



# **The latest in SF<sub>6</sub> Maintenance Equipment Technology**

## **3<sup>rd</sup> International Conference of SF6 and the Environment**



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# Basic SF<sub>6</sub> Recovery System Functions

- **SF<sub>6</sub> Recovery from GIE**
  - SF<sub>6</sub> Filtration
- **Evacuation of Air**
- **Filling SF<sub>6</sub> into GIE**





# **New Requirements for SF<sub>6</sub> Recovery Systems**

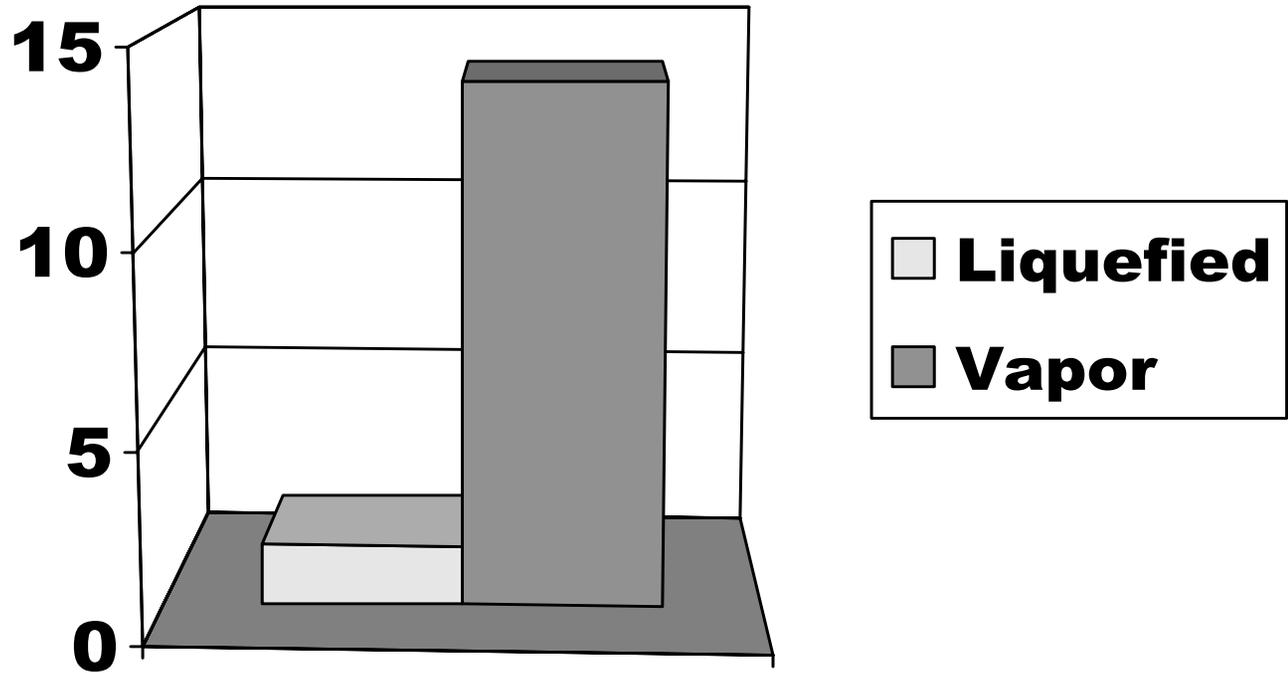
- **Monitor SF6 Quantity**
  - Weighing device
  - Mass flow
- **Cylinder Transfer/Heal Recovery**
- **Filtration to CIGRE 2003 Standard**
- **Compact DOT Approved Storage**





# Liquid vs. Gaseous Storage

## Cubic Foot Volume



**115 lbs. @ 80°F**



# **SF<sub>6</sub> Recovery**

- **Filtration**
  - **Removal of H<sub>2</sub>O and Decomposition By-Products**
- **Recovery Speed**
  - **No replacement for displacement?**
- **Complete Recovery / Compression Ratio**



# Piston Comparison



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# **SF<sub>6</sub> Recovery Comparison**

- **Gas compartment containing 2,200 lbs @ 87 PSIG operating pressure**
- **Recovery to 0 PSIG = 85.71% SF<sub>6</sub> Removal**
  - **315 lbs of SF<sub>6</sub> lost (> 3 full cylinders)**
- **Recovery to 200 mmHG = 96.21% SF<sub>6</sub> Removal**
  - **83 lbs of SF<sub>6</sub> lost**



# Calculating Recovery Percentages

$$\left( \frac{P_I - P_F}{P_I} \right) \times 100 = \% \text{recovered}$$

$P_I$  = Initial breaker pressure in mmHg(absolute)

$P_F$  = Final breaker pressure in mmHg(absolute)



# Evacuation of Air

- **Speed**
  - **Pump displacement**
  - **Restrictions**
    - **Fitting size**
    - **Hose diameter**

**Compartment preparations**

**N<sub>2</sub> Pre-filling**





## **Filling SF<sub>6</sub> into GIE**

- **Fast SF<sub>6</sub> Processing**
  - **External Heat Source (Evaporator)**
  - **Cylinders with dip-tube**
- **Filling to preset pressure**
- **Filling to predetermined weight**
  - **Weighing device**
  - **Mass flow scale**



# Design Considerations

- **Properly designed Recovery Equipment:**
  - **eliminates contaminants (Oil / Air intrusion)**
  - **is easy to operate / SF<sub>6</sub> loss or contamination due to operator error not possible**
  - **is capable of 100% SF<sub>6</sub> Recovery**
  - **off-site SF<sub>6</sub> Treatment rarely needed**
  - **beneficial equipment speed/price ratio**



# Future Developments

- **Integrated SF<sub>6</sub> / Air / N<sub>2</sub> Separation**
  - **SF<sub>6</sub> losses < 1%**
- **Compact Large Capacity Filters**
- **Faster Small System Recovery Speeds**



# Questions?

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