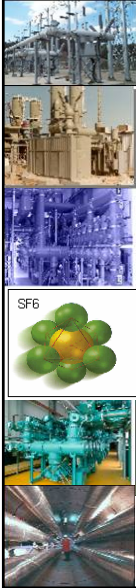




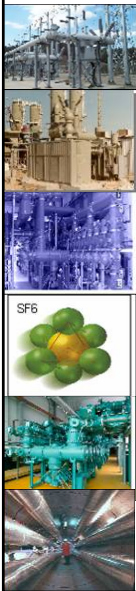


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IEEE
Substations Committee
GIS Subcommittee K2
Module
Gas Insulated Substation (GIS)
Basics
Development and Manufacturing

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Contents
GIS Basics

- A Development and Manufacturing**
- B Typical GIS Layout**
- C Testing**
- D Installation and Commissioning**
- E Operation and Maintenance**







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Contents GIS Basics

A Development and Manufacturing







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Development and Manufacturing

- Steps of development
- Manufacturing process
 - Assembly
 - Quality assurance
- Production and design tests
 - Mechanical
 - Gas tightness
 - Electrical

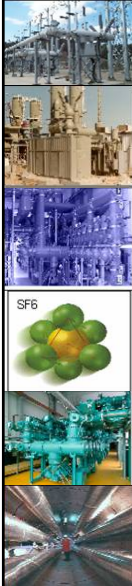







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Steps of Development More than 40 Years of Experience





SF₆

- 1960: Start of fundamental studies in research and development of SF₆-technology
- 1968: Delivery of first GIS
- 1974: Delivery of first 420 kV GIL Gas-Insulated Busbar (GIL)
- 1976: Delivery of first 550 kV GIS
- 1979: Delivery of first 800 kV GIS
- 1995: First 420 kV circuit-breaker with only one interrupting chamber per pole


more than 60.000 bays in over 6.000 substations installed world-wide

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- 5 -


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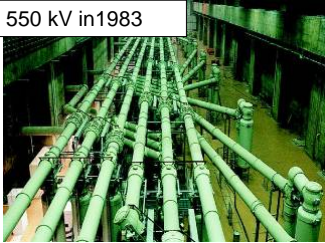
Steps of Development Evolution of GIS Design




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345 kV in 1970



550 kV in 1983




230 kV in 1995




420 kV in 2007







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Huge reduction in size of equipment 245kV












S105 ~1975
T105 ~1982
B105 ~1995







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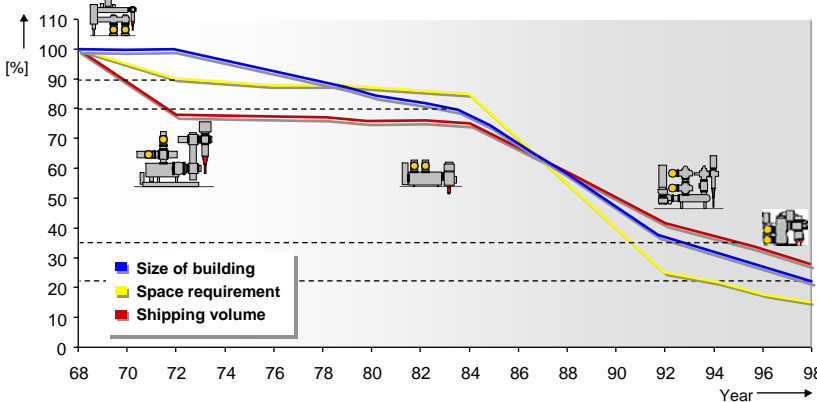
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Steps of Development Progress of GIS Development (145 kV)

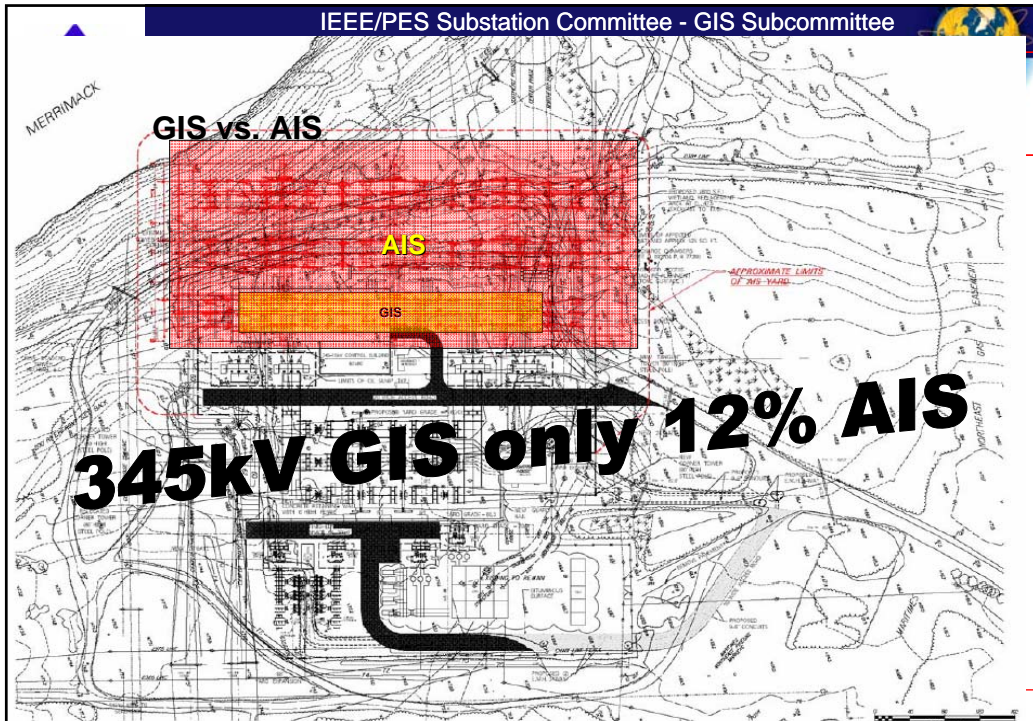






Year	Size of building [%]	Space requirement [%]	Shipping volume [%]
1968	100	100	100
1970	100	95	80
1972	100	90	75
1974	95	85	70
1976	90	80	65
1978	85	75	60
1980	80	70	55
1982	75	65	50
1984	70	60	45
1986	65	55	40
1988	60	50	35
1990	55	45	30
1992	50	40	25
1994	45	35	20
1996	40	30	15
1998	35	25	10


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National Grid-Ward Hill

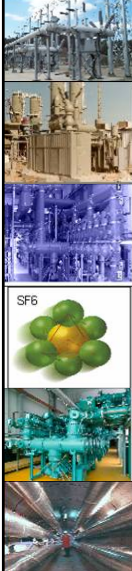


of CB: 11

Max Rated Voltage: 362 kV

Continuous Current: 3000 A

Interrupting Current: 50 kA




SF6


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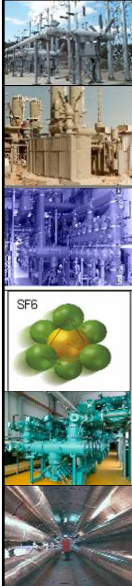
- 10 -


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Manufacturing Process GIS Factory








Production of main components:

Insulating Parts/
Vessels/Drive
Components


- Assembly (clean area)
- Test lab
- Training center

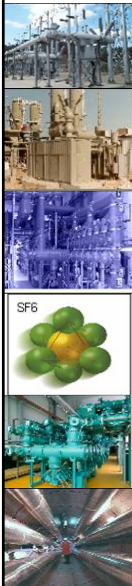
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- 11 -



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Manufacturing Process Insulating Parts: Cast Resin





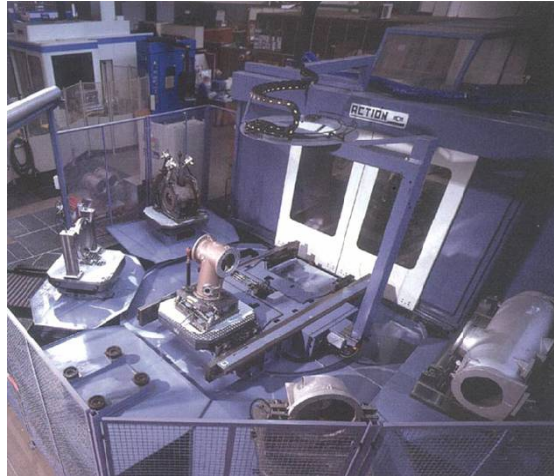
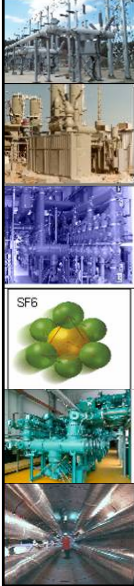
Vacuum Casting

Preparation of Electrodes

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- 12 -



Manufacturing Process Prefabrication – Housings/Components (1)



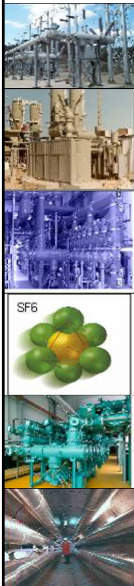
Machining:
Computer-controlled
machine center CMC
for GIS housings

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- 13 -



Manufacturing Process GIS Hydro Static Factory Testing



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- 14 -

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Manufacturing Process Prefabrication – Painting



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Painting

- Inside and outside
- Colour outside acc. to customers specification

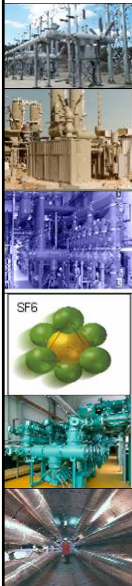
Example:
Aluminum-pressure vessel

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- 15 -


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Manufacturing Process Preassembly – Interrupter Units



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Preassembly


Example:
GIS-interrupter unit 420 kV

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- 16 -


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Manufacturing Process Preassembly – Hydraulic Drive Unit



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Preassembly
Preassembled and pretested components

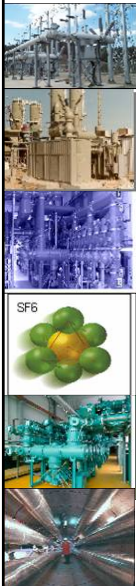
Example:
Hydraulic drive for GIS 420 kV

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Manufacturing Process Assembly – Main Assembly Hall



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Main Assembly
Circuit-breaker and switchgear assembly
"clean room"

Example:
GIS Bays 245 kV







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- 18 -

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Contents GIS Basics



B Typical GIS Layout







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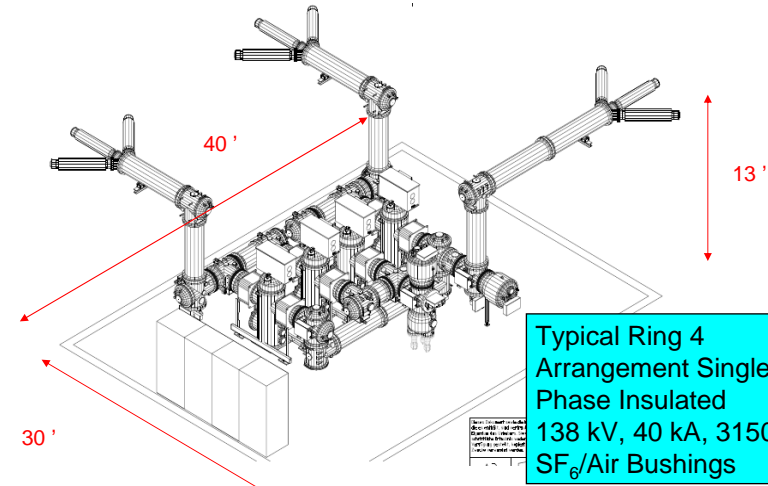
- 19 -

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Typical GIS Ring Bus Arrangement, indoor



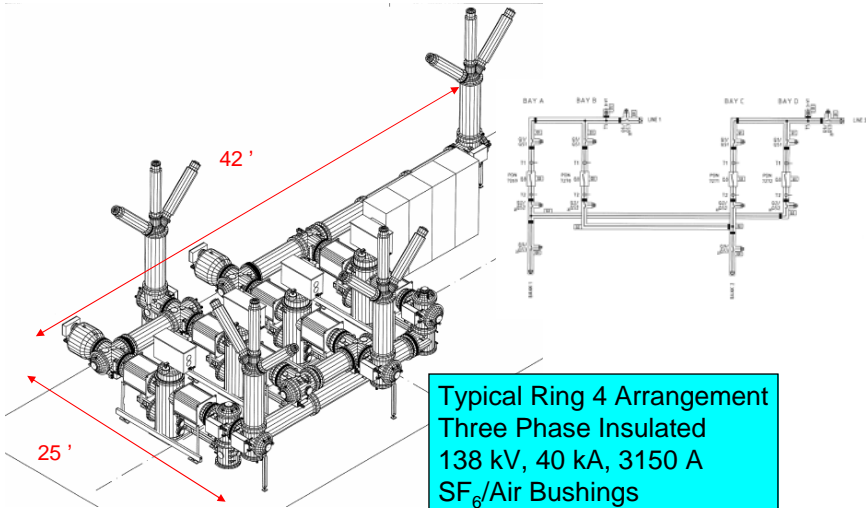
Typical Ring 4
Arrangement Single
Phase Insulated
138 kV, 40 kA, 3150 A
SF₆/Air Bushings

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- 20 -



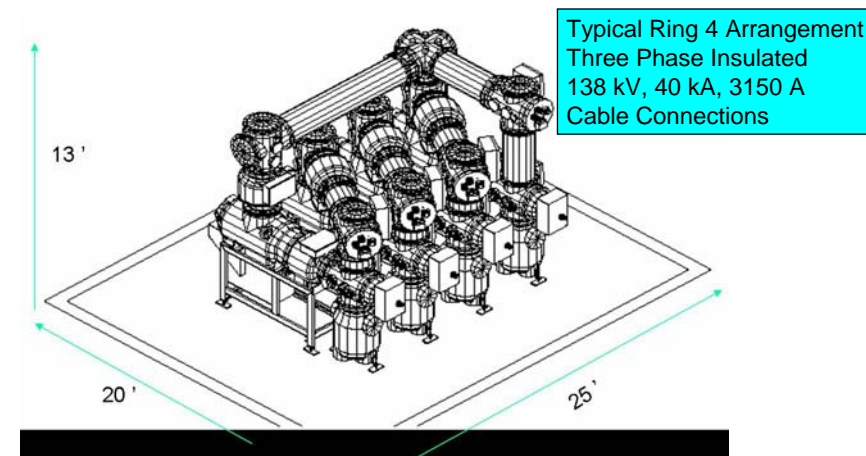
Typical GIS Ring Bus Arrangement, outdoor



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Typical GIS Compact Ring Bus Arrangement



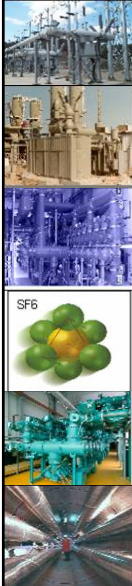
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Contents GIS Basics



C Testing



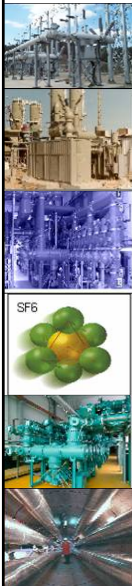
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Design Tests High Voltage and Mechanical tests



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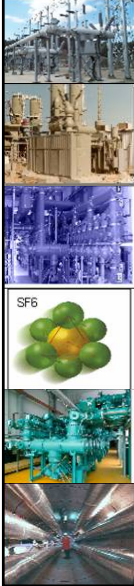


Dielectric testing of a transportation unit
245 kV/50 kA, 4000 A
1998

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Design Tests Temperature Rise



High Voltage Temperature-rise Testing

by applying current to the
conductors

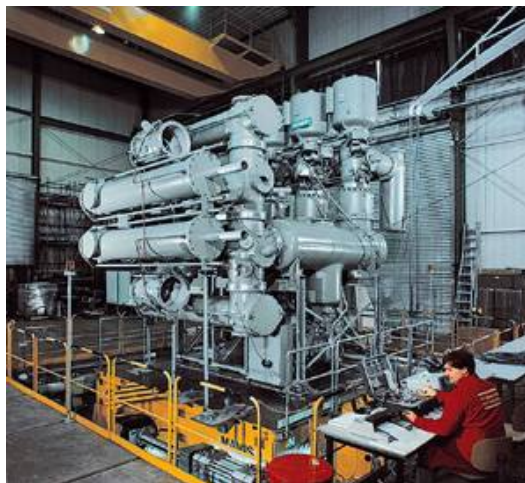
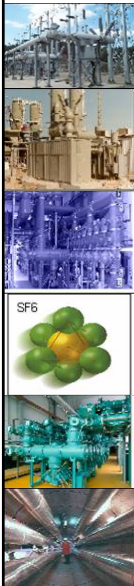
- up to 6 kA
- 1 and 3-phase
- 16 2/3 Hz up to 60 Hz

Example:
170 kV GIS

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Type Testing Seismic Test





Three axis seismic testing
of a transportation unit

550 kV/63 kA, 4000 A


1992

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Design Tests Long Duration





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Long-duration tests on post insulators with increased voltage stress

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- 27 -

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Contents GIS Basics

D Installation and Commissioning

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- 28 -

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Installation and Commissioning Shipping and Transportation



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Complete Bay for
operating voltage
245 kV being unloaded
at site

245 kV/40 kA, 4000 A

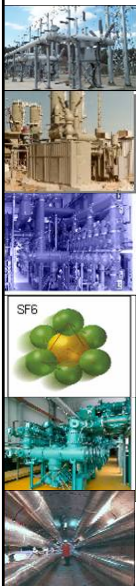
1998

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- 29 -


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Installation and Commissioning Shipping and Transportation



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Example:
GIS Double-Bay Unit
170 kV as one
transportation unit

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- 30 -

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Installation and Commissioning Unloading





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Unloading at site and transport to the switchgear room

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- 31 -

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Installation and Commissioning Unloading







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Placing into the switchgear room with two simple lift trucks


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- 32 -

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Contents GIS Basics



E Operation and Maintenance




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- 33 -

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Operations Disconnect Switch Position Indicator (1)



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- 34 -

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Operations Typical View Port of 550 kV GIS



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WARNING: THIS IS A HIGH VOLTAGE AREA. DO NOT TOUCH ANY PARTS OF THE GIS. CONTACT WITH ANY PART OF THE GIS CAN BE FATAL. ALWAYS WEAR YOUR SAFETY GEAR AND FOLLOW THE SAFETY PROCEDURES.

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- 35 -

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Operations View Port with Endoscope





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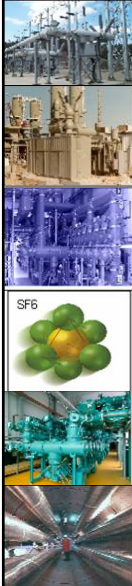



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- 36 -

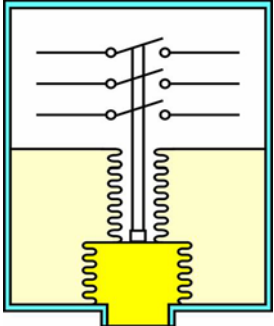
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SF₆ Density Monitor Example: Trafag







Arun
Dilo Type

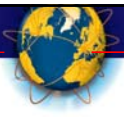
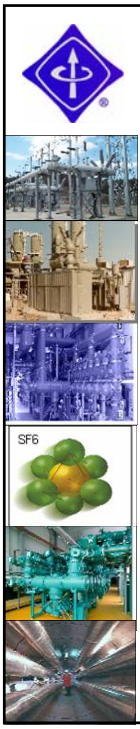
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- 37 -

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- 38 -



Thank you for your attention.
Any Questions?