

**SF<sub>6</sub> Emission Reduction  
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> Emission**

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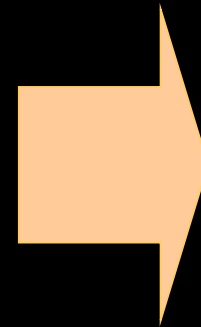
# Joint Study on SF<sub>6</sub>

**Academy  
(Universities in Japan)**

**Electric Power  
Companies**

**Electric Equipment  
Manufacturers**

**Gas Producer**



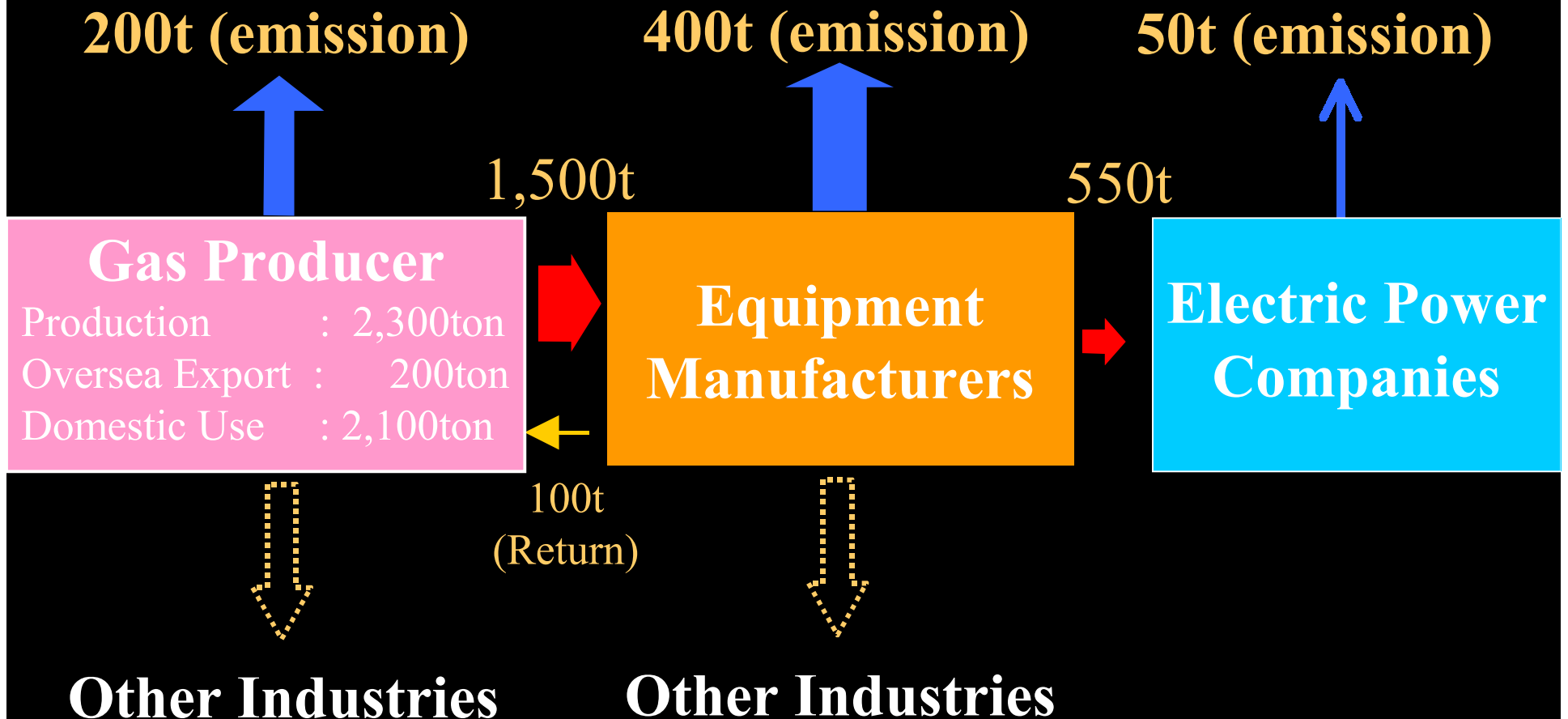
*Electric  
Technology  
Research  
Association*

**Chairman: Prof.  
Takuma (Kyoto Univ.)  
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 Emission within Electric Industry
- **Investigation on site**
  - Gas Leakage Rate
  - Gas Purity & Humidity
  - Decomposition Product
- **Requirement for Reused SF<sub>6</sub>**

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

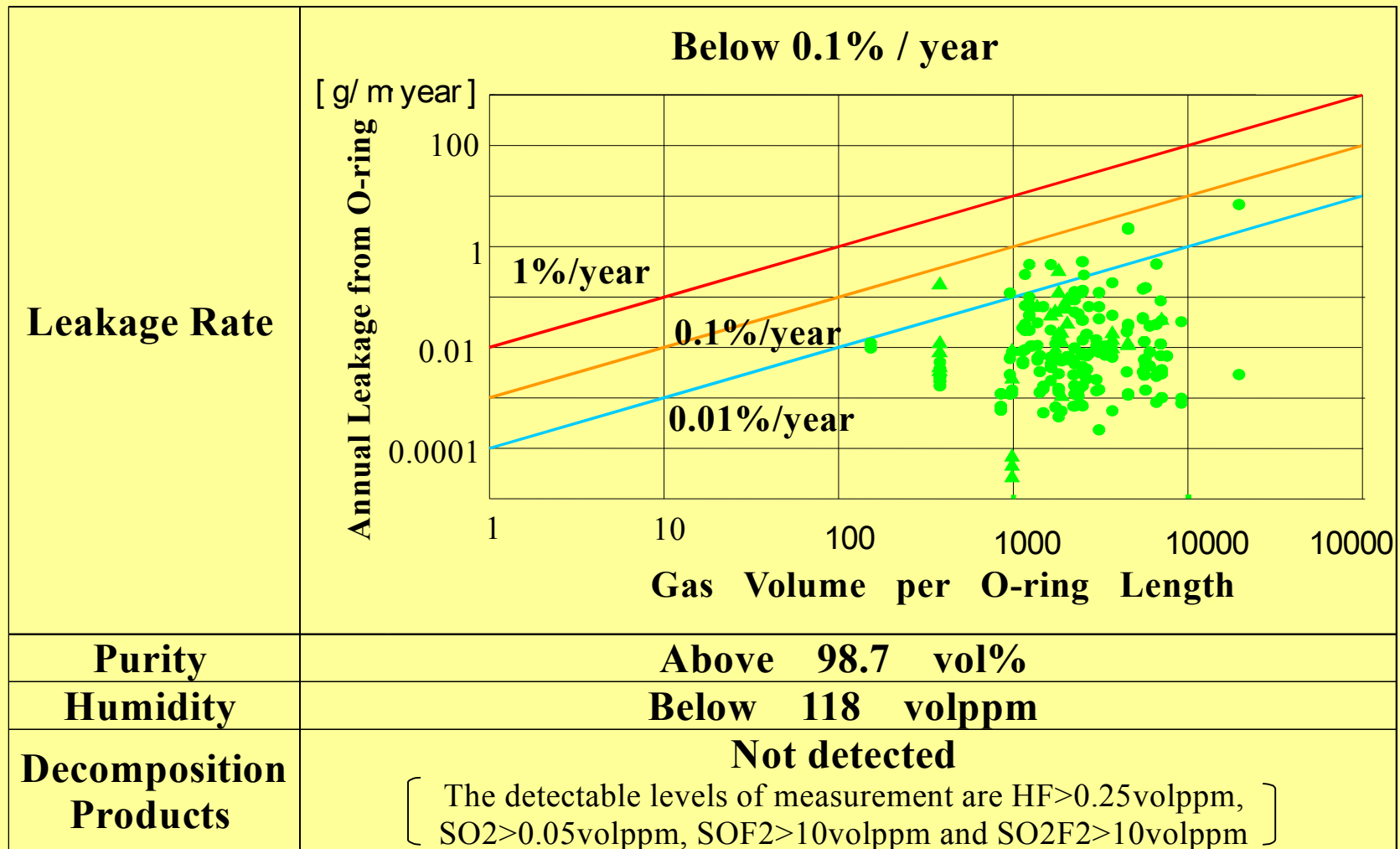


# Actual Emissions at Electric Power Companies<sub>(up to 1995)</sub>

	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)



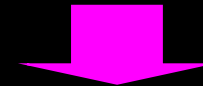


# Recovery Targets

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

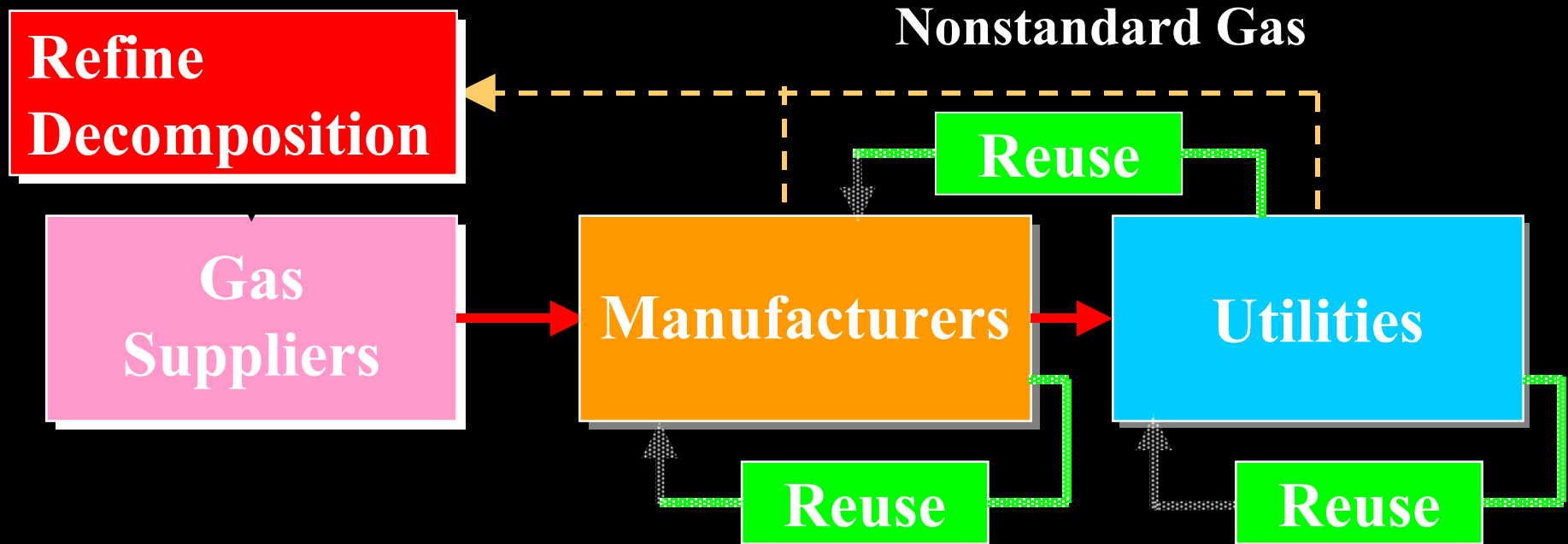
# Quality criteria for Recycle SF<sub>6</sub>

		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

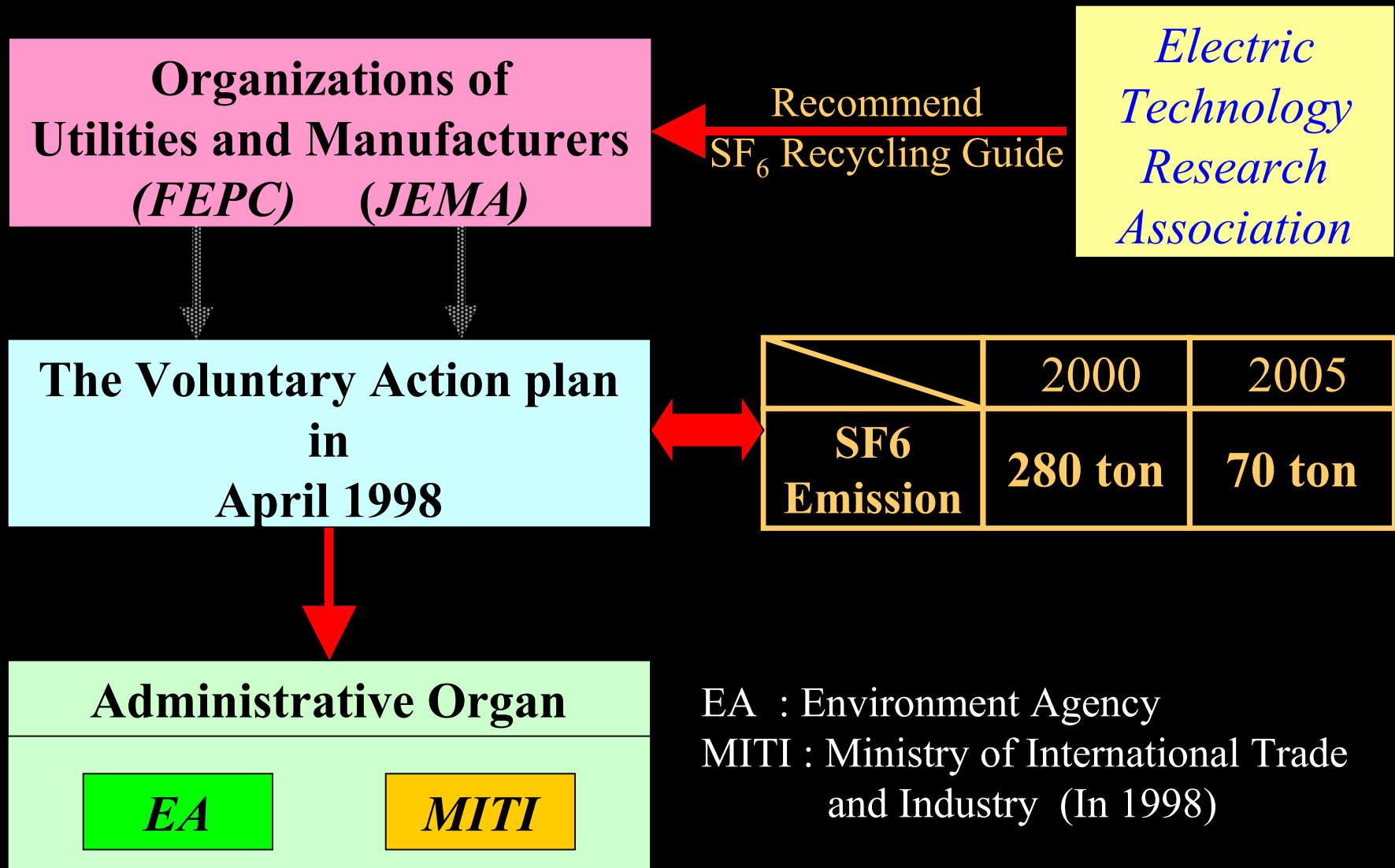


Recycle Standard	
Requirement for Reused SF <sub>6</sub>	SF <sub>6</sub> Recovery Ratio in Internal Inspection
<b>Purity</b>	<b>:97vol%</b>
<b>Humidity</b>	<b>:150volppm</b>
<b>Decomposition Products: Not Detected</b>	<b>90% in 2000</b> <b>97% in 2005</b>

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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 Emission

- 1990 – 1995 400ton >> by 2000 240ton  
by 2005 30ton

## Target for Gas Recovery & Usage

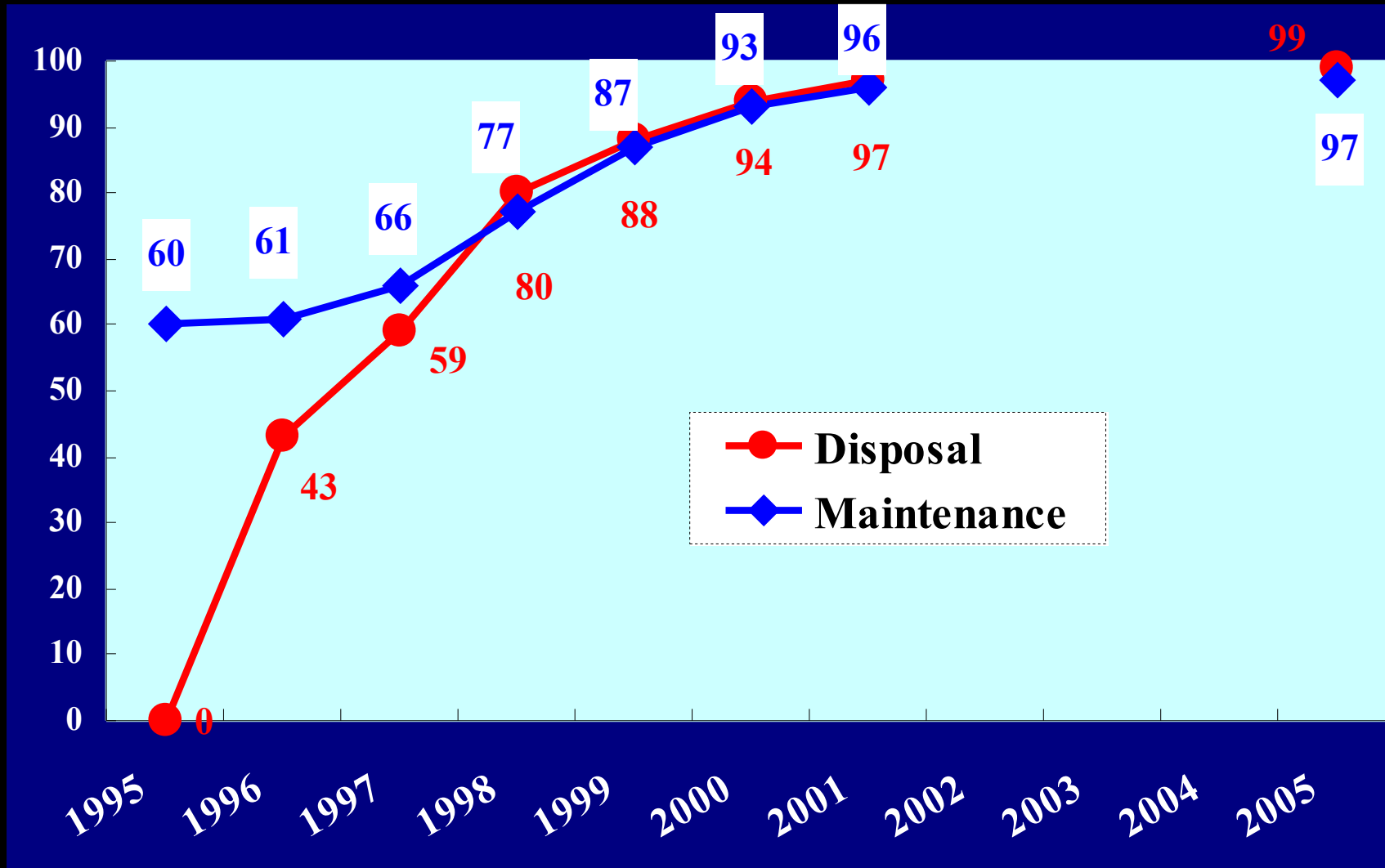
- Development of High Performance Gas Handling Equipment
- Development of Compact Gas Insulated Equipment With Minimum SF<sub>6</sub> gas

# **Voluntary Actions by the Concerned Parties**

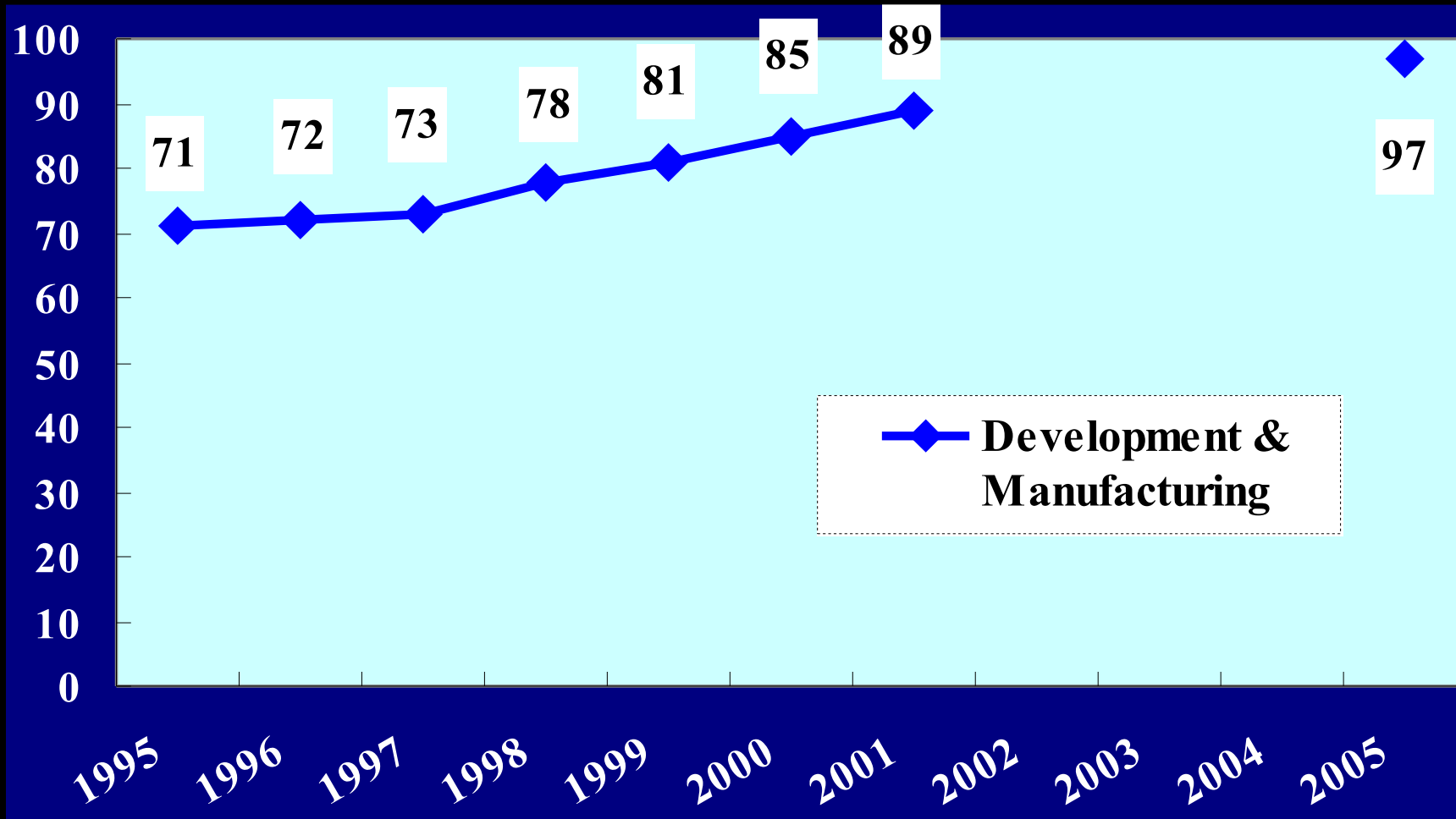
- **Improvement of Inventory System**
  - Record of SF<sub>6</sub> Gas Amount at Every Job
  - Annual Report to Government relating to Progress of SF<sub>6</sub> Gas Recovery
- **Promotion of Gas Recovery**



# Recovery Rate from Equipment by Electric Power Companies



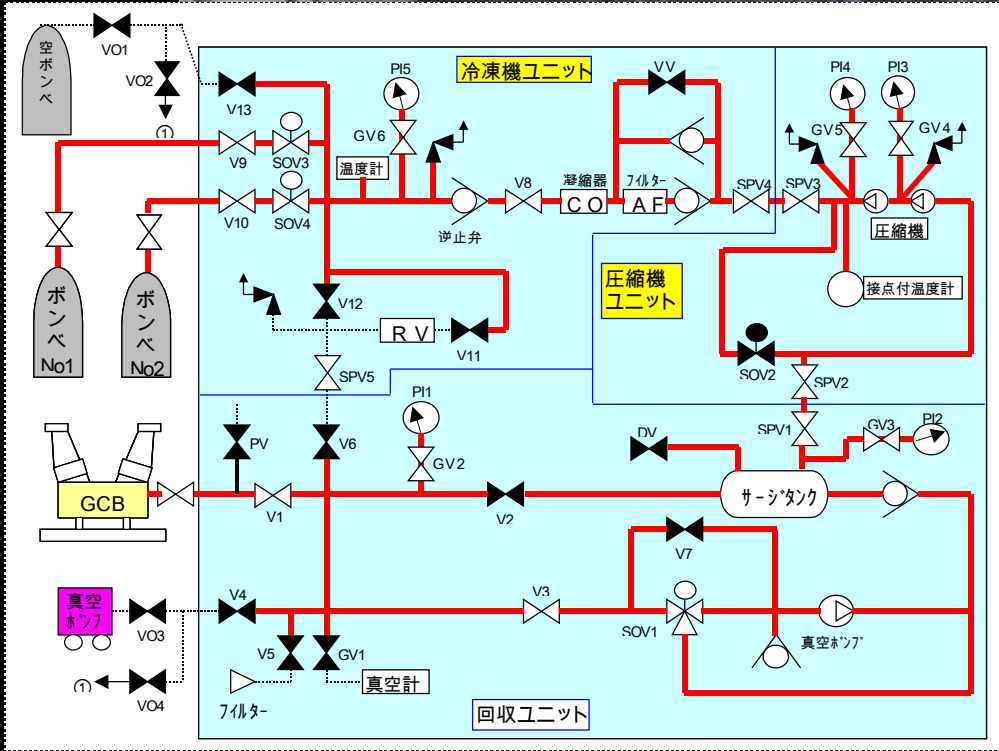
# SF<sub>6</sub> Recovery Rate by Equipment Manufacturers



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



**SF6回収一歩手順書 (No7)**  
ガス充填運転

順序	設備名	状態	操作機器名	操作内容	確認	備考
1	蒸発器予熱	完了				
2	真空1-外V13バルブ	開				
3	真空1-外V14バルブ	開				
4	真空1-外V12バルブ	開				
5	真空1-外V11バルブ	開				
6	真空1-外V10バルブ	開				
7	真空1-外V9バルブ	開				
8	真空1-外V8バルブ	開				
9	真空1-外V7バルブ	開				
10	真空1-外V6バルブ	開				
11	真空1-外V5バルブ	開				
12	真空1-外V4バルブ	開				
13	真空1-外V3バルブ	開				
14	真空1-外V2バルブ	開				
15	圧縮1-外V16バルブ	開				
16	真空1-外V15バルブ	開				
17	真空1-外V14バルブ	開				
18	真空1-外V13バルブ	開				
19	真空1-外V12バルブ	開				
20	真空1-外V11バルブ	開				
21	真空1-外V10バルブ	開				
22	真空1-外V9バルブ	開				
23	真空1-外V8バルブ	開				
24	真空1-外V7バルブ	開				
25	真空1-外V6バルブ	開				
26	真空1-外V5バルブ	開				
27	真空1-外V4バルブ	開				
28	真空1-外V3バルブ	開				
29	真空1-外V2バルブ	開				
30	真空1-外V1バルブ	開				
31	真空1-外V1バルブ	開				
32	真空1-外V2バルブ	開				
33	真空1-外V3バルブ	開				
34	真空1-外V4バルブ	開				
35	真空1-外V5バルブ	開				
36	真空1-外V6バルブ	開				
37	真空1-外V7バルブ	開				
38	真空1-外V8バルブ	開				
39	真空1-外V9バルブ	開				
40	真空1-外V10バルブ	開				
41	真空1-外V11バルブ	開				
42	真空1-外V12バルブ	開				
43	真空1-外V13バルブ	開				
44	真空1-外V14バルブ	開				
45	真空1-外V15バルブ	開				
46	真空1-外V16バルブ	開				
47	真空1-外V17バルブ	開				
48	真空1-外V18バルブ	開				
49	真空1-外V19バルブ	開				
50	真空1-外V20バルブ	開				
51	真空1-外V21バルブ	開				
52	真空1-外V22バルブ	開				
53	真空1-外V23バルブ	開				

**SF6回収一歩手順書 (No4)**  
ガス回収運転

順序	設備名	状態	操作機器名	操作内容	確認	備考
1	ホース	真空引き完了				
2	回収装置	真空引き完了				
3	真空1-外V4バルブ	開				
4	真空1-外V5バルブ	開				
5	真空1-外V15バルブ	開				
6	真空1-外V21バルブ	開				
7	圧縮1-外V16バルブ	開				
8	真空1-外V10バルブ	開				
9	真空1-外V14バルブ	開				
10	真空1-外V13バルブ	開				
11	真空1-外V11バルブ	開				
12	真空1-外V2バルブ	開				
13	真空1-外V3バルブ	開				
14	真空1-外V6バルブ	開				
15	圧縮1-外V7バルブ	開				
16	圧縮1-外V8バルブ	開				
17	真空1-外V9バルブ	開				
18	真空1-外V19バルブ	開				
19	真空1-外V20バルブ	開				
20	真空1-外回収運転, SW	点灯				
21	圧縮1-外 圧縮機C	運転				
22	圧縮1-外 電動77/FA1	運転				
23	圧縮1-外 電動77/FA2	運転				
24	真空1-外電機1-1	開				
25	真空1-外電機2-1	開				
26	真空1-外圧力計PS1	動作				
27	真空1-外真空ポンプVP	動作				
28	真空1-外電機1-1	開				
29	真空1-外電機2-1	開				
30	真空1-外電機1-2	動作				
31	真空1-外電機計VS	20Torr以下				
32	真空1-外電機1-1	動作				
33	真空回収上乗せ時間経過					
34	真空1-外電機1-1	開				
35	10秒後					
36	圧縮1-外 圧縮機C	自動停止				
37	圧縮1-外 電動77/FA1	自動停止				
38	圧縮1-外 電動77/FA2	自動停止				
39	真空1-外真空ポンプVP	自動停止				
40	真空1-外電機1-1	開				
41	真空1-外電機2-1	開				
42	真空1-外電機1-2	動作				
43	真空1-外電機計VS	2分後				
44	真空1-外電機1-1	開				
45	真空1-外回収運転, SW	消灯				
46	真空1-外V1バルブ	開				
47	真空1-外V2バルブ	開				
48	真空1-外V3バルブ	開				
49	真空1-外V6バルブ	開				
50	真空1-外V7バルブ	開				
51	真空1-外V8バルブ	開				
52	真空1-外V9バルブ	開				
53	真空1-外V10バルブ	開				

(注意事項) 回収運転時 ストートタンク内のSF6流量が90%以上で回収完了と同様に自動停止します。



# 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

# SF6 Inventory by Standardized work slip

- Work slip for
  - Initial Filling
  - Handling at maintenance
  - Recovery at Equipment disposal
  - Return to SF6 producer
  - SF6 disposal at gas producer
  - Remaining SF6 in Container

Banking volume at New installation & extension

Handling Date:

Site name				Type of Work	New installation/Extension/Others			
No.	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	Type of Equipment	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

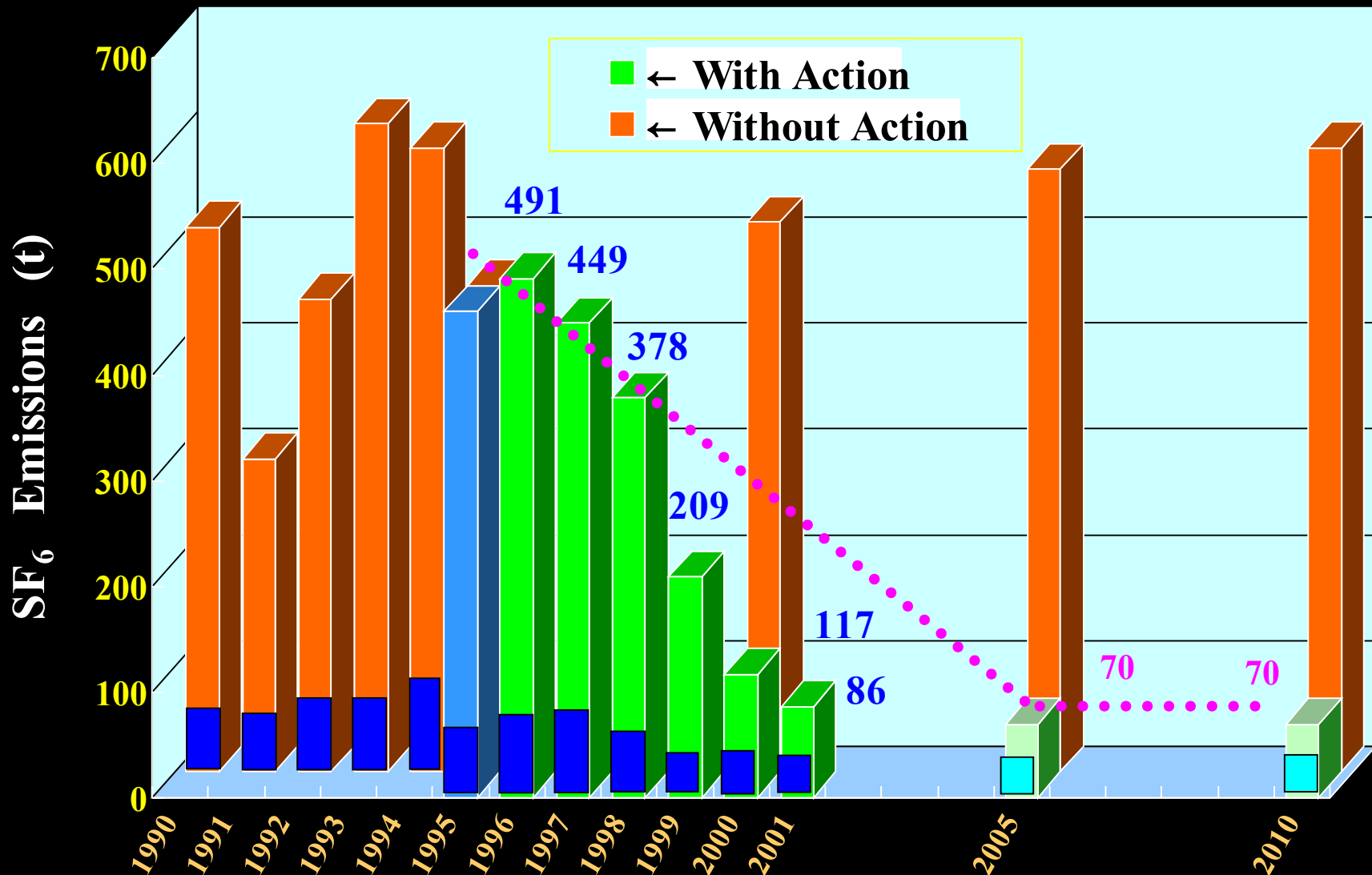
Handling Date:

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)			

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





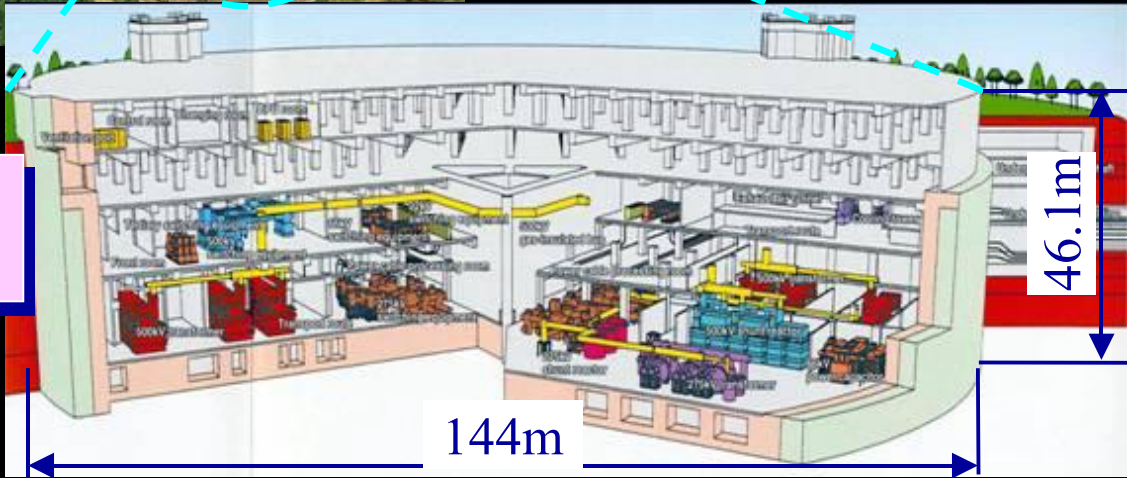
# Less Impact by Gas insulated technology



**500kV/275kV Conventional Substation**

$$\frac{16,286.02\text{m}^2}{116,125.37\text{m}^2} \doteq \frac{1}{7}$$

**500kV/275kV Underground Substation**



*Thanking you for your attention*