ABB SpA Power Products
SF6 Instrument Transformers
Introduction

ABB S.p.A
Power Products Division
Unità Operativa Adda-HV
Introduction
ABB ADDA History Line (1/2)

Established in 1926
- High Voltage Technology since 80 years
- Production of oil-insulated Current Transformers for more than 50 years

Long & Strong Experience
- GIS technology since 1974
- Production of SF6 stand alone Current Transformers since 1981
Introduction
ABB ADDA History Line (2/2)

Late ’90s
- Pioneering Spirit
- First in the world to conceive Hybrid Switchgears

New Focus Factory 2005
- Worldwide success
- New Focus Factory
SF₆ Instrument Transformers
Product portfolio

<table>
<thead>
<tr>
<th>Voltage [kV]</th>
<th>TG</th>
<th>TVI</th>
<th>TIP</th>
<th>TG COMBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 800kV</td>
<td>SF₆ Current Transformer</td>
<td>SF₆ Voltage Transformer</td>
<td>SF₆ Substation Service Voltage Transformer</td>
<td>SF₆ COMBIned Current and Voltage Transformer</td>
</tr>
<tr>
<td>Up to 420kV</td>
<td>SF₆ Current Transformer</td>
<td>SF₆ Voltage Transformer</td>
<td>SF₆ Substation Service Voltage Transformer</td>
<td>SF₆ COMBIned Current and Voltage Transformer</td>
</tr>
<tr>
<td>Up to 550kV / 500 kVA</td>
<td>SF₆ Substation Service Voltage Transformer</td>
<td>SF₆ Substation Service Voltage Transformer</td>
<td>SF₆ COMBIned Current and Voltage Transformer</td>
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</tr>
<tr>
<td>Up to 245kV</td>
<td>SF₆ COMBIned Current and Voltage Transformer</td>
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TG strengths
SF₆ insulation – advantages

- **Explosion proof design:** a pressure relief device protects the apparatus from internal overpressure.
- **Non flammable** gas insulation.
  - Life time dielectric **quality** assured (no checks, no treatment).
  - Total absence of partial discharges.
  - Oil filling and periodical oil samplings are not required.
  - Gas leakage < 0.1% a year.
  - Remote control of the internal insulation level by means pressure gauge provided with an alarm threshold and lock threshold.
  - Totally **maintenance free**.
TG strengths
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TG strengths
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TG – SF6 Stand Alone Current Transformers
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Technical data
- Basic technical data.
- Product range (silicon - porcelain insulator).
- TG “building blocks”
- Packing.

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- SF6 insulation – advantages
- TG quality.
- TG reliability.
- Reference list.
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Introduction

- The modularity of TG design (i.e. several tank sizes, different type of primary windings, makes it possible to meet most of our client requests).
- HV installation fully obtained by means SF6 gas instead of oil & paper.
- Cores and primary re-connections positioned inside and around the top head respectively.
- Fibre glass insulator with silicon rubber shields (porcelain available as alternative)
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Basic Technical data

- System voltages: 72.5kV – 800kV
- Insulation level: up to 2100kV
- Rated primary current: 4.000A
- Rated short-circuit current:
  - thermal: up to 63kA;
  - dynamic: up to 170kA.
- Rated secondary current: 1 or 5
- Accuracy: according to IEC and IEEE
- Ambient temperature: -50°C - +40°C
1. Primary turns.
2. Aluminium alloy head.
3. Terminals.
4. Insulator.
5. Pressure relief device.
6. Densimeter.
7. SF6 gas filling gauge.
8. Earthing screw.
9. Low voltage cable entry.
10. Secondary terminal block.
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TG – SF6 Current Transformers

Product range

- System voltages: 72.5kV – 800kV
- Insulation level: up to 2100kV
- Rated primary current: 4,000A

- Rated short-circuit current:
  - thermal: up to 63kA;
  - dynamic: up to 170kA.

Accuracy: according to IEC and IEEE

TG 72.5kV  TG 145-170kV  TG 245kV  TG 362kV  TG 420kV  TG 550kV  TG 800kV
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TG “building blocks”

**Aluminium**
- supports the live part of the CT (with a tube)
- closes the bottom of the insulator
- connects the secondary terminal box

**Insulator:**
- High strength silicon (or porcelain) conforming with the strictest mechanical requirements (ANSI/CENELEC/...)

**Head:**
- Special light alloy (total absence of porosity, i.e. total sealing of the SF6)
  - The head contains:
    - passing bar primary winding
    - toroidal cores (hot rolled steel strip or mumetal or mix)
    - secondary windings uniformly distributed around cores
    - internal shields to optimise the distribution of dielectric field

**Base:**
- Aluminium
  - Functions:
    - supports the live part of the CT (with a tube)
    - closes the bottom of the insulator
    - connects the secondary terminal box
TG “building blocks”
The primary

Advantages

- Short primary conductor with low thermal losses
- High rated current and short-time current

Top-core type
TG “building blocks”
The head

- Tap changer
- Rupture disk
- Internal shield
- Double O-Ring
TG “building blocks”
Materials (1/2)

- Hot dip galvanised components.
- Epoxy paint protection for other parts in anticorrosive light alloy.
- Synthetic rubber gasket fit to resist SF₆ and thermal variation.
- The metallic head is cast in a special light alloy to assure absence of porosity (complete sealing of SF₆).
- High strength composite or porcelain insulator conforming to the strictest requirements (ANSI/CENELEC).
ADVANTAGES OF SILICON RUBBER

- low weight
- excellent pollution and rain performance
- sandstorm resistant
- maintenance free
- cheaper than porcelain (in most cases)
- high degree of safety (crack and explosion resistant)
TG “building blocks”
Base

- Density monitor
- Secondary terminal box
- DILO valve for filling
TG “building blocks”

Cores

- Primary/secondary reconnections.
- Different possibilities in the number of cores.
- Metering/protection cores.
- Burden & Class example:
  - cl. 0.2, 20 VA, FS 5;
  - cl. 5P20, 30 VA;
  - TPX, TPY and TPZ are available.
- Rated continuous thermal current (Rf):
  - 1.0, 1.2, 1.5, … (IEC).
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Packing
Different solutions to ensure the safety of the equipment during transportation

- Wooden crate
- Shock Indicators
- Metallic structure with anti-vibration rubber supports
- Barrier bag
- Shock Recorders
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TG quality

- Leverage on other SF$_6$ insulated HV equipment manufacturing **know-how** (AIS, GIS, Hybrid).
- Extensive “in-house” **tests** (special dedicated testing room).
- Integrated system for the management of **quality**
- **ISO** quality certifications.
TG quality
HV test laboratory
Inbound Control

**Activities:**
- Supplier Qualification Process
- Supplier Performance monitoring (Audits...)
- Incoming Inspection
- Statistical Process Control
- Analysis of defects
- Feedback to R&D on technical gaps

Process Control

**Activities:**
- Definition of procedures for assembling and testing activities
- Definition of operators checklists
- Monitoring of compliancy with procedures
- Defects monitoring and analysis
- Feedback to R&D on technical gaps
- Training
- Weekly quality meetings on shopfloor
- Improvement projects

Testing

**Activities:**
- Visual checks
- Functional tests
- Mechanical tests
- Leakage tests
- Dielectric tests

Outbound Control

**Activities:**
- Visual check e completeness of delivery
- Monitoring of packing adequacy
- Customer Claim Management (CCRP)
- Quality Reporting
- Improvement projects
TG quality
ABB Adda ISO quality certifications

2002: ISO 9001 (Quality)
2004: ISO 14001 (Environment)
2008: ISO 18001 (OHS)
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TG Reliability

Designed, manufactured and tested to have the best performances in the market of CTs
### TG Reliability

**Dielectric strength**

#### TG 245 under test

<table>
<thead>
<tr>
<th>Power Frequency</th>
<th>IEC</th>
<th>TG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG 145-170</td>
<td>275-325</td>
<td>310-360</td>
</tr>
<tr>
<td>TG 245-300</td>
<td>460</td>
<td>510</td>
</tr>
<tr>
<td>TG 330-420</td>
<td>630</td>
<td>680</td>
</tr>
</tbody>
</table>
## TG Reliability

### Dielectric strength

<table>
<thead>
<tr>
<th>BIL</th>
<th>IEC</th>
<th>TG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG 145-170</td>
<td>650-750</td>
<td>715-825</td>
</tr>
<tr>
<td>TG 245-300</td>
<td>1.050</td>
<td>1.175</td>
</tr>
<tr>
<td>TG 330-420</td>
<td>1.425</td>
<td>1.550</td>
</tr>
</tbody>
</table>

**TG 420 under test**
### TG 145: Vertical Load

<table>
<thead>
<tr>
<th></th>
<th>IEC</th>
<th>TG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>class I</td>
<td>class II</td>
</tr>
<tr>
<td>Longitudinal</td>
<td>2.000</td>
<td>3.000</td>
</tr>
<tr>
<td>Transversal</td>
<td>2.000</td>
<td>3.000</td>
</tr>
<tr>
<td>Vertical</td>
<td>2.000</td>
<td>3.000</td>
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</table>
TG Reliability
Mechanical strength

![TG 245: Transversal Load](image)

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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>Longitudinal</td>
<td>2.500</td>
<td>4.000</td>
</tr>
<tr>
<td>Transversal</td>
<td>2.500</td>
<td>4.000</td>
</tr>
<tr>
<td>Vertical</td>
<td>2.500</td>
<td>4.000</td>
</tr>
</tbody>
</table>

For Longitudinal, IEC class I is 2.500 and class II is 4.000, achieving a TG of 12.100
For Transversal, IEC class I is 2.500 and class II is 4.000, achieving a TG of 4.000
For Vertical, IEC class I is 2.500 and class II is 4.000, achieving a TG of 4.900
## TG Reliability
### Mechanical strength

### TG 420: Longitudinal Load

<table>
<thead>
<tr>
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<th>TG</th>
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<tr>
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</tr>
<tr>
<td>Vertical</td>
<td>4.000</td>
<td>6.000</td>
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TG Reliability
Special Type Tests

- Arcing due to internal fault (class II)
- Seismic test
- Tightness test (-50 °C)
- Lightning Impulse → Chopped Wave
- Dielectric Type Tests → performed with gas mixture (SF6/N2)
TG Reliability
Internal arc test

Video
TG Reliability
Seismic test

TG 420

TG 245

TG 145

Video
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TG – SF6 Current Transformers
Reference countries for SF6

MORE THAN 16,000 INSTALLATIONS

Market features:
- Customers turning to SF6
- Demanding customers
- High rated voltage
- High rated current
- Short-time delivery
TG – SF6 Current Transformers
Reference countries for SF6

TG reference customers:

- Terna (Italy)
- Hydro Québec (Canada)
- Eskom (South Africa)
- Energoatom (Russia)
- Ukreenergo (Ukraine)
- TransGrid (Australia)
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