EU-F-Gas-regulation and its impact on manufacturers and users of SF$_6$-electric power equipment

EPA‘s 2009 Workshop on SF$_6$ Emission Reduction Strategies
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Characteristics of SF$_6$

SF$_6$ is colorless, odorless and a chemical neutral (inerted) gas.

SF$_6$ is 5x heavier than air, is not toxic and has no dangerous components inside.

SF$_6$ is no hazardous material.

SF$_6$ has no eco-toxic potential.

SF$_6$ has no impact for the ozonosphere.

SF$_6$ is a potent greenhouse gas.

SF$_6$ has excellent electrical characteristics.
Total SF₆-emission contribution only 0,28 %
SF₆-emission from electric power equipment: 0,05 %
(„closed and sealed pressure systems“); in Germany: 0,03 % !

Other SF₆-emission sources were: magnesium and aluminium industry, footwear, tyres, window noise insulation, military applications, semiconductor industry, medical devices (mainly „open applications“)
“Reductions of SF₆ emissions from electrical high and medium voltage equipment in Europe”

- In 2002 in the EU-15 the SF₆-emission of electrical power equipment was 0.05 % of all greenhouse gases → Slide 4
- Volunteer actions of manufacturers and users of electrical high and medium voltage equipment in Europe realized a reduction of 40% SF₆-emission in the last 10 years
- Additional reduction of SF₆-emission possible – improve tightness, gas-recycling; complete & Europe-wide realization of this activities in the future
- Environmental life cycle assessments show a relief of the CO₂-balance by using SF₆-technology

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1) Coordinating Committee for the Associations of Manufacturers of Industrial Electrical Switchgear and Control gear in the European Union (now renamed/reorganized to “T&D Europe”)
2) European Union of the Electricity Industry (utilities/users)

Possible SF₆ emissions in the lifecycle process of switchgear

SF₆ is used in a closed cycle

The EU-F-Gas regulation concentrates on the individual processing

(↑↓=possible emission)

$\text{SF}_6$ is considered in some articles only

The use of $\text{SF}_6$ in electric power equipment is permitted

Certain measures to be carried out by manufacturers and users have been implemented

Amendments have been released to describe measures more in detail
European F-Gas-regulation 842/2006
relevant articles for \( \text{SF}_6 \) electric power equipment

Regulation (EC) Nr. 842/2006 on certain fluorinated greenhouse gases*

- Article 4 „Recovery“
  - Recovery by certified staff only
- Article 5 „Training and certification“
  - (EC) 305/2008 definitions, minimum requirement on certification of staff
- Article 6 „Reporting“
  - (EC) 1493/2007 definitions, format of reporting
- Article 7 „Labelling“
  - (EC) 1494/2007 definitions, form of labels

*) “certain fluorinated greenhouse gases” means hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (\( \text{SF}_6 \))
Definitions for SF₆-handling

- **Recovery**
  Collection and storage of SF₆ from electric power equipment or containers
  → *in practice: taking out SF₆ from equipment and putting it into a container*

- **Recycling**
  Reuse of recovered SF₆ following a basic cleaning process
  → *in practice: recycling of SF₆ on site*

- **Reclamation**
  Reprocessing of recovered SF₆ in order to meet a specific standard* of performance
  → *in practice: used SF₆ is reprocessed (e.g. SF₆-production plant)*

- **Destruction**
  Transformation or destruction into one or more stable substances which are not fluorinated GHG
  → *in practice: burning of SF₆*

*) - IEC 60376 “Specification of technical grade sulfur hexafluoride (SF₆) for use in electrical equipment”
- IEC 60480 “Guidelines for the checking and treatment of sulfur hexafluoride (SF₆) taken from electrical equipment and specification for its re-use”
SF₆-handling processes are described – based on IEC 62271-303 (2008) (and CIGRÉ No 276/2005 SF₆-handling, IEEE P1712/D1 guide for SF₆-handling)
### SF₆ Filling / Refilling in Practice

<table>
<thead>
<tr>
<th>Activity</th>
<th>In Practice</th>
<th>Certificate Necessary</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF₆ handling at high voltage switchgear</td>
<td>maintenance, service, end-of-life of equipment</td>
<td>YES ✓</td>
</tr>
<tr>
<td>SF₆ recycling, processing</td>
<td>improvement of SF₆-quality</td>
<td>YES ✓</td>
</tr>
<tr>
<td>SF₆ filling / refilling</td>
<td>topping-up of transport filling pressure to nominal pressure</td>
<td>NO ✗</td>
</tr>
</tbody>
</table>

Which measures have to be considered therefore?

- **Certificate necessary?**
- **YES ✓**
- **YES ✓**
- **NO ✗**

- **certify own staff**
- **contract OEM or service companies with certified personal only**
European F-Gas-regulation 842/2006, article 5 „Training and certification“ together with regulation 305/2008

„Commission regulation No. 305/2008 establishing minimum requirements and the conditions for mutual recognition for the certification of personnel recovering certain fluorinated GHG from HV switchgear“

Process and responsibilities

Training
(not subject to conditions of regulation)

Evaluation body/
Examination
(content defined)

Proof of competence

Certification body issues certifications

Individual certificate

Evaluation body and Certification body have to be independent

*) regulation refers to HV switchgear only

SIEMENS
European F-Gas-regulation 842/2006, article 5 „Training SIEMENS and certification“ together with regulation 305/2008

Minimum requirements
- to be known by technicians
- to be tested by evaluation body

(a) **theoretical test** with one or more questions testing that skill or knowledge, as indicated in the column ‘Test type’ by T

(b) **practical test** where the applicant shall perform the corresponding task with the relevant material, tools and equipment, as indicated in the column ‘Test type’ by P

<table>
<thead>
<tr>
<th>No</th>
<th>Minimum knowledge and skills</th>
<th>Test type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic knowledge of relevant environmental issues (climate change, Kyoto Protocol, Global Warming Potential), the relevant provisions of Regulation (EC) No 842/2006 and of the relevant Regulations implementing provisions of Regulation (EC) No 842/2006</td>
<td>T</td>
</tr>
<tr>
<td>2</td>
<td>Physical, chemical and environmental characteristics of SF₆</td>
<td>T</td>
</tr>
<tr>
<td>3</td>
<td>Use of SF₆ in electric power equipment (insulation, arc quenching)</td>
<td>T</td>
</tr>
<tr>
<td>4</td>
<td>SF₆ quality, according to the relevant industrial standards (?)</td>
<td>T</td>
</tr>
<tr>
<td>5</td>
<td>Understanding of the design of electric power equipment</td>
<td>T</td>
</tr>
<tr>
<td>6</td>
<td>Checking the SF₆ quality</td>
<td>P</td>
</tr>
<tr>
<td>7</td>
<td>Recovery of SF₆ and SF₆ mixtures and purification of SF₆</td>
<td>P</td>
</tr>
<tr>
<td>8</td>
<td>Storage and transportation of SF₆</td>
<td>T</td>
</tr>
<tr>
<td>9</td>
<td>Operation of SF₆ recovery equipment</td>
<td>P</td>
</tr>
<tr>
<td>10</td>
<td>Operation of tight drilling systems, if necessary</td>
<td>P</td>
</tr>
<tr>
<td>11</td>
<td>Re-use of SF₆ and different re-use categories</td>
<td>T</td>
</tr>
<tr>
<td>12</td>
<td>Working on open SF₆ compartments</td>
<td>P</td>
</tr>
<tr>
<td>13</td>
<td>Neutralising SF₆ by-products</td>
<td>T</td>
</tr>
<tr>
<td>14</td>
<td>Monitoring of SF₆ and appropriate data recording obligations under national or Community legislation, or international agreements</td>
<td>T</td>
</tr>
</tbody>
</table>

(?) For instance IEC 60376 and IEC 60480.
Optimized gas recovery needs
„State of the Art“ equipment

1mbar SF₆- maintenance unit

SF₆ – measurement device
- % SF₆,
- dew-point temperature,
- SF₆-byproducts

SF₆ – collecting device for measurement of gas

Source: DILO

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Energy Sector - Power Transmission High Voltage Substations
Optimized SF₆ handling

With State-of-the-art-handling equipment SF₆ recovery of each gas compartment till very low pressure (1 - 20 mbar) is possible, thus securing losses of at least less than 2% during maintenance and end of life.

SF₆-residual quantity (emission) dependence on the SF₆ rated filling pressure / compartment size / SF₆ residual pressure

- **420 kV-circuit breaker, 3-pole**
  - volume: approx. 7000 l
  - working pressure: 6.6 bar abs.
  - SF₆-amount: approx. 300 kg
  - SF₆-density: 43 g/l

- **420 kV-disconnector, 3-pole**
  - volume: approx. 870 l
  - working pressure: 4.8 bar abs.
  - SF₆-amount: approx. 27 kg
  - SF₆-density: 26.7 g/l

Source: Cigré-Guide no. 276, application of table 25; Example: GIS Siemens

„Commission regulation No 1493/2007 establishing the format for the report to be submitted by producers, importers and exporters of certain fluorinated GHG“

- Reporting of producers, importers and exporters in the EU

- Submission of the report by 31 March of the year following the year for which the report applies

- Report shall be submitted to the EU commission and the competent authority of the member state

- For utilities usually not relevant

The reporting is a must to do in case of...

- Import SF₆ > 1 t in container or bottles from: country A outside EU to: country B outside EU
- Export SF₆ > 1 t in container or bottles from: country B outside EU to: country A outside EU

The reporting is not necessary for...

- import / export SF₆ in equipment inside EU countries
- import / export < 1 t per year and company

In some countries additional voluntary commitments regarding reporting exist.

„Commission regulation establishing the form of labels and additional labelling requirements as regards products and equipment containing certain fluorinated GHG“

- It applied from 1. April 2008
- SF₆ labelling on the product itself
- Information in the instruction manual
Standards required SF₆-weight already in the past: declaration of "weight of gas" according to IEEE C37.122 or IEC 62271-203

The label shall be placed clearly, indelibly and adjacent to the service point of the equipment

*) Content defined in the regulation but the form can vary between the different manufactures
Labelling of products

The instruction manual must contain a note in the sense of…

“This equipment contains the fluorinated greenhouse gas SF₆ covered by the Kyoto Protocol and with a global warming potential (GWP) 22 200. SF₆ shall be recovered and not released into the atmosphere. For further information on use and handling of SF₆ please refer to IEC 62271-303: High-voltage switchgear and control gear – Part 303 Use and handling of sulphur hexafluoride (SF₆)”

Source: T&D Europe, Guide for Manufacturers of HV Switchgear containing SF₆…
What can users of SF₆-electric power equipment expect from the manufactures?

- Low leakage rates during lifetime of equipment
- Comply with the EU-F-Gas regulation and additional SF₆-voluntary commitment (in selected countries)
- Training & certification of staff handling/recovering SF₆
- Use of state-of-the-art equipment for SF₆ handling (factory, on-site service)
- Continuous improvement of products (more compact, less emission)
Conclusion

- $\text{SF}_6 \rightarrow$ excellent insulation and arc quenching; no equivalent at the moment
- $\text{SF}_6$-technology $\rightarrow$ compact equipment with low material usage, high operational safety, minimized fire load, high availability
- Positive ecological balance $\rightarrow$ lower energy losses compared to conventional AIS solutions (therefore CO$_2$-reduction)
- Potent greenhouse gas $\rightarrow$ low leakage rates and handling losses necessary, reuse-concept to be considered during maintenance and end-of-life
- Further European & world-wide realization of emission reduction necessary
Thank you for your attention!

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