maintained between specified feeders during extension

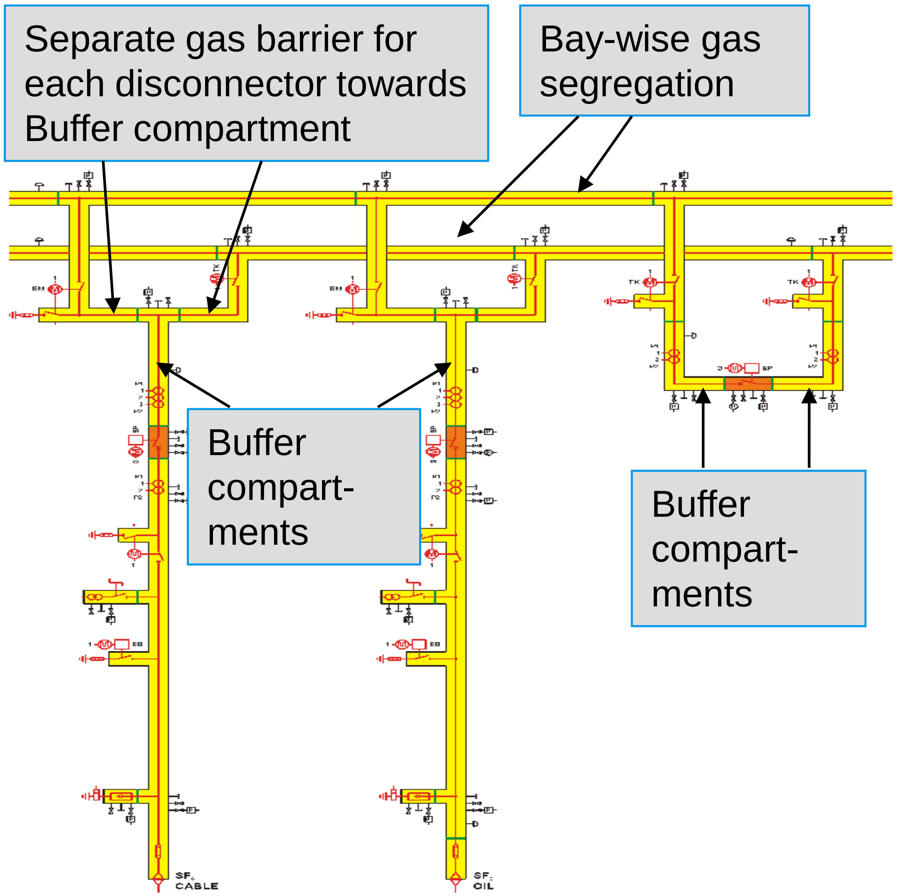
Users responsibility to define strategy of service continuity

→ **Manufacturers** responsibility to define partitions

→ **User may define general statements:**

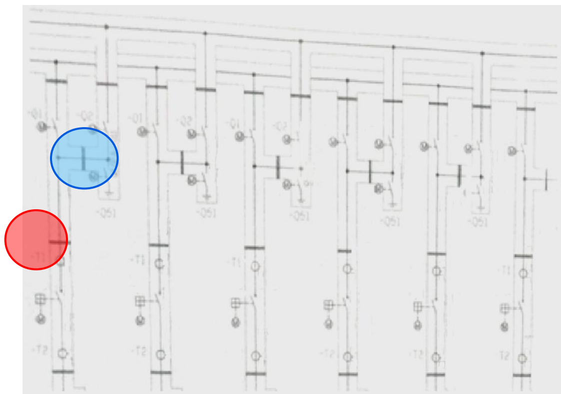
- At least one feeder must remain in service
- Maximum one busbar out of service
- Maintain power flow during extensions

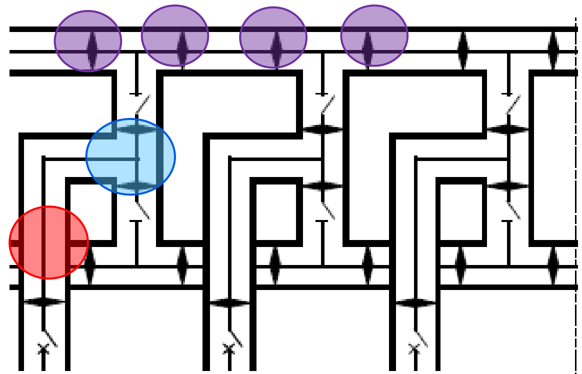
Service continuity in GIS
3 basic rules

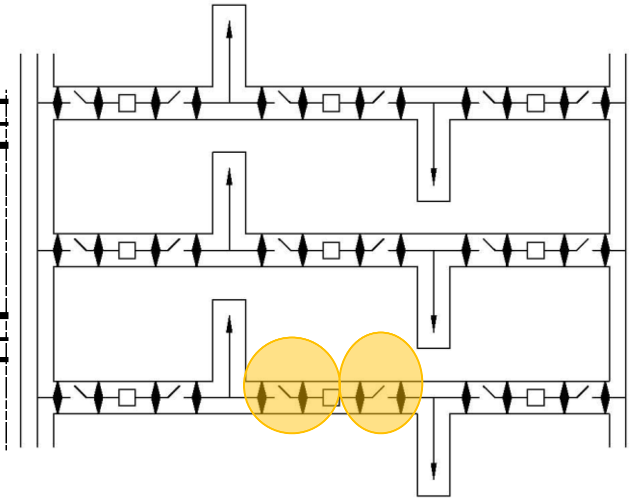


1. **Bay-wise gas-segregation**
2. **Buffer zone between busbar disconnectors**
3. **Buffer zone between busbar disconnector and circuit breaker**

Service continuity in GIS
3 basic rules







Negative exemple of DBB arrangement

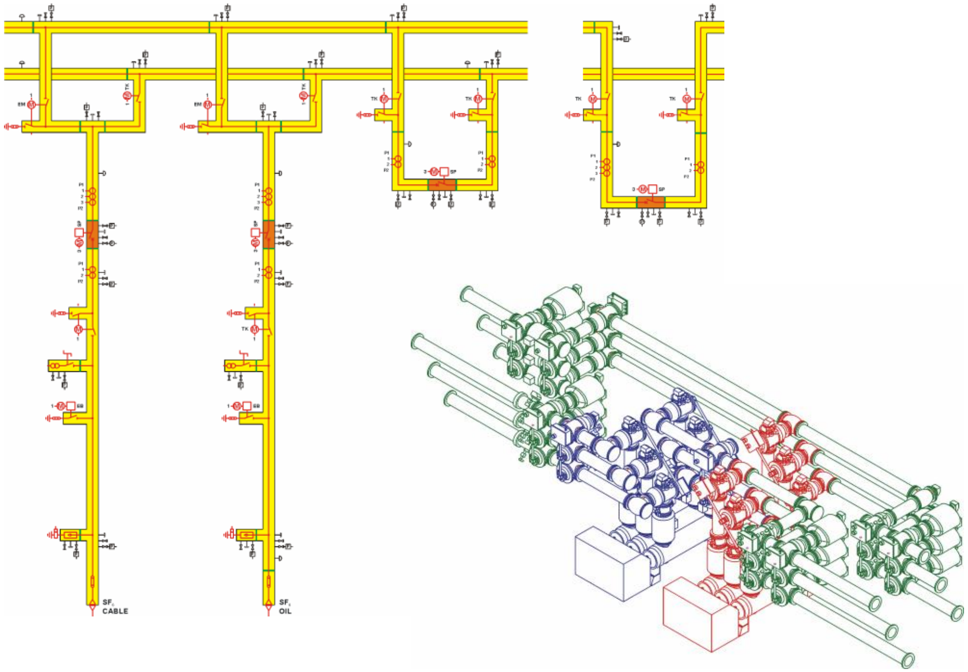
Example of DBB arrangement & Example 1 ½ CB arrangement of
«IEEE PC37.122.1™/D12 Draft Guide for Gas-Insulated Substations Rated Above 52 kV"

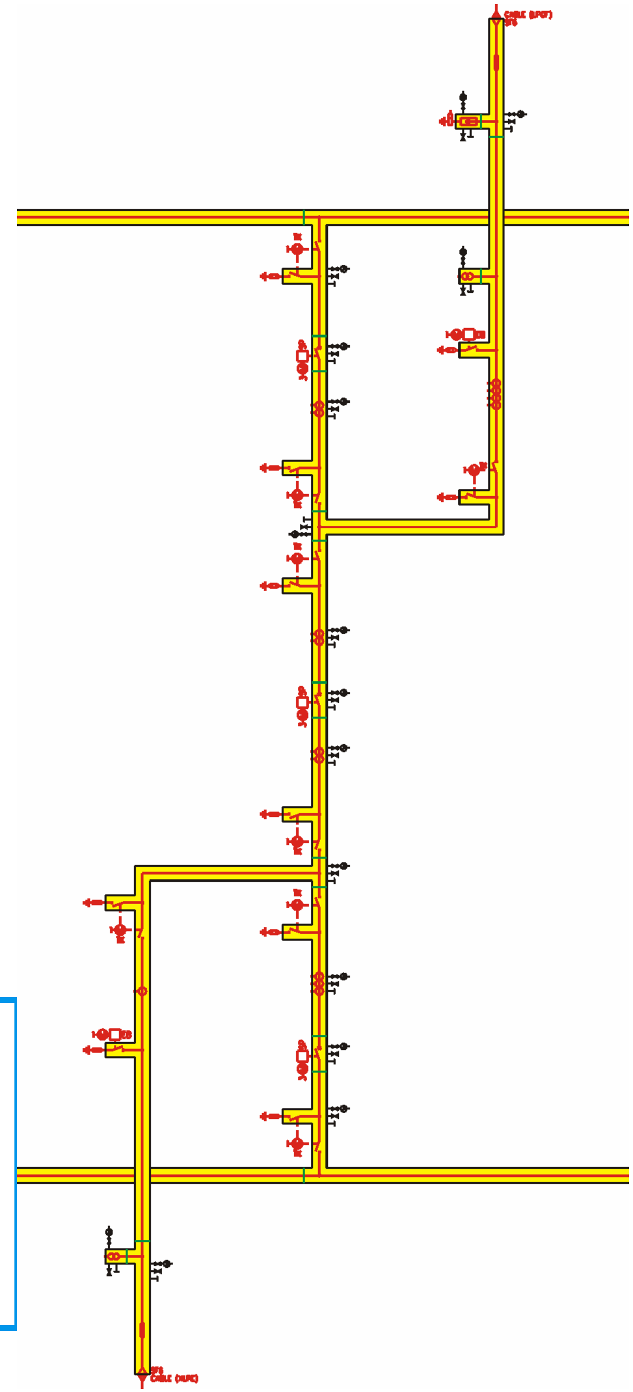
In case of maintenance or repair

1. Bay-wise gas segregation → to avoid outages of complete busbars
2. Buffer compartment between busbar disconnectors → to avoid shutdown of complete substations (DBB systems only)
3. Buffer compartment between
   - Circuit breaker and busbar disconnector → to remain both busbars (DBB) or
   - Disconnectors → to keep feeder in service (11/2 CB).

→ If you follow these rules, you will be fit for managing the risks….

Service continuity in GIS
3 basic rules





Benefits

- Highest Availability
- Minimum outage time
- Low environmental impact: Reduced SF6 gas-handling

Service Continuity in GIS
Final assumption

- High reliability & low maintenance are fundamental of GIS
- But service continuity in adverse situation → Define & evaluate
  - Maintenance
  - Repair
  - Extensions
  - Dielectric tests on site
- Critical applications → power plants, industrial plant, or important nodal transmission S/S need higher availability.
- Service continuity should take care about environmental aspect

What you invest now, you will safe in the future

As minimum: remember the 3 basic rules

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