

# **The Situation of Reduction in SF<sub>6</sub> Emissions from Gas-insulated Electrical Equipment In Japan**

**The Federation of Electric Power Companies  
The Japan Electrical Manufacturers' Association  
Japan**

# Contents

- **Joint study**
- **Voluntary Action Plan**
- **Emission Reduction Activity from 1998**
- **Future Perspective for SF<sub>6</sub> Emissions**

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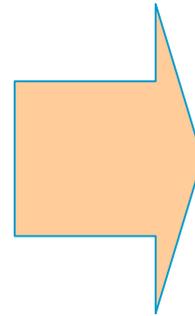
# Joint Study on SF<sub>6</sub>

**Academic  
(Universities in Japan)**

**Electric Power  
Companies**

**Electric Equipment  
Manufacturers**

**Gas Producers**



*Electric  
Technology  
Research  
Association*

**Purpose**

Technical standards for  
handling and recycling of  
SF<sub>6</sub> gas

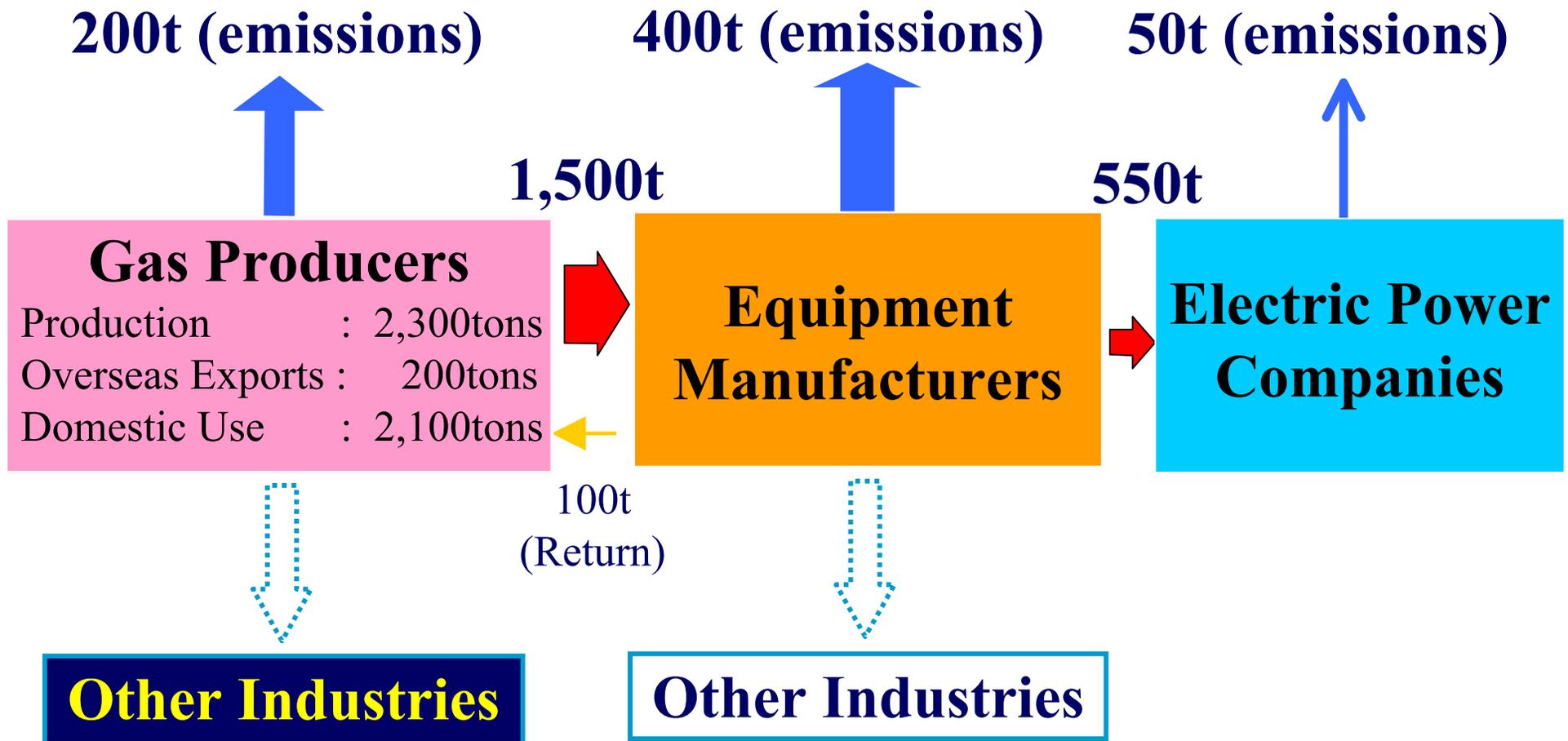
**Period**

From 1996 to 1998

# Joint Study on SF<sub>6</sub>

- **Actual Usage in Japan**
  - Total SF<sub>6</sub> amount for Electric Industry
  - Actual Emissions within Electric Industry
- **Investigation on site**
  - Gas Leakage Rate
  - Gas Purity & Humidity
  - Decomposition Product
- **Requirements for Reused SF<sub>6</sub>**

# Averaged SF<sub>6</sub> Balance Sheet In Japan (From 1990 to 1995)

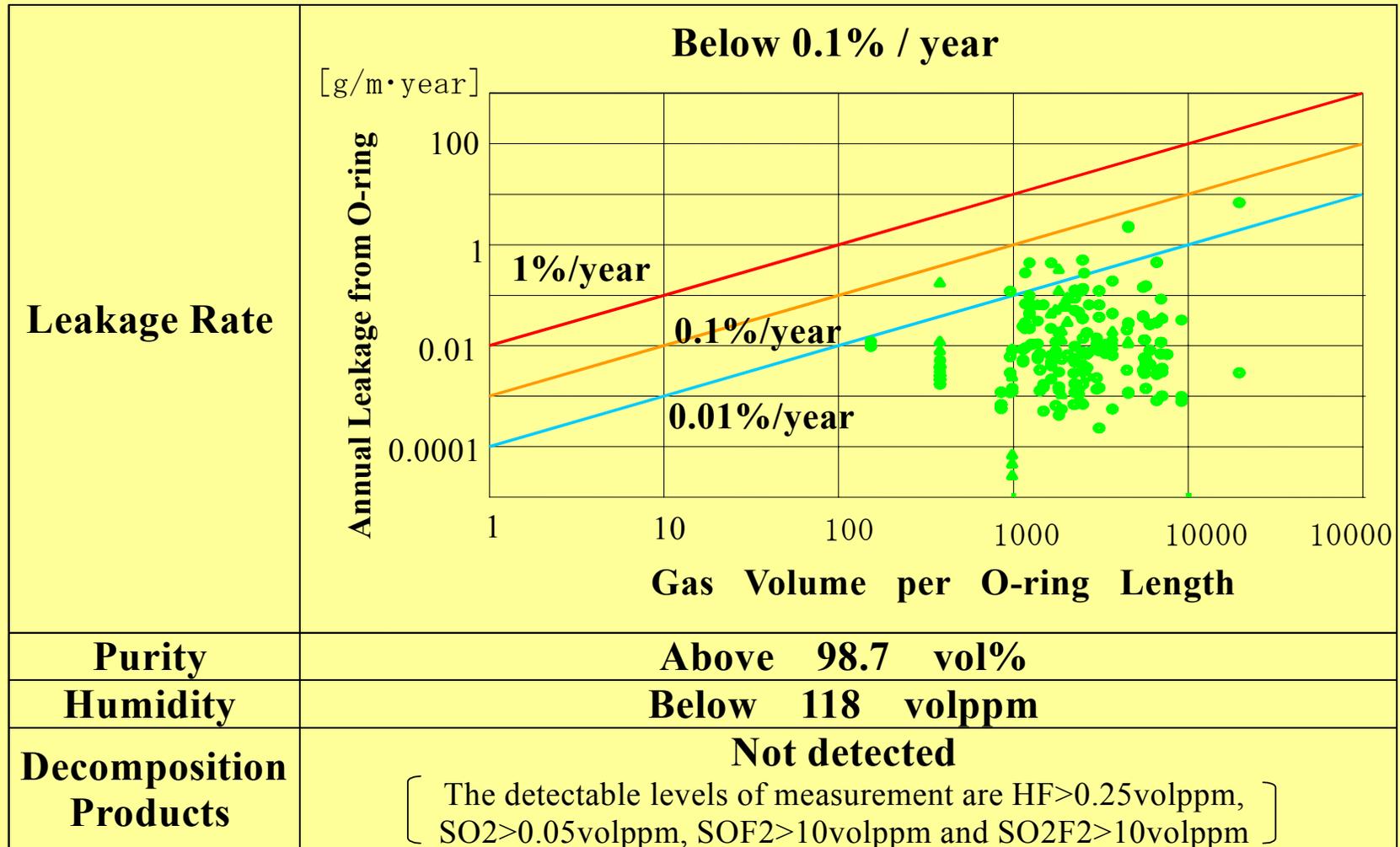


# Actual Emissions at Electric Power Companies<sub>(up to 1995)</sub>

Voltage Range	Maintenance	Removal	Leakage
110kV or higher	Recovery down to 0.05 MPa(gage)	Fully released	0.1%/year
Lower than 110kV	Fully released		

# Investigation on site

(300 points on 40 Circuit Breakers in operation)

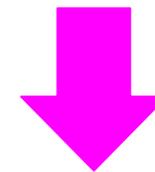


# Recovery Targets

Item		Recovery terminal pressure		Recovery rate	
		Lower than 110 kV	110 kV or higher	Lower than 110 kV	110 kV or higher
<b>Before 1995</b>	<b>During testing</b>	<b>No Recovery</b>		<b>No Recovery</b>	
	<b>During manufacturing</b>	<b>0 - 0.05 MPa·G</b>		<b>Approx. 70%</b>	
	<b>During installation/maintenance</b>	<b>No Recovery</b>	<b>0 - 0.05 MPa·G</b>	<b>No Recovery</b>	<b>Approx. 70%</b>
	<b>During removal</b>	<b>No Recovery</b>		<b>No Recovery</b>	
<b>In the future (from 2005 onward)</b>	<b>During testing/ Manufacturing/ Installation/ maintenance</b>	<b>0.015 MPa·abs (114 Torr) or lower</b>		<b>97% or higher</b>	
	<b>During removal</b>	<b>0.005 MPa·abs (38 Torr) or lower</b>		<b>99% or higher</b>	

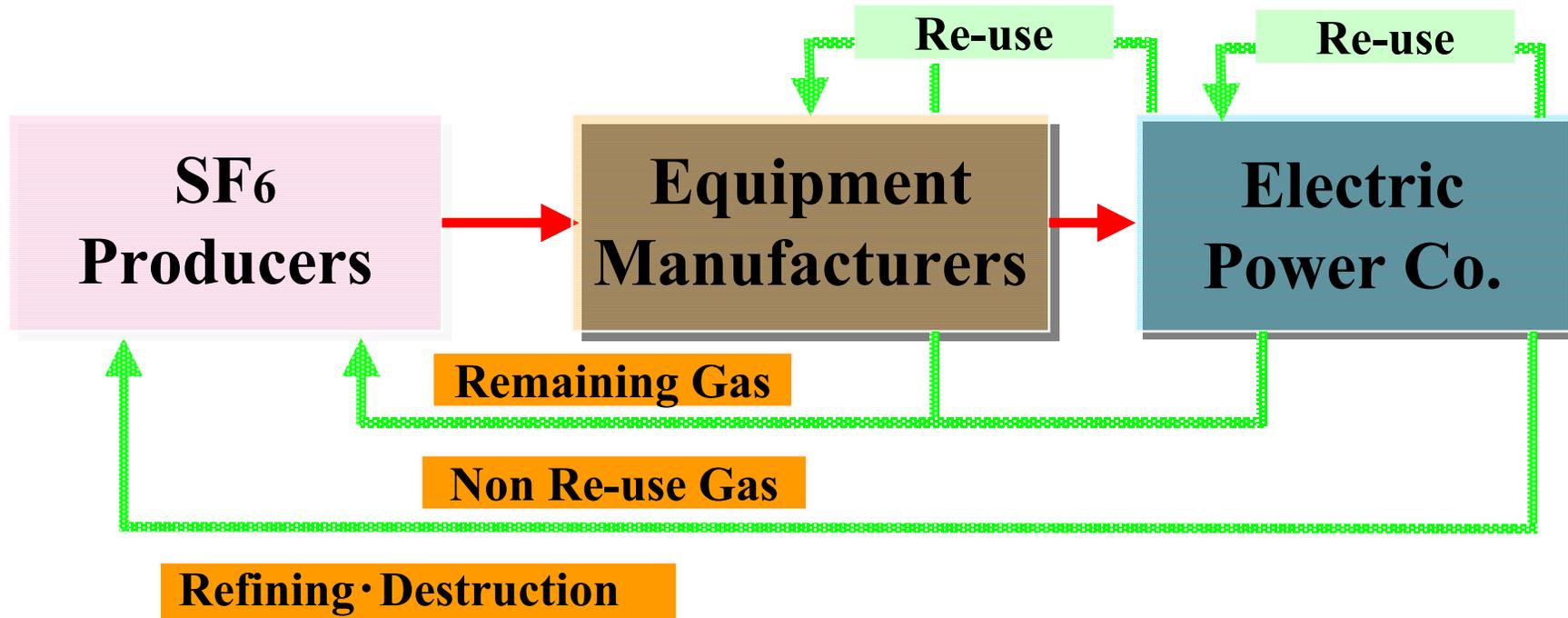
## Quality criteria for Recycle SF<sub>6</sub>

Item		Permissible limits	Criteria
SF <sub>6</sub> gas purity		95 vol. %	97 vol. %
Air		(5 vol. %)	(3vol. %) including CF <sub>4</sub>
Water content	Equipment without Current Interruption	1000 ppm (vol.)	500 ppm (vol.)
	Equipment with Current Interruption	300 ppm (vol.)	150 ppm (vol.)
Dissolved gases/decomposition products		-	No color reaction in detecting tube



**To be Reused**

# SF<sub>6</sub> Recycling flow & Standard

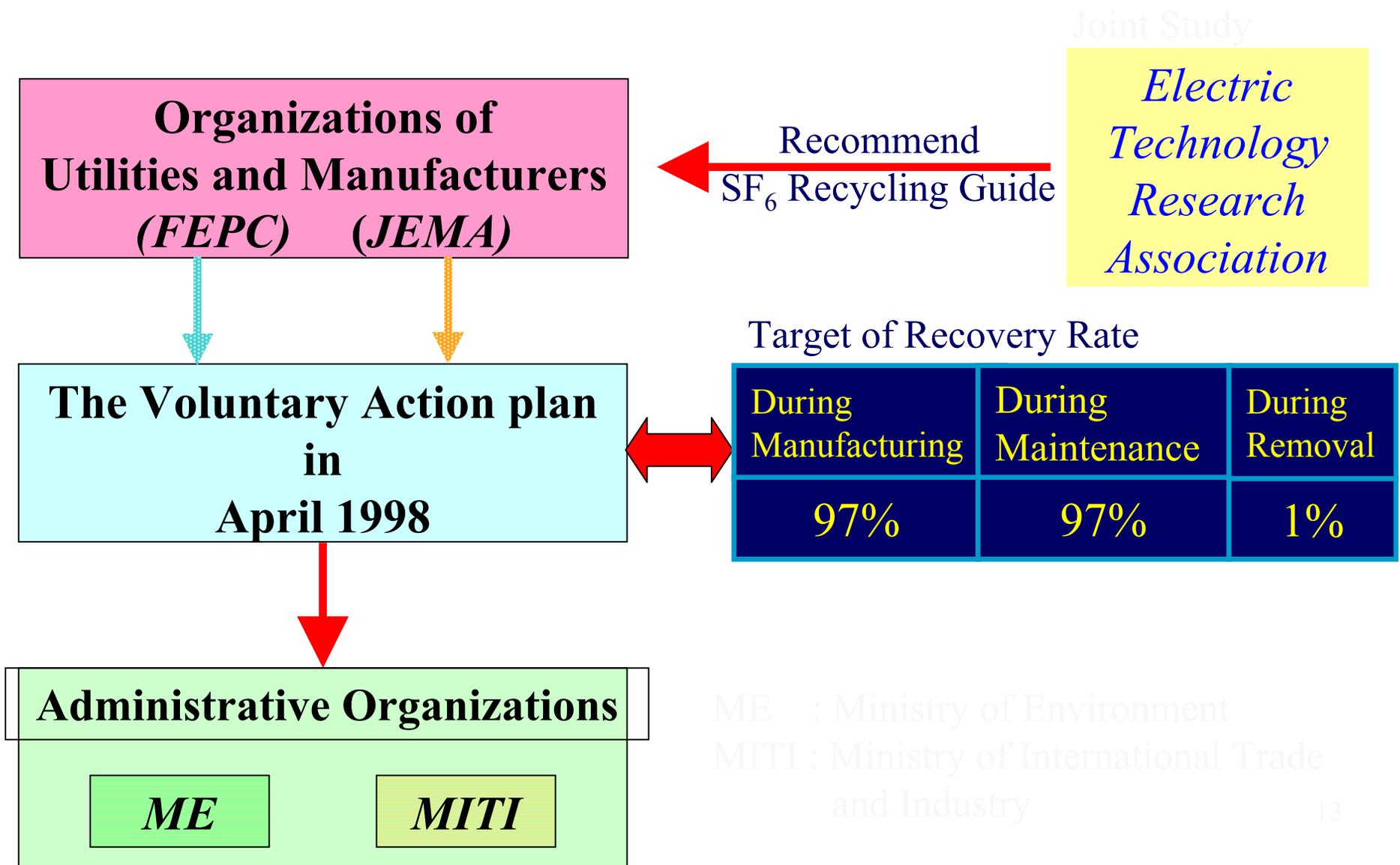


Recycle Standard	
Requirement for Reused SF <sub>6</sub>	
Purity	:97vol%
Humidity	:150volppm
Decomposition Products: Not Detected	

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# Voluntary Action Plan (1998)



# Voluntary Actions by Electric Power Companies

## Target of Recovery Rate

- Usage ( During Maintenance Work )  
1990 – 1995 60% >> by 2000 90%  
by 2005 97%
- Disposal (During Removal Work)  
1990 – 1995 0% >> by 2005 99%

## Voluntary Actions by Equipment Manufacturers

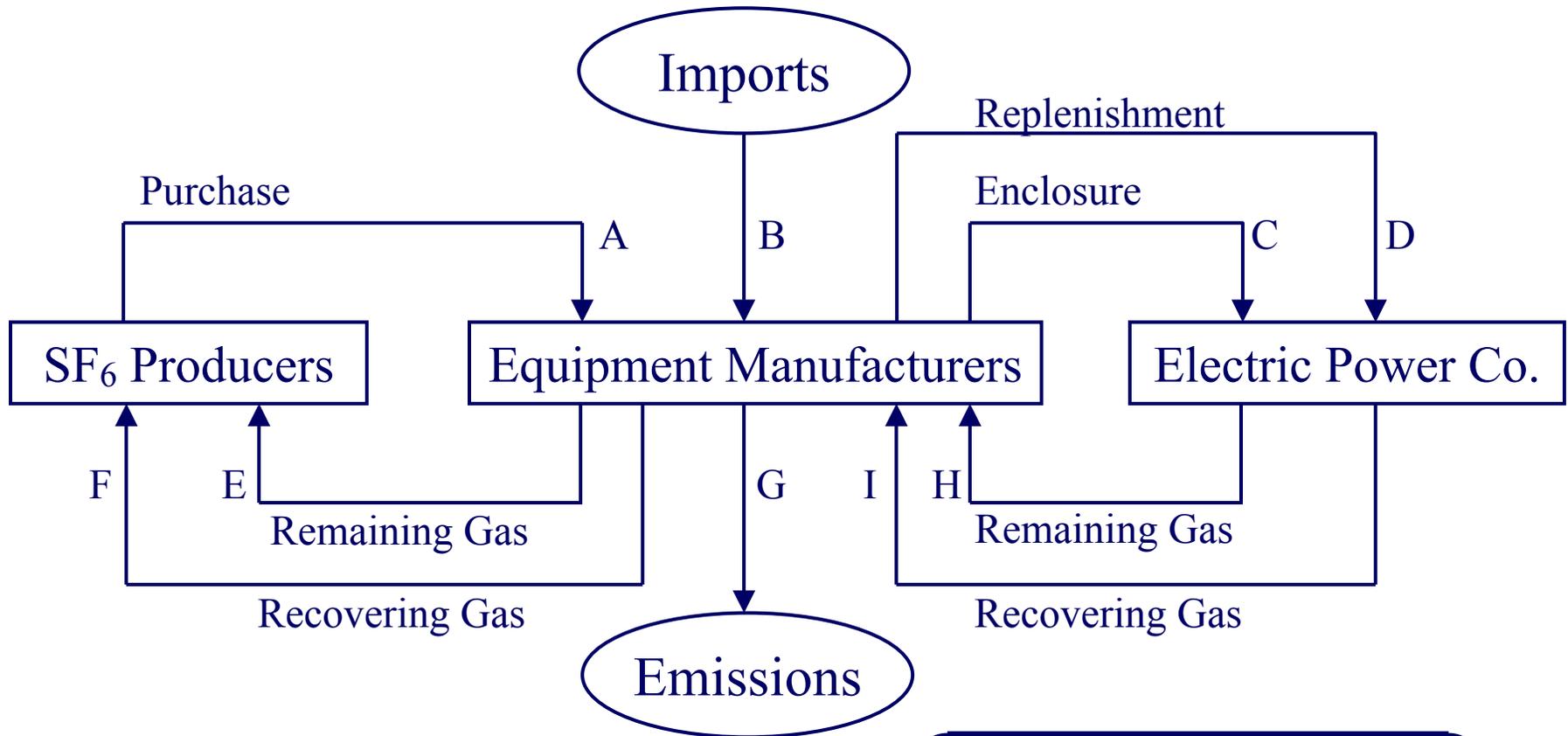
### **Target of Recovery Rate (Manufacturing)**

- 1990 – 1995 70% >> by 2000 85%  
by 2005 97%

### **Target of Gas Recovery & Usage**

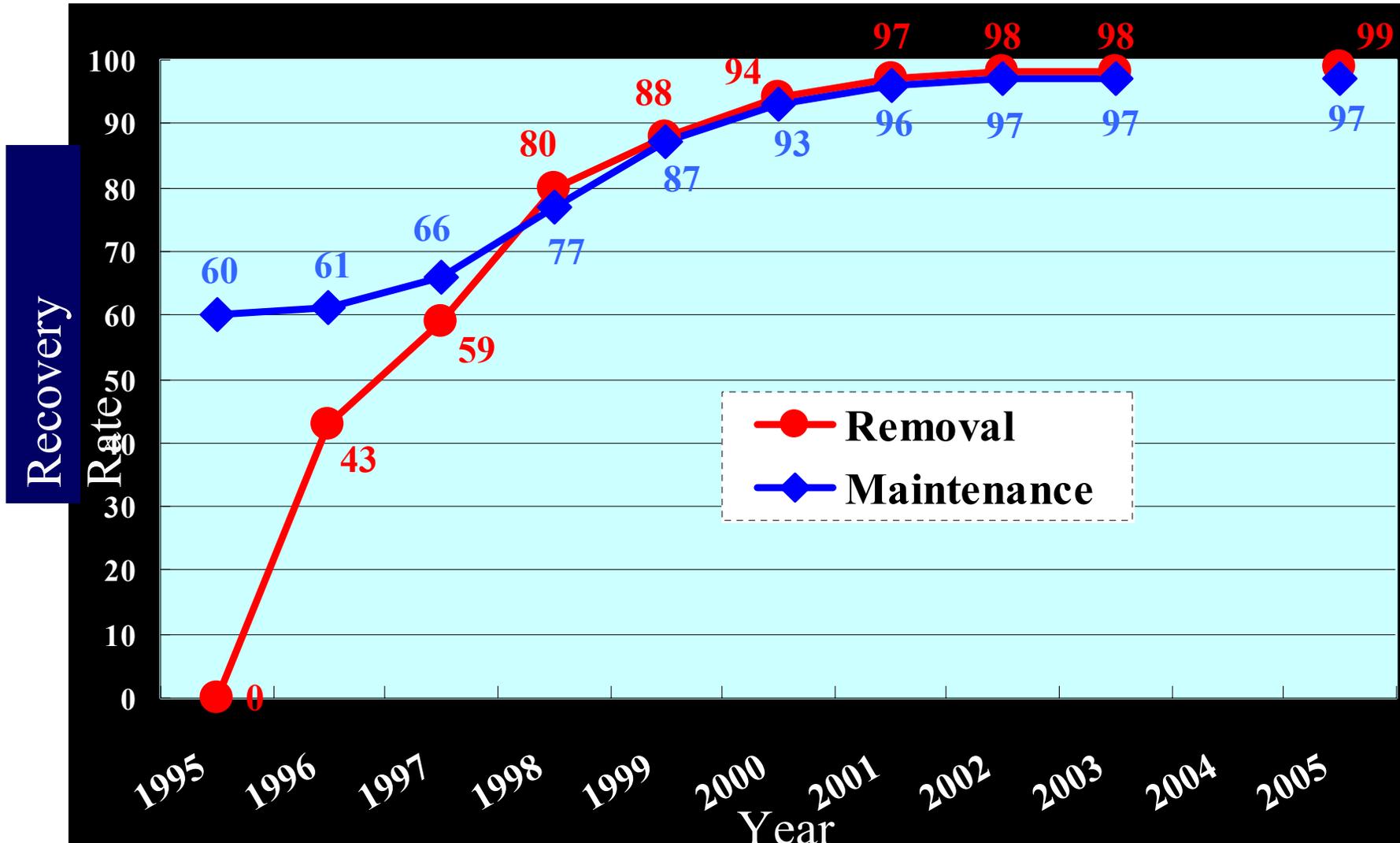
- Development of High Performance Gas Handling Equipment
- Development of Compact Gas-Insulated Equipment With Minimum SF<sub>6</sub> gas

# Voluntary Actions by the Concerned Parties

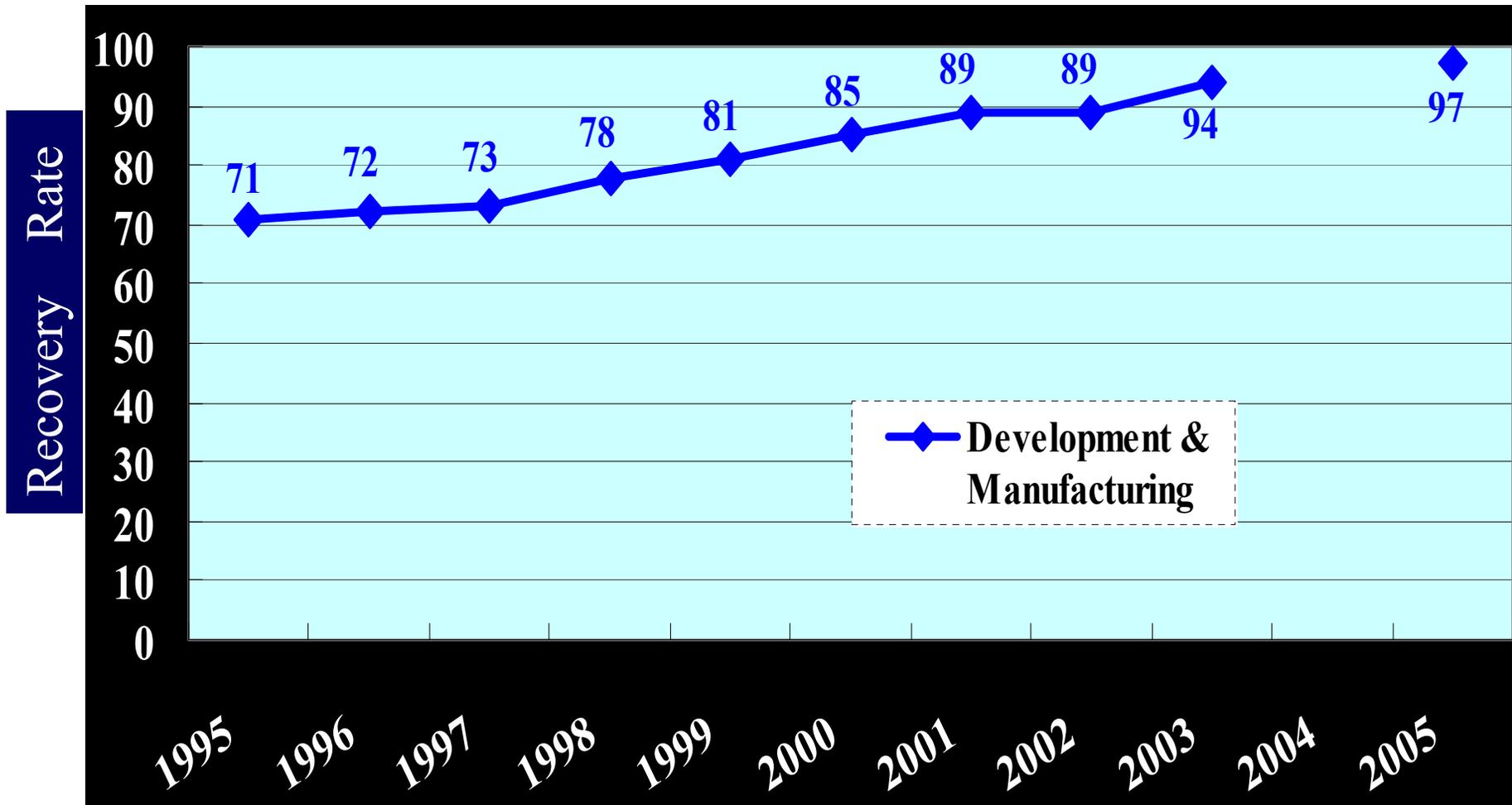


Industries Storing SF<sub>6</sub>  
A~G : Equipment  
Manufacturers  
M, N : Electric Power Co.

# Recovery Rate from Equipment by Electric Power Companies



# Recovery Rate by Equipment Manufacturers

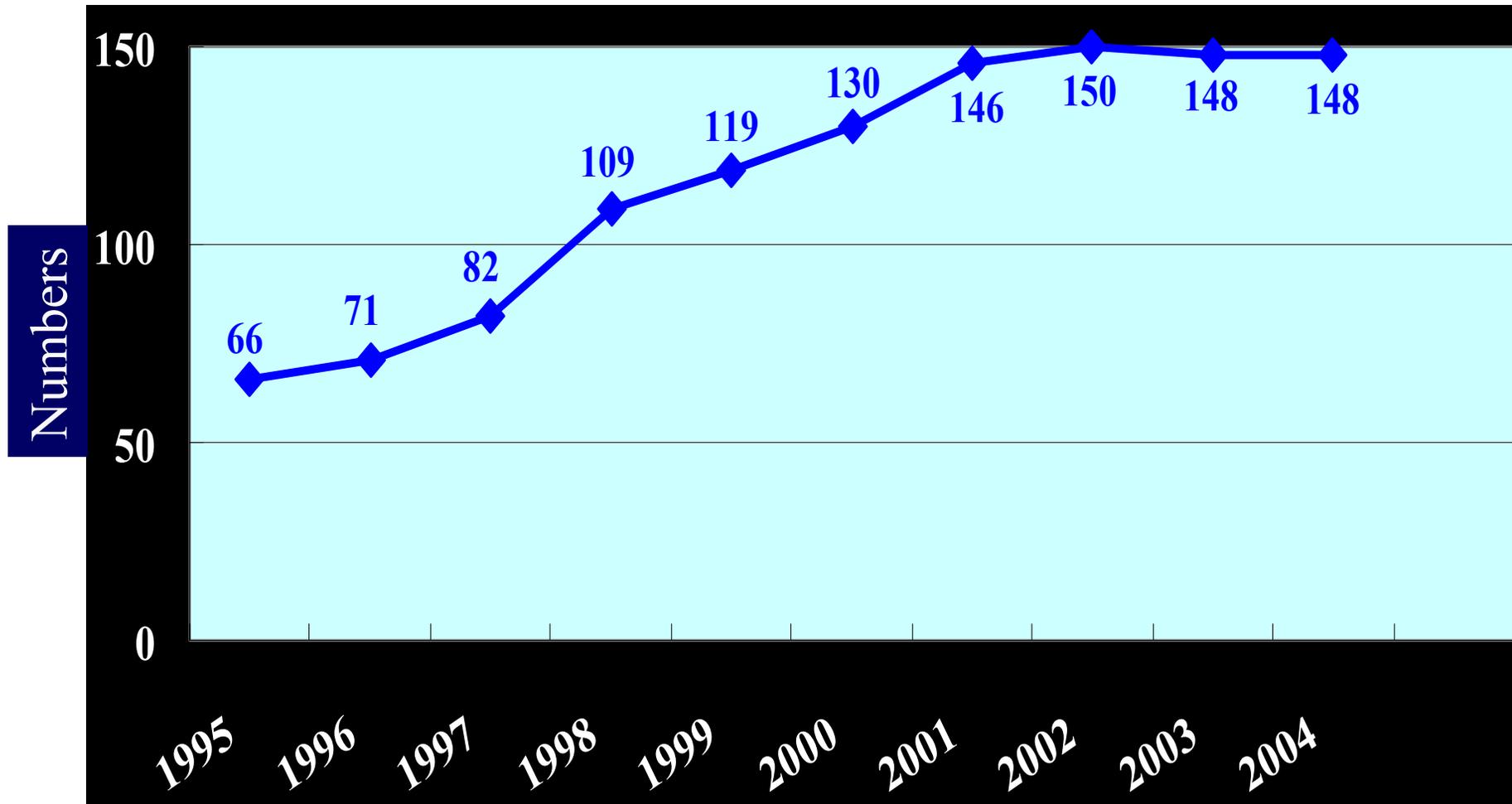


Year

# Contents

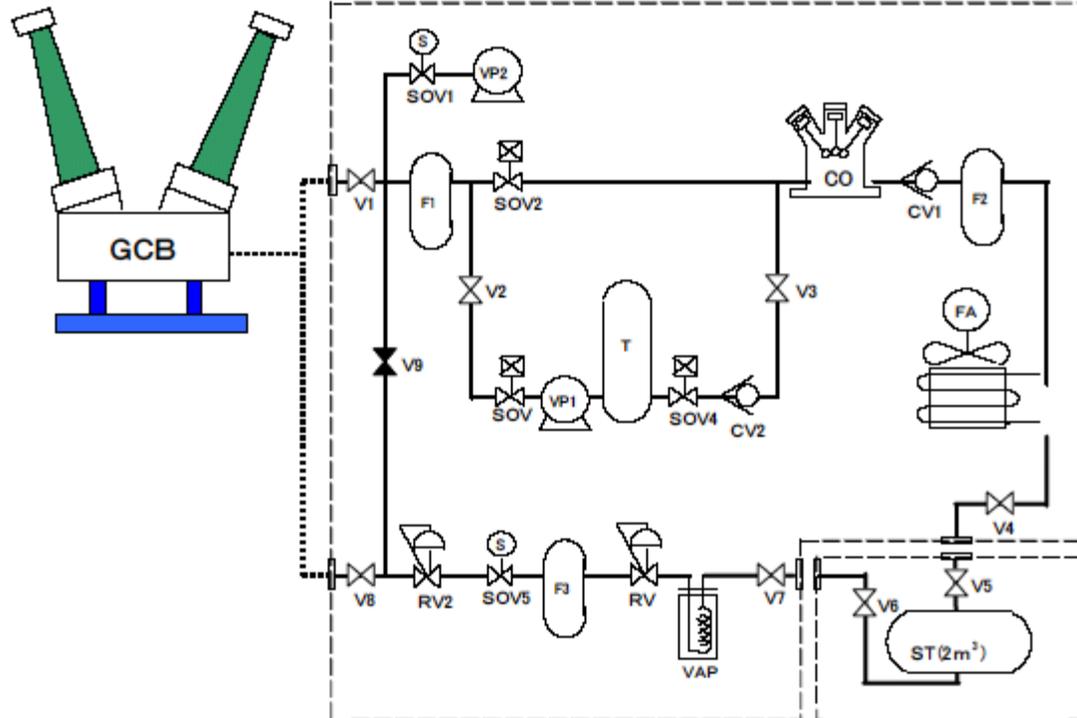
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# Transition of Gas-recovery Equipment



Year

# Standardized Workflow of SF<sub>6</sub> handling



Gas-recovery Equipment



SF<sub>6</sub>ガス 回収-充填手順表

順序	作業内容	回収装置内使用部品名
1	接続ホース回収装置真空引	VP2
2	大気圧までガス回収	F1,CO,CV1,F2,FA,ST
3	0.0013Mpaまでガス回収	F1,VP1,T,CV2,CO,CV1,F2,FA,ST
4	ガス充填	ST,VAP,RV1,F3,RV2

No	記号	部品名	機能
1	CO	回収圧縮器	0.05Mpa～0.7Mpaのガスを4.4Mpaまで圧縮
2	FA	ガス凝縮器	高温ガスを空冷で液体ガスに
3	ST	ストレージタンク	液体ガスの貯蔵保管(MAX2480kg)
4	VAP	ガス蒸発器	液体ガスを高圧気体ガスに(ヒータ10kW)
5	VP1	真空回収ポンプ	0.1Mpa以下のガスを回収(Max1000pa)
6	VP2	排気ポンプ	装置、接続ホースの真空化(1.0pa以下)
7	T	真空排気ヘッダー	真空回収時の1時保管
8	F1	フィルタ	0.9μm フィルタ
9	F2	フィルタ	0.1μm フィルタ
10	F3	フィルタ	0.5μm フィルタ
11	V1	回収弁	ガス回収時 開
12	V2	真空回収弁	大気圧以下のガス回収時 開
13	V3	真空回収弁	大気圧以下のガス回収時 開
14	V4	ガス OUT 弁	液体ガスの出口弁
15	V5	ST IN 弁	ストレージタンクの入口弁
16	V6	ST OUT 弁	ストレージタンクの出口弁
17	V7	ガス IN 弁	液体ガスの入口弁
18	V8	充填弁	ガス充填時 開
19	V9	循環弁	普通は 閉
20	SOV1	排気ST弁	装置、接続ホースの真空化時 自動開 他は閉
21	SOV2	回収ST弁	0.1Mpa以上のガスを回収時 自動開 他は閉
22	SOV3	真空回収ST弁	0.1Mpa以下のガスを回収時 自動開 他は閉
23	SOV4	真空回収ST弁	0.1Mpa以下のガスを回収時 自動開 他は閉
24	SOV5	充填ST弁	ガス充填時 開 他は閉
25	RV1	減圧弁	2.0Mpa以上のガスを0.8Mpaに減圧
26	RV2	減圧弁	0.8Mpaのガスを充填圧力に減圧
27	CV1	逆流防止弁	逆流防止
28	CV2	逆流防止弁	逆流防止

## Improvement of Inventory system

- **Efficient use of SF<sub>6</sub> recovery equipment**
  - Share large-capacity recovery equipment among the electric companies
  - Coordinate the maintenance work schedule
- **Brush up the existing inventory system**
  - Standardized procedure for SF<sub>6</sub> handling
  - Standardized measuring method and equipment
  - Share the common understanding for recycle SF<sub>6</sub> handling

# SF<sub>6</sub> Inventory by Standardized work slip

- Work slip for
  - Initial Filling
  - Handling at maintenance
  - Recovery at Equipment disposal
  - Return to SF<sub>6</sub> producer
  - SF<sub>6</sub> disposal at gas producer
  - Remaining SF<sub>6</sub> in Container

Banking volume at New installation & extention									
Site name					Type of Work	New installation/Extention/Others			
Type of Unit	Unit/Equip. No.	Typeform		Rated gas pressure	Filling volume (kg)				
					CB[A]	CH[B]	Others [C]	tot	
1									

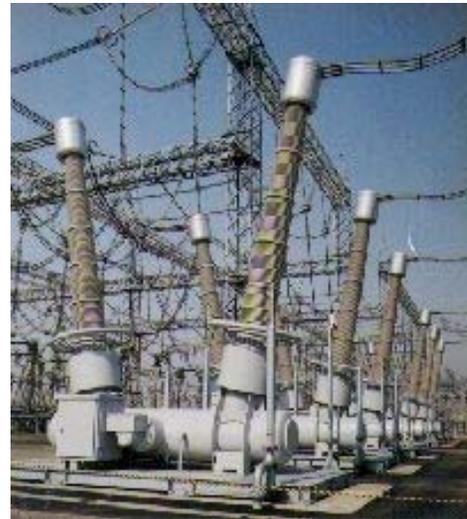
SF6 Handling Volume			
Handling Date:			
Substation/Place			Type of Work
Date of Work			Unit No.
Design SF6 volume (kg)			Rated gas pressure (Mpa. Gage)
Volume of gas compartment (m3)			
Gas pressure before work (Mpa gage)			(Mpa at 20 deg.C)
Recovery terminal pressure (Mpa abs.)			(Mpa at 20 deg.C)

Returned volume to Gas Manufacturer							
Handling Date:							
Name of Company (Returner)							
Date when SF6 was recovered							
Recovered at (e.g. name of SS)							
Identification Number of container (Bottle)							
Quantity							
Remaining SF6 volume (kg)							
Classification of returned SF6				Conform to Criteria / Non-conform to Criteria			
	Measuring Instrument	Type form	Reg. No.	Measuring Values	Date	Ambient Temp.(degC)	R/Humidity (%)
Purity				(Vol%)			
Water Contents				(Volppm)			
Dissolved gas (HF)				(Volppm)			

# Compact Gas-Insulated Equipment (550kV Circuit Breaker )



**550kV GCB**  
**4 break**  
**SF<sub>6</sub> / phase:**  
**1900kg**

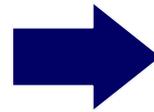


**2 break**  
**1000kg**



**1 break**  
**850kg**

# SF<sub>6</sub> Recycling (240kV Hybrid GIS)



**Existing GIS**

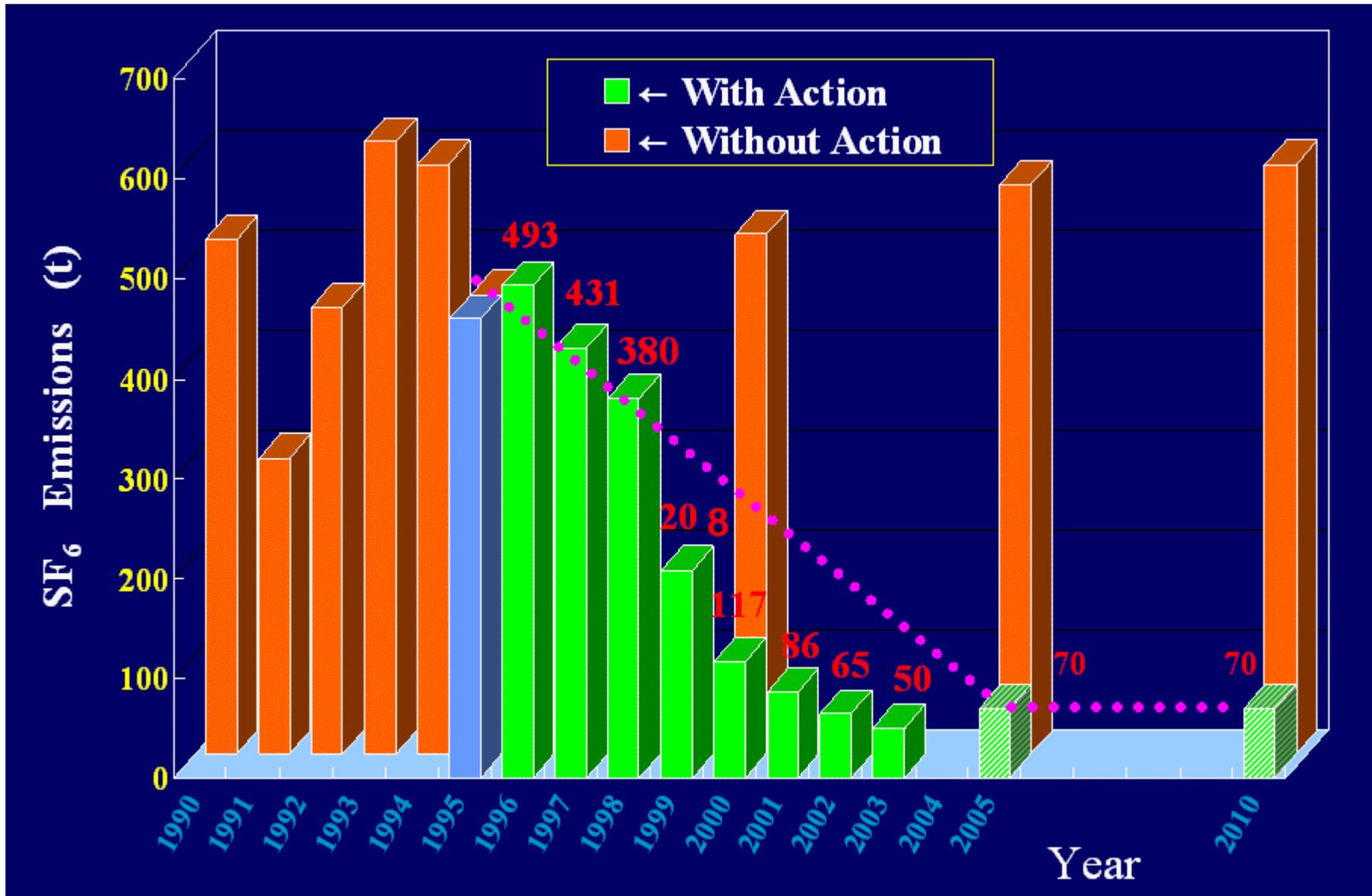
**Re-formed GIS**

**All remaining SF<sub>6</sub> gas was re-used.  
New SF<sub>6</sub> gas was added for replenishment.**

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# Estimation of SF<sub>6</sub> Emission from Electric Power Industry



**Thank you for your attention**