SF\textsubscript{6} Emission Reduction and Leak Repair in Japan

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The Japan Electrical Manufacturers’ Association (JEMA)
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29-11-2006
Overview

1. Joint study concerning reducing SF$_6$ emission
2. Voluntary Action Plan in Japan
3. Emission Reduction Activity from 1998
4. Recent Leak Repair of GIS
5. Conclusion
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Joint Study on SF₆

Academic (Universities in Japan)

Electric Power Companies

Electric Equipment Manufacturers

Gas Producers

Electric Technology Research Association

<Purpose>
Technical standards for handling and recycling of SF₆ (From 1996 to 1998)
Gas Producers
Production: 2300t
Oversea Export: 200t
Domestic Use: 2100t

200t (Emissions)

Gas Insulated Equipment
Manufacturers
Production
Installation

400t (Emissions)

1500t

Other industries

50t (Emissions)

Return Process 100t

Other industries

Electric Power Company
Maintenance Removal

550t
$SF_6$ Recycling flow & Standard

Decomposition

Gas Suppliers

Manufacturers

Utilities

Reuse

Remaining gas

Nonstandard Gas

Recycle Standard

<table>
<thead>
<tr>
<th>Requirement for Reused $SF_6$</th>
<th>$SF_6$ Recovery Ratio in Internal Inspection</th>
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<tbody>
<tr>
<td>Purity</td>
<td>97vol%</td>
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<tr>
<td>Humidity</td>
<td>150volppm</td>
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<tr>
<td>Decomposition Products: Not Detected</td>
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<tr>
<td></td>
<td>90% in 2000</td>
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<td>97% in 2005</td>
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Organizations of Utilities and Manufacturers (FEPC) (JEMA)

The Voluntary Action plan in April 1998

Administrative Organ

Electric Technology Research Association

Recommend SF6 Recycling Guide

<table>
<thead>
<tr>
<th>SF6 Emission</th>
<th>2000</th>
<th>2005</th>
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<tr>
<td>280 ton</td>
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<td>70 ton</td>
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</table>

EA : Environment Agency
MITI : Ministry of International Trade and Industry (In 1998)
Voluntary Actions by Electric Power Companies

Target for Recovery Rate

- **Usage (During Maintenance Work)**
  
  1990 – 1995 60%  >>  by 2000 90%
   
  by 2005 97%

- **Disposal (During Replacement Work)**
  
  1990 – 1995 0%  >>  by 2005 99%
Voluntary Actions by Equipment Manufacturers

Target for Recovery Rate
- 1990 – 1995 70% >> by 2000 85%
  by 2005 97%

Target for Gas Recovery & Usage
- Development of High Performance Gas Handling Equipment
- Development of Compact Gas Insulated Equipment With Minimum SF$_6$
Voluntary Actions by the Concerned Parties

• Improvement of Inventory System
  – Record of SF$_6$ Amount at Every Job
  – Annual Report to Government relating to Progress of SF$_6$ Recovery

• Promotion of Gas Recovery
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Operation of Inventory System on SF$_6$ by Electric companies

SF$_6$ inventory system

1) Maintenance record of SF$_6$
   - Registration of New installation, Extension, Disposal of Gas Insulated Equipment & renewal
   - All maintenance is recorded
   - Spare SF$_6$ cylinder data is recorded

2) Making up the storage and emission of SF$_6$
   - Gas insulated equipment's SF$_6$ storage
   - Total SF$_6$ storage & emission amounts per each voltage range
   - All maintenance is recorded

3) File to import or export for mail

4) System maintenance
### Storage and Emissions of SF6 gas (Result)

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<td>187~275kV</td>
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Deployment plan of SF$_6$ reclaimers for electric power companies in Japan

Power companies had a plan to invest 81 SF$_6$ reclaimers by 2005.
Actual situation of SF$_6$ gas recovery work in EHV equipment

SF6 recovery of EHV GCB & GIS was performed mainly during the maintenance work on May and October.
Improvement of Inventory system

Efficient use of SF₆ recovery equipment
- Share large-capacity recovery equipment among the electric power companies and manufacturers.
- Coordinate the maintenance work schedule

Brush up the existing inventory system
- Standardized procedure for SF₆ handling
- Standardized measuring method and equipment
- Share the common understanding for recycle SF₆ handling
$\text{SF}_6$ Emission from the Equipment by Electric Power Companies
The emission of SF$_6$ in manufacturer was a little bit large. In 2005 we reached the target value SF$_6$ emission rate (3%).
$\text{SF}_6$ Emission from Electric Power Industry of Japan

- With Action
- Without Action
1. In 2005, we achieved the target value (3% at development & manufacture, 3% at maintenance, 1% at disposal.)

The emission of SF$_6$ was 29ton/year in 2005.

2. To make an effort to reduce more emission and to keep the low emission of SF$_6$ is our next target.
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Recent repair of $\text{SF}_6$ leakage

1. Outdoor GIS application & longer life expectation

   Outdoor GIS is now widely applied in Japan. Recently GIS is expected to have longer life more than 50 years, so it becomes to be important to keep the low emission of $\text{SF}_6$ from GIS for long term.

   New repair technique or some of countermeasures to keep emission of $\text{SF}_6$ low from aged GIS, GCB, and GIT in near future.
Some countermeasures to $SF_6$ leakage

Flange Corrosion $\rightarrow$ $SF_6$ Leakage

Countermeasure against flange corrosion of GIS
Some countermeasures to $SF_6$ leakage

Flange Corrosion $\rightarrow$ $SF_6$ Leakage

The double shell concept (Filling up the shell with resin)

Reference: CIGRE 2006, B3-102 Session paper
Gas leakage from the bellows by Stress Corrosion Crack

Recently we experienced the gas leakage from the bellows of GIS owing to Stress Corrosion Crack in outdoor GIS after 20 years’ Service.

550kV GIS installed in coastal area
Gas leakage from the bellows by SCC

1. The life expectancy is assumed 50 years based on the life of O ring and the corrosion of the flange. The material of the bellows is a stainless steel which thickness is approx. 1.5mm.

2. The stain material (NaCl etc) adheres to the bellows. This causes stress corrosion crack (SCC) around the flange and the welded parts of bellows.

3. As a result, the replace of bellows became necessary in 20 years.
**Solution for obtaining enough life in outdoor GIS**

The structure of bellows of GIS has changed, attaching rubber and a plastic cover for surroundings and for enough life.

These rubber and a plastic cover already applied about 30 years as a water-proof cover of GIS.
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1) We achieved the target values for SF₆ emission from Electric Power Industry in Japan. The target values are as follows.: 3% during development & manufacture, 3% during maintenance, 1% at disposal.

2) Environment is a key for us to survive and therefore, to reduce SF₆ emission preserves our Earth and ourselves.

3) Since economical alternative of SF₆ has not found yet, we have to keep SF₆ emission as low as possible.

4) Since GIS is expected to have a longer lifetime by utilities than before, it’s necessary to develop a new techniques to prevent or to repair the leakage from aged GIS and GIS under severe environment.
• Thanking you for your attention