



SF₆ Emission Reduction and Leak Repair in Japan

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Overview

- 1. Joint study concerning reducing SF₆ 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

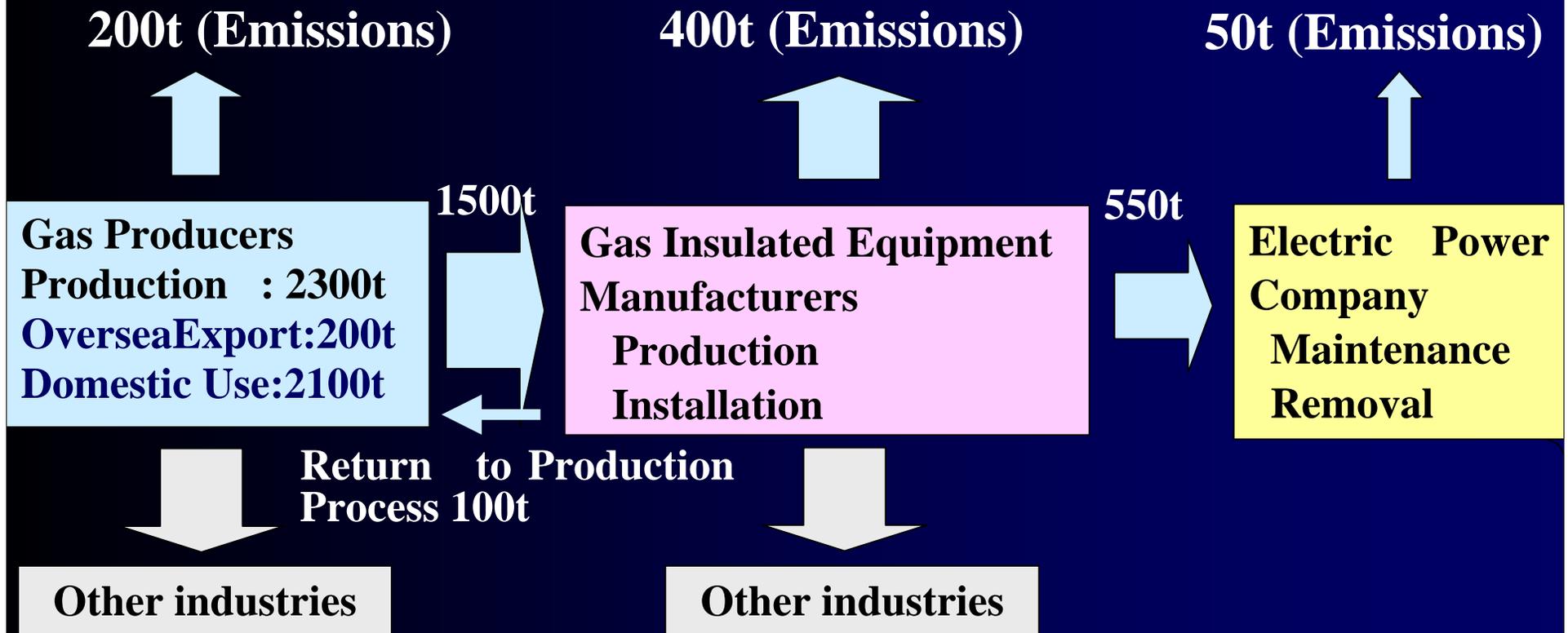
*Electric
Technology
Research
Association*

<Purpose>

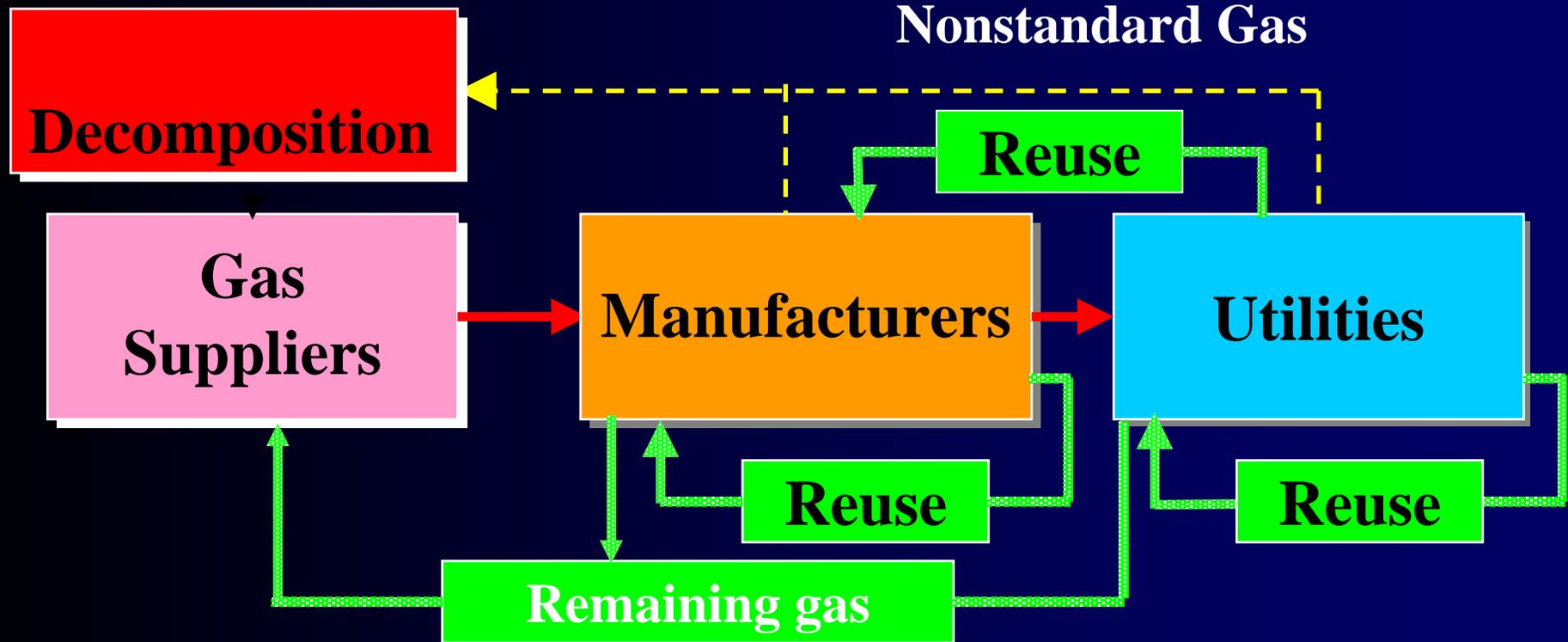
Technical standards for
handling and recycling of
SF₆
(From 1996 to 1998)

SF₆ Balance Sheet In Japan

(Average from 1990 to 1995)



SF₆ Recycling flow & Standard

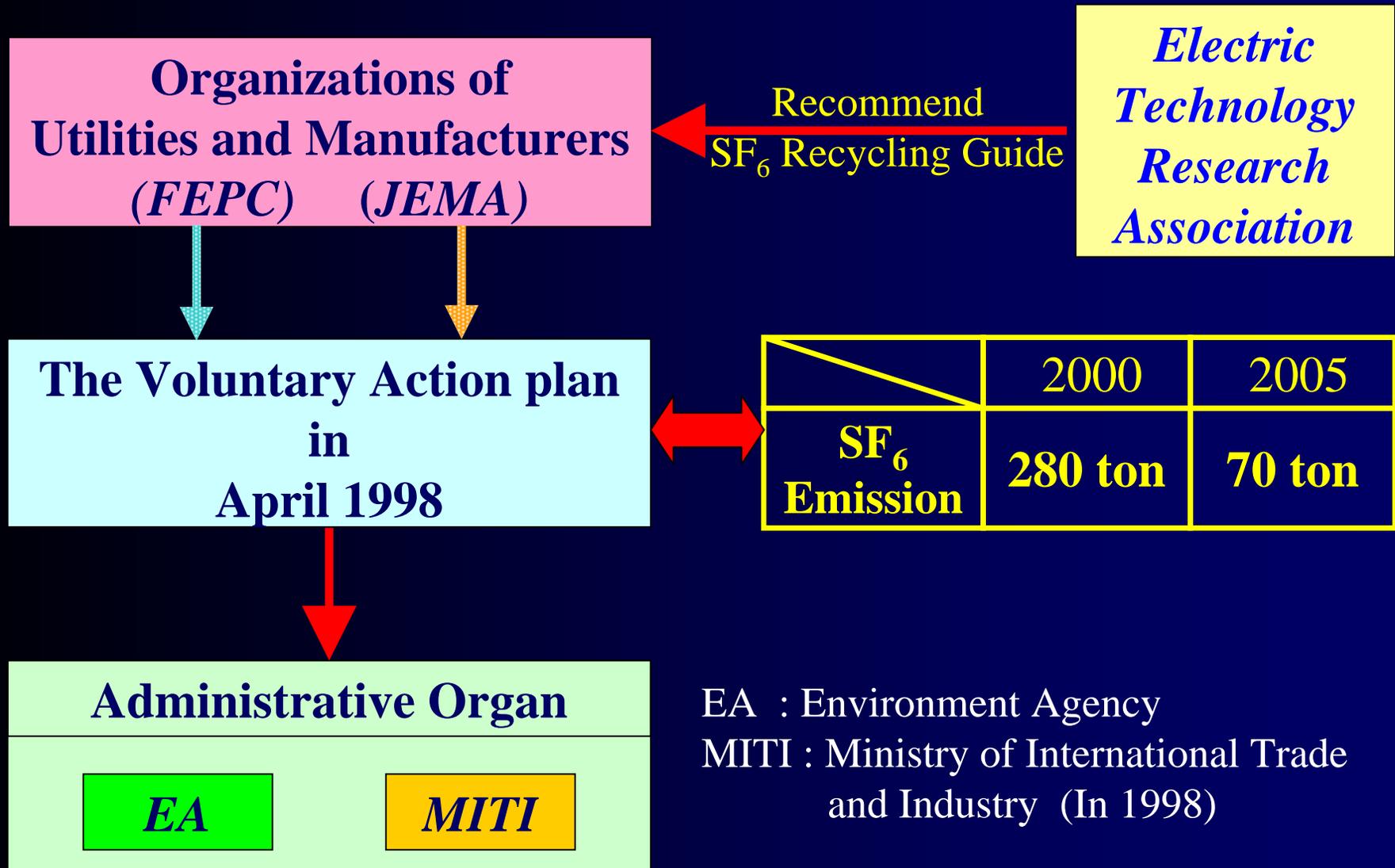


Recycle Standard	
Requirement for Reused SF ₆	SF ₆ Recovery Ratio in Internal Inspection
Purity	97vol%
Humidity	150volppm
Decomposition Products: Not Detected	90% in 2000 97% in 2005

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Voluntary Action Plan (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 SF₆

Voluntary Actions by the Concerned Parties

- **Improvement of Inventory System**
 - Record of SF₆ Amount at Every Job
 - Annual Report to Government relating to Progress of SF₆ Recovery
- **Promotion of Gas Recovery**

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Operation of Inventory System on SF₆ by Electric companies

SF₆ inventory system

1) Maintenance record of SF₆

- **Registration of New installation, Extension, Disposal of Gas Insulated Equipment & renewal**
- **All maintenance is recorded**
- **Spare SF₆ cylinder data is recorded**

2) Making up the storage and emission of SF₆

- **Gas insulated equipment's SF₆ storage**
- **Total SF₆ storage & emission amounts per each voltage range**
- **All maintenance is recorded**

3) File to import or export for mail

4) System maintenance

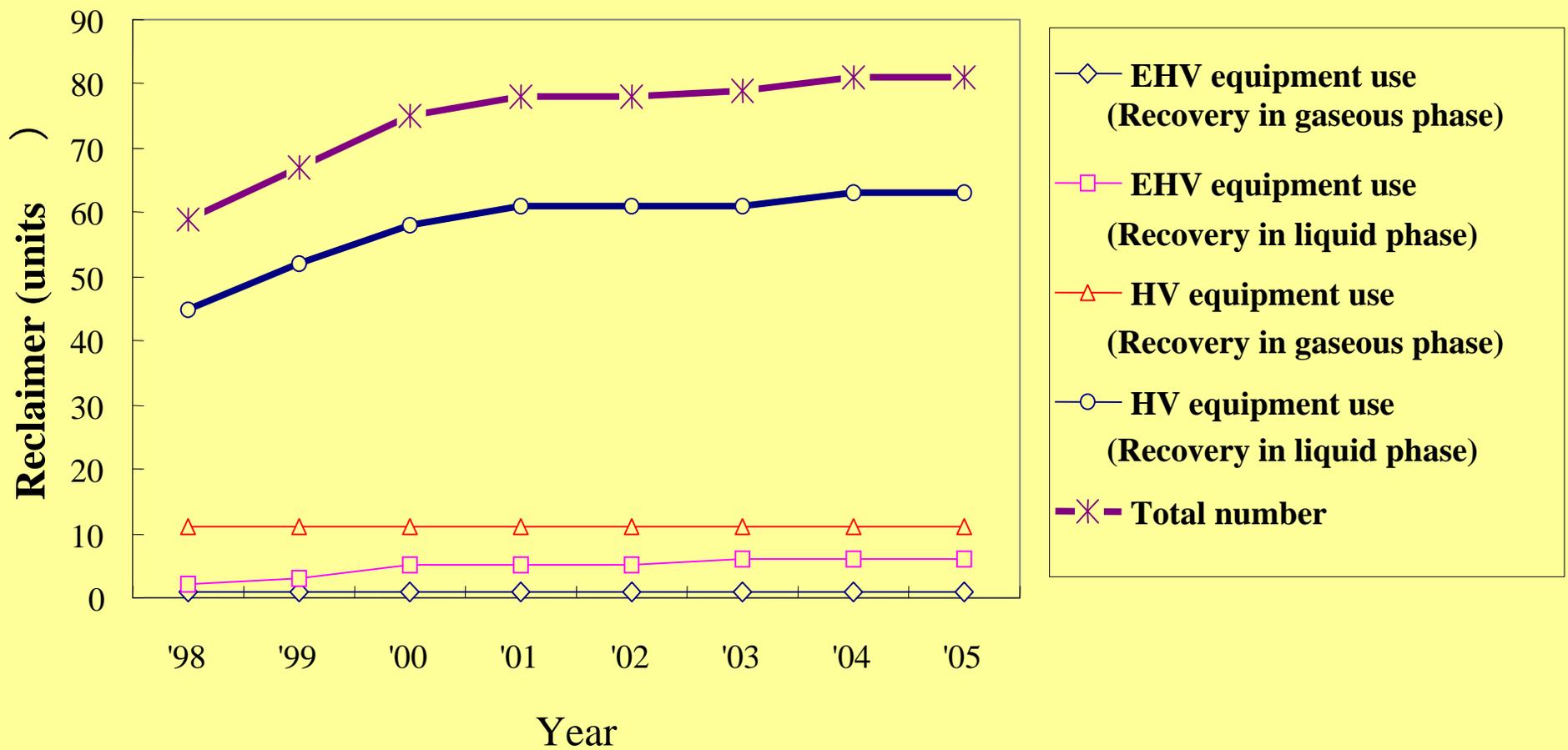
SF₆ inventory system and report formats of one utility

Storage and Emissions of SF6 gas(Result)

Equipment		Maintenance			Disposal			Disposal		
name of equipment	Voltage	Handling No.	Recovery No.	Recovery/Handling(%)	Handling No	Recovery No	Recovery/Handling(%)	Handling N	Recovery N	Recovery/Handling(%)
GCB	500~	***	***	***	***	***	***	***	***	***
	187~275kV	***	***	***	***	***	***	***	***	***
	110~154kV	***	***	***	***	***	***	***	***	***
	66~77kV	***	***	***	***	***	***	***	***	***
	22~55kV	***	***	***	***	***	***	***	***	***
	~11kV	***	***	***	***	***	***	***	***	***
	sub total	***	***	***	***	***	***	***	***	***
GS	500~	***	***	***	***	***	***	***	***	***
	187~275kV	***	***	***	***	***	***	***	***	***
	110~154kV	***	***	***	***	***	***	***	***	***
	66~77kV	***	***	***	***	***	***	***	***	***
	22~55kV	***	***	***	***	***	***	***	***	***
	~11kV	***	***	***	***	***	***	***	***	***
	sub total	***	***	***	***	***	***	***	***	***

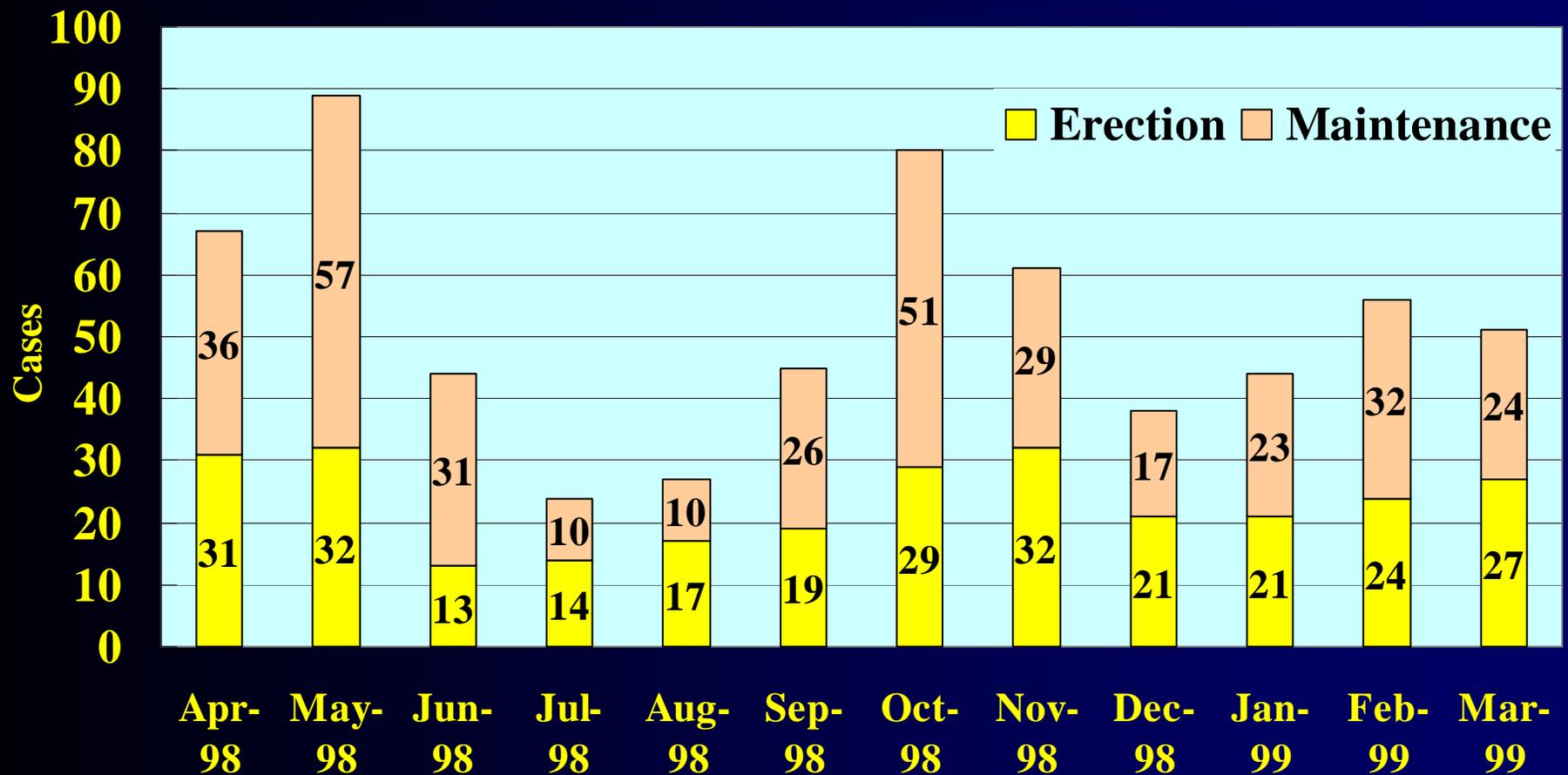
Deployment plan of SF₆ reclaimers for electric power companies in Japan

Power companies had a plan to invest 81 SF₆ reclaimers by 2005.



Actual situation of SF₆ 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

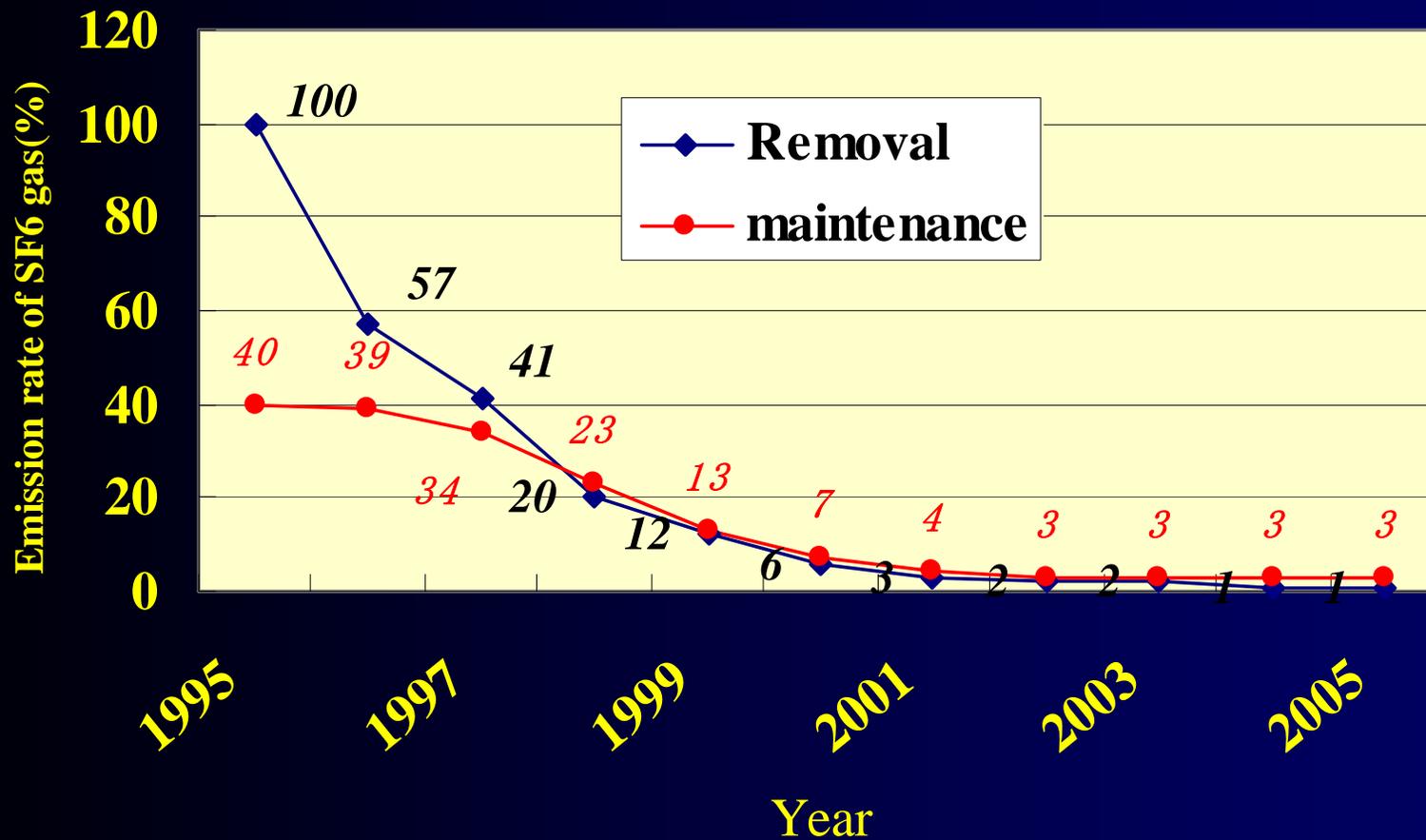
- **Share large-capacity recovery equipment among the electric power companies and manufacturers.**
- **Coordinate the maintenance work schedule**

Brush up the existing inventory system

- **Standardized procedure for SF₆ handling**
- **Standardized measuring method and equipment**
- **Share the common understanding for recycle**

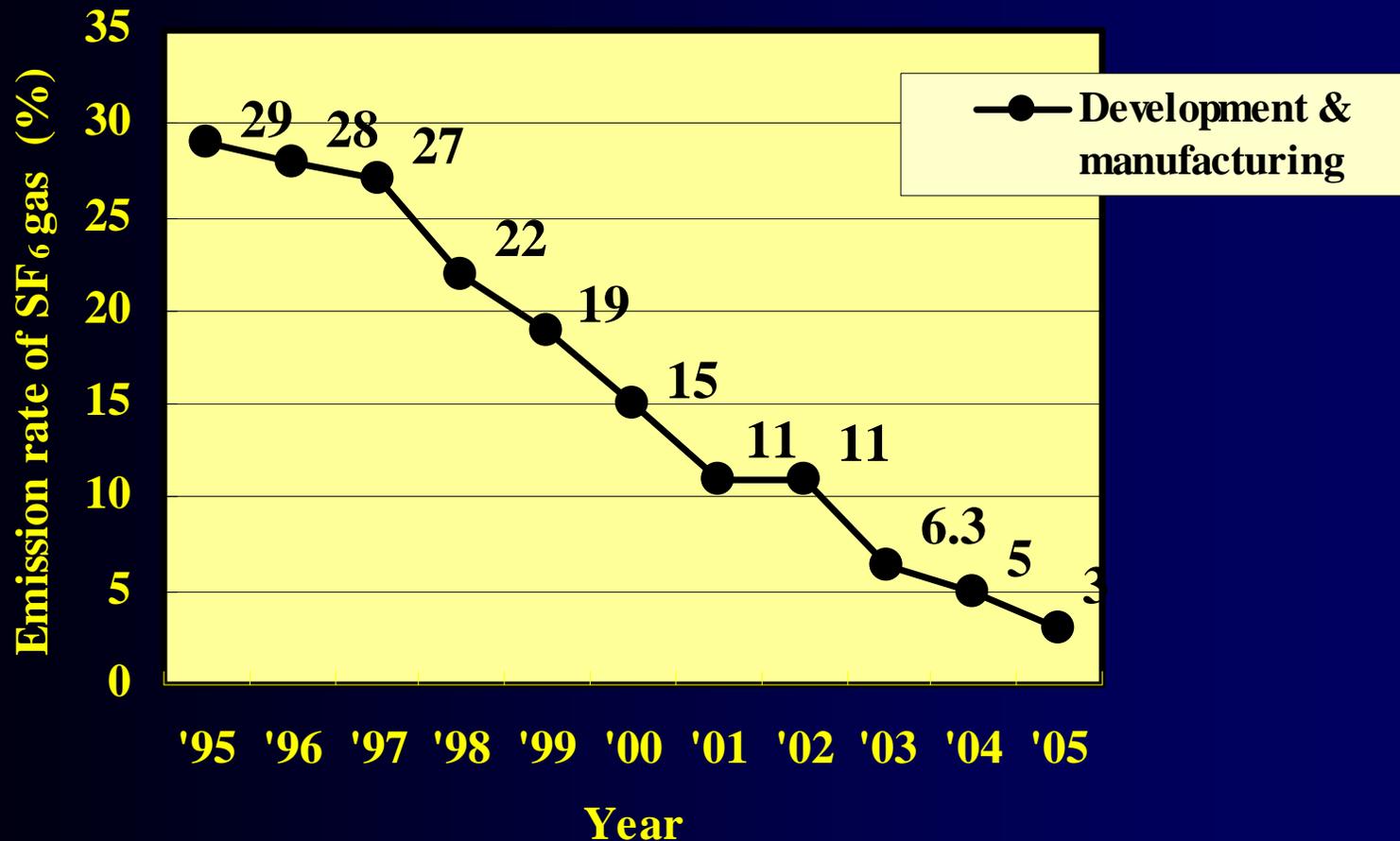
SF₆ handling

SF₆ Emission from the Equipment by Electric Power Companies

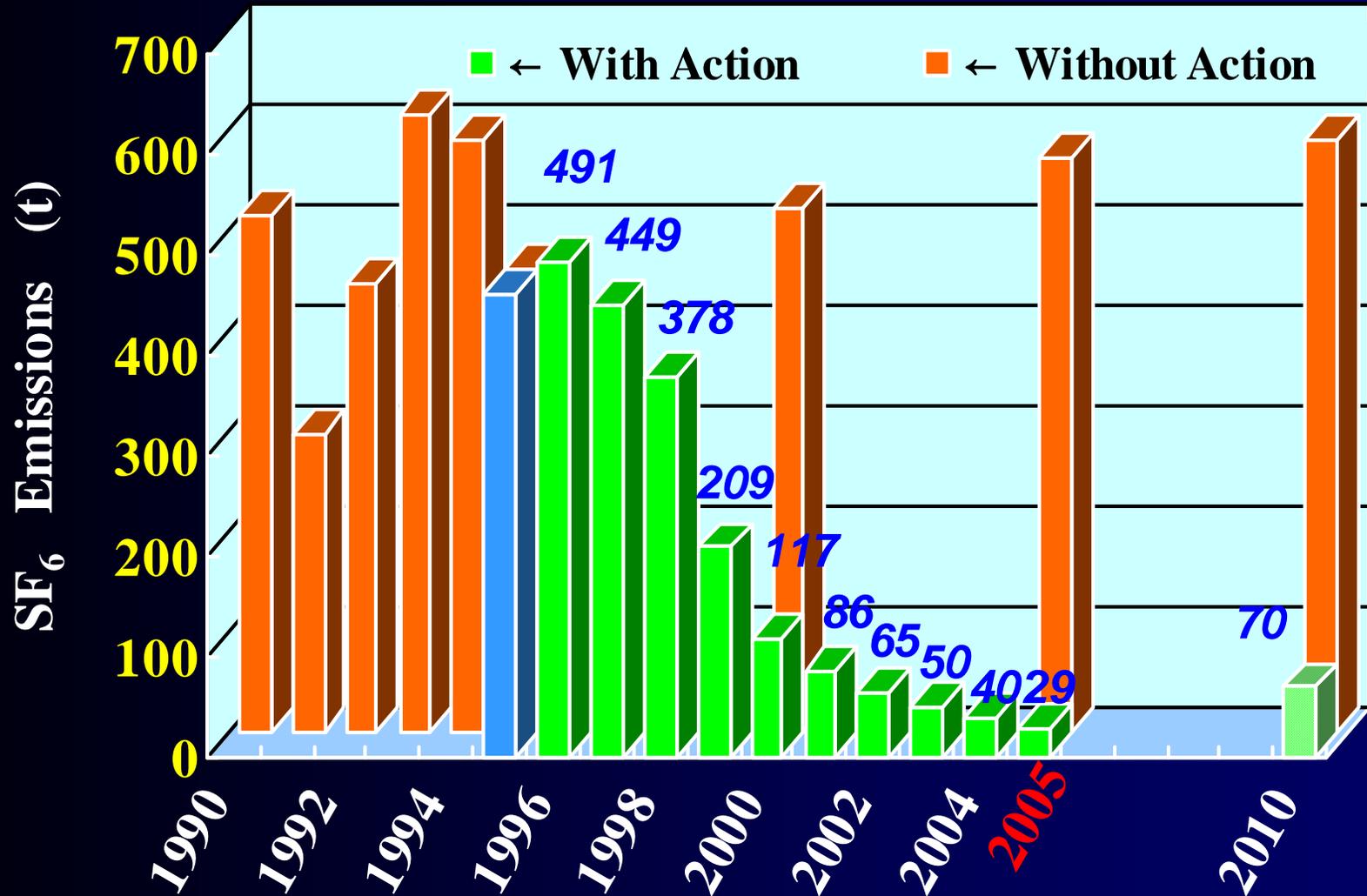


SF₆ Emission from the Equipment by manufacturers

The emission of SF₆ in manufacturer was a little bit large.
In 2005 we reached the target value SF₆ emission rate(3%).



SF₆ Emission from Electric Power Industry of Japan



SF₆ Emission from Electric Power Industry of Japan

1. In 2005, we achieved the target value (3% at development & manufacture, 3% at maintenance, 1% at disposal.)

→ The emission of SF₆ was 29ton /year in 2005.

2. To make an effort to reduce more emission and to keep the low emission of SF₆ is our next target.

Overview

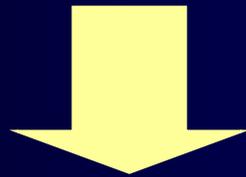
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Recent repair of SF₆ leakage

1. Outdoor GIS application & longer life expectation

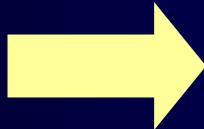
Outdoor GIS is now widely applied in Japan.

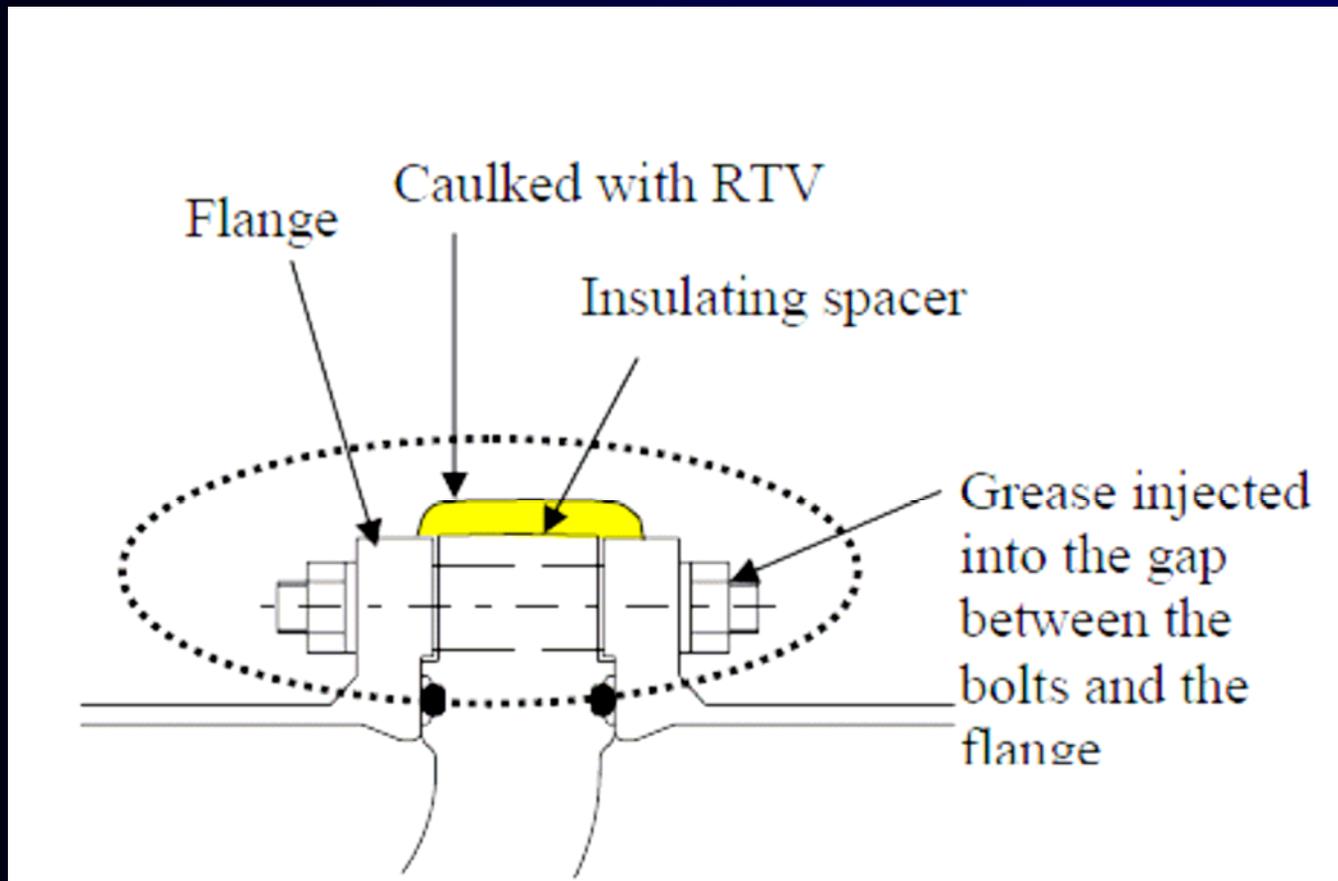
Recently GIS is expected to have longer life more than 50 years, so it becomes to be important to keep the low emission of SF₆ from GIS for long term.



New repair technique or some of countermeasures to keep emission of SF₆ low from aged GIS, GCB, and GIT in near future.

Some countermeasures to SF₆ leakage

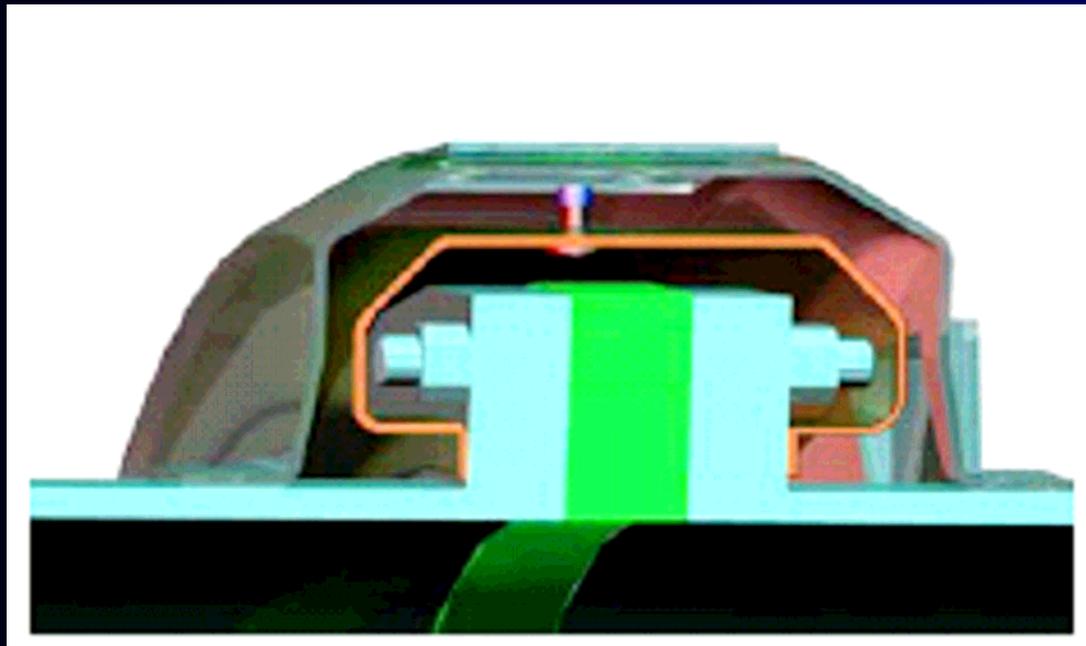
Flange Corrosion  **SF₆ Leakage**



Countermeasure against flange corrosion of GIS

Some countermeasures to SF₆ leakage

Flange Corrosion  **SF₆ 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

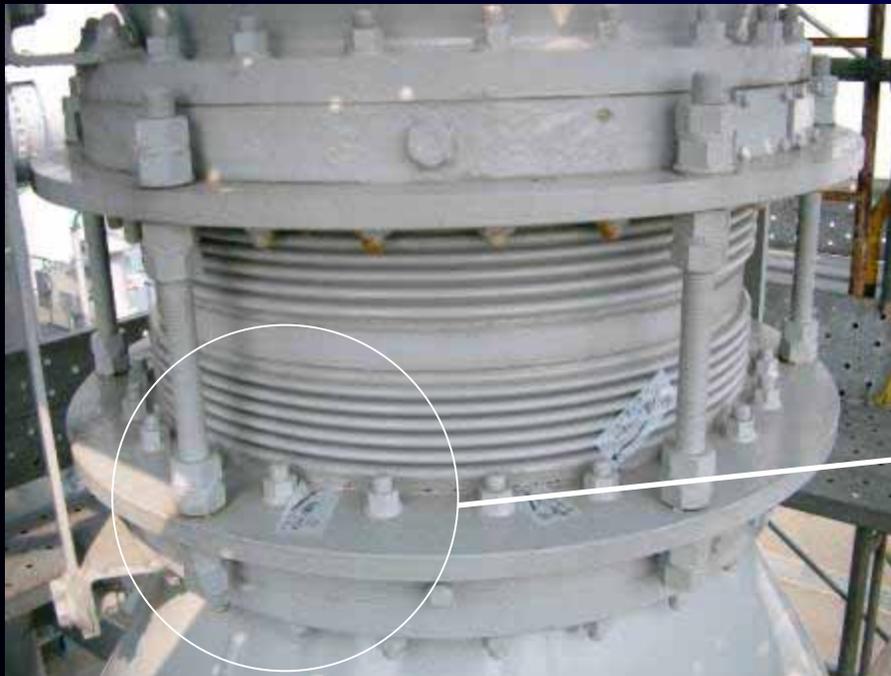
Recently we experienced the gas leakage from the bellows of GIS owing to Stress Corrosion Crack in outdoor GIS after 20 years' Service.



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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Conclusion

- 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