SF6 Emission Mitigation Strategies & High Voltage Electrical Equipment

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International Symposium on Near-Term Solutions for Climate Change Mitigation in California

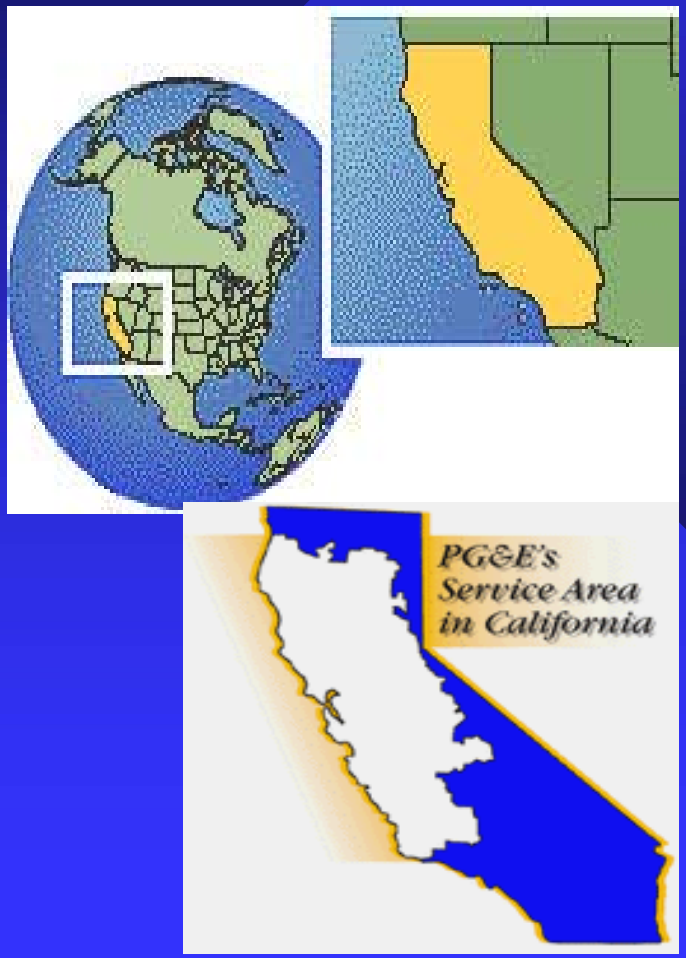
6 March 2007
Sacramento, CA

Pacific Gas and Electric Company

Agenda:

1. PG&E & the Environment;
2. SF6 & Utilities, EPA & the MOU;
3. EPA's SF6 Memorandum of Understanding;
4. EPA's Annual Emission Estimate Procedure;
5. Emission Reduction Techniques;
6. Results.

1. PG&E & the Environment:

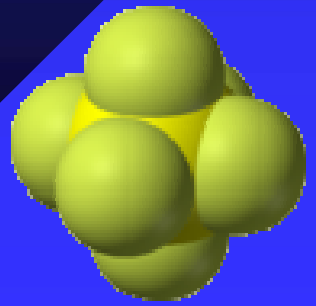


PG&E Corporation is committed to being an environmental leader by providing safe, economical, and reliable products and services in a responsible and environmentally sensitive manner.

Pacific Gas and Electric Company

2. SF6 & Utilities, EPA & the MOU

- **SF6 is used extensively in high voltage electrical equipment (1500-2 0lb/ circuit breaker).**
- **SF6 has a GHG potency ~22,200 (23,900 for reporting purposes) times that of CO2, atmospheric lifetime ~3,400 years.**
- **Voluntary Memorandum of Understanding (MOU) between EPA & Individual Utilities to reduce SF6 emissions.**



3. EPA's MOU SF6 - What's Required by the Utility?

- Establish & implement SF6 handling policies & procedures;
- Establish Emission Reduction Goals;
- Complete Annual Inventory & Emission Estimate.

What is not Measured cannot be Managed

CA Utilities in the MOU

- Pacific Gas & Electric Co.
- Edison International
- City of Palo Alto
- Kings River Conservation District
- Silicon Valley Power

4. EPA's Annual Emission Estimate Procedure under the MOU

- Complete on EPA Provided Form/ Spreadsheet;
- Based on a system-wide, mass-balance approach;
- Can be confusing….

Step 1: Cylinder Inventory

A. Cylinder Inventory Change:

SF6 in Inventory Jan 06, pounds
- SF6 in Inventory Jan 07, pounds

(Only SF6 in cylinders, tanks etc.– not equipment & positive if inventory decreases over year)

Step 2: Inputs

A. Cylinder Inventory Change:

SF6 in Inventory Jan 06
- SF6 in Inventory Jan 06

B. Purchases & Acquisitions, pounds (Inputs):

+Purchases from producers or distributors
+SF6 provided with/in new equipment
+SF6 returned after off-site recycling

Step 3: Outputs

B. Purchases & Acquisitions (Inputs):
+Purchases from Producers or distributors
+SF6 provided with/in new equipment
+SF6 returned after off-site recycling

A. Cylinder Inventory Change:
SF6 in Inventory Jan 06
- SF6 in Inventory Jan 06

C. Sales/ Disbursements, pounds (Outputs):
+Sales, including gas remaining in sold equipment
+SF6 returned to supplier
+SF6 sent for destruction
+SF6 sent for off-site recycling

Step 3: Equipment Turnover

B. Purchases & Acquisitions (Inputs):
+Purchases from Producers or distributors
+SF6 provided with/in new equipment
+SF6 returned after off-site recycling

A. Cylinder Inventory Change:
SF6 in Inventory Jan 06
- SF6 in Inventory Jan 06

C. Sales/ Disbursements (Outputs):
+Sales, including gas remaining in sold equipment
+SF6 returned to supplier
+SF6 sent for destruction
+SF6 sent for off-site recycling

D. Nameplate Capacity Changes (Outputs):
Operational Capacity of New Equipment
- Operational Capacity of Retired/Sold Equipment

Step 4: Annual Emission Rate:

+ A. Cylinder Inventory Change
+ B. Purchases & Acquisitions (Inputs)
- C. Sales/ Disbursements (Outputs)
- D. Nameplate Capacity Changes (Outputs)
= Annual SF6 Emission Rate, lb/year

Step 5: Annual Leak Rate % Calculation:

Annual SF6 Emission Rate*100/
Year End Nameplate Capacity

5. SF6 Reduction Techniques

Company-Wide Program with:

Upper Management Support & Champion

Cross Functional SF6 Reduction Team:

- Electric Transmission
- Environmental Services
- Purchasing

Accomplishments happen through Relationships

SF6 Tracking Systems Implemented:

- Cylinder Annual Inventory (how much & where);
- SF6 Purchases & Returns (new, recycled & destroyed);
- SF6 Equipment Inventory + Purchases & Retirement.

Team Challenges:

- Multiple SF6 Vendors serving 24 Maintenance Headquarters
- New & Scrapped Breaker inventories
- Old & Leaking Breakers
- Attitude

Retirement/Replacement Program

Leaking breakers installed pre 1985, all essentially replaced

Post-1985 leakers repaired or replaced

Program justified by:

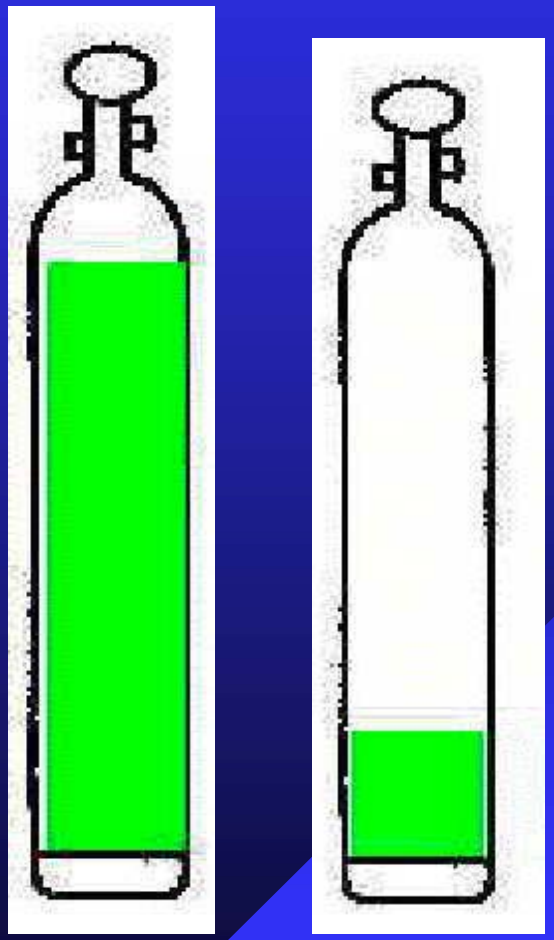
- Breaker Reliability Concerns
- Reduced Maintenance Costs
- SF6 EPA MOU

Standardize & Simplify

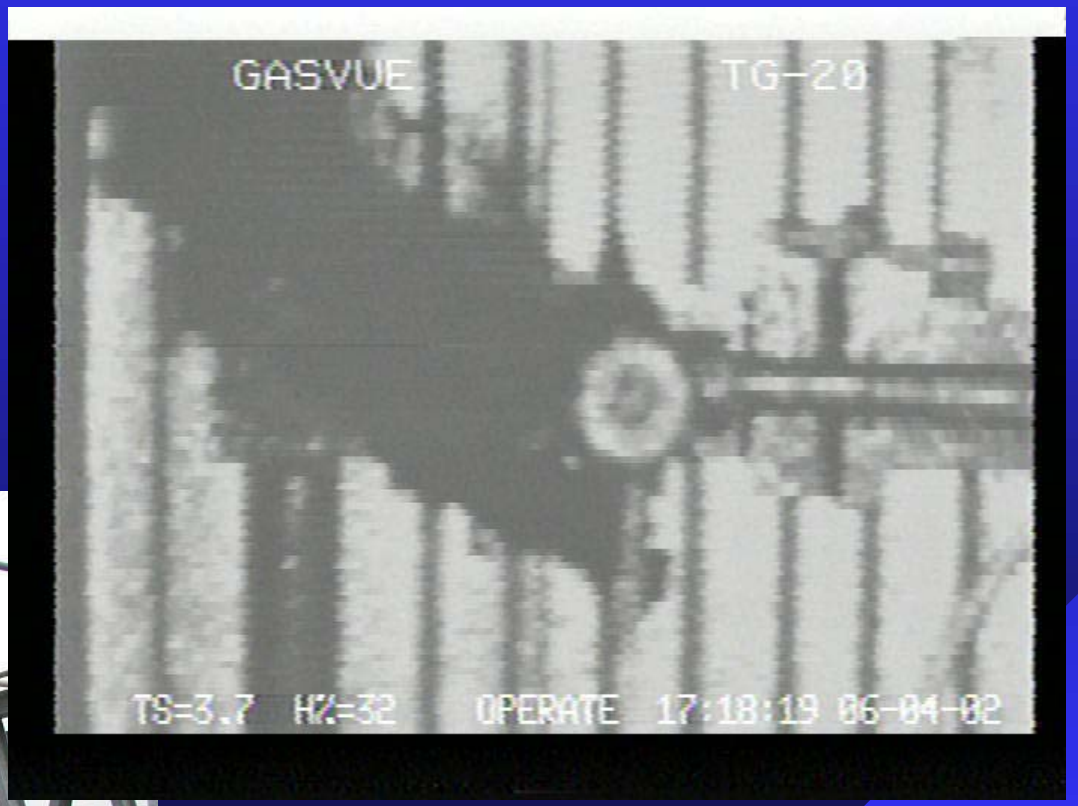
- Equipment Suppliers provide “empty” breakers & extended warrantees
- Recover Gas on Breaker Retirement
- Educate Operations
- Cleaned up cylinder farms
- 1 Full Service SF6 Vendor

One SF6 Vendor:

- Provides all SF6
- Removes, Recycles & Returns SF6 Gas
- Cylinder heel buy-back program
- Subcontracts Leak Detection Program



Leak Detection & Laser Imaging



Leak Detection & X-Ray Imaging

Gas Carts/ Buggies:

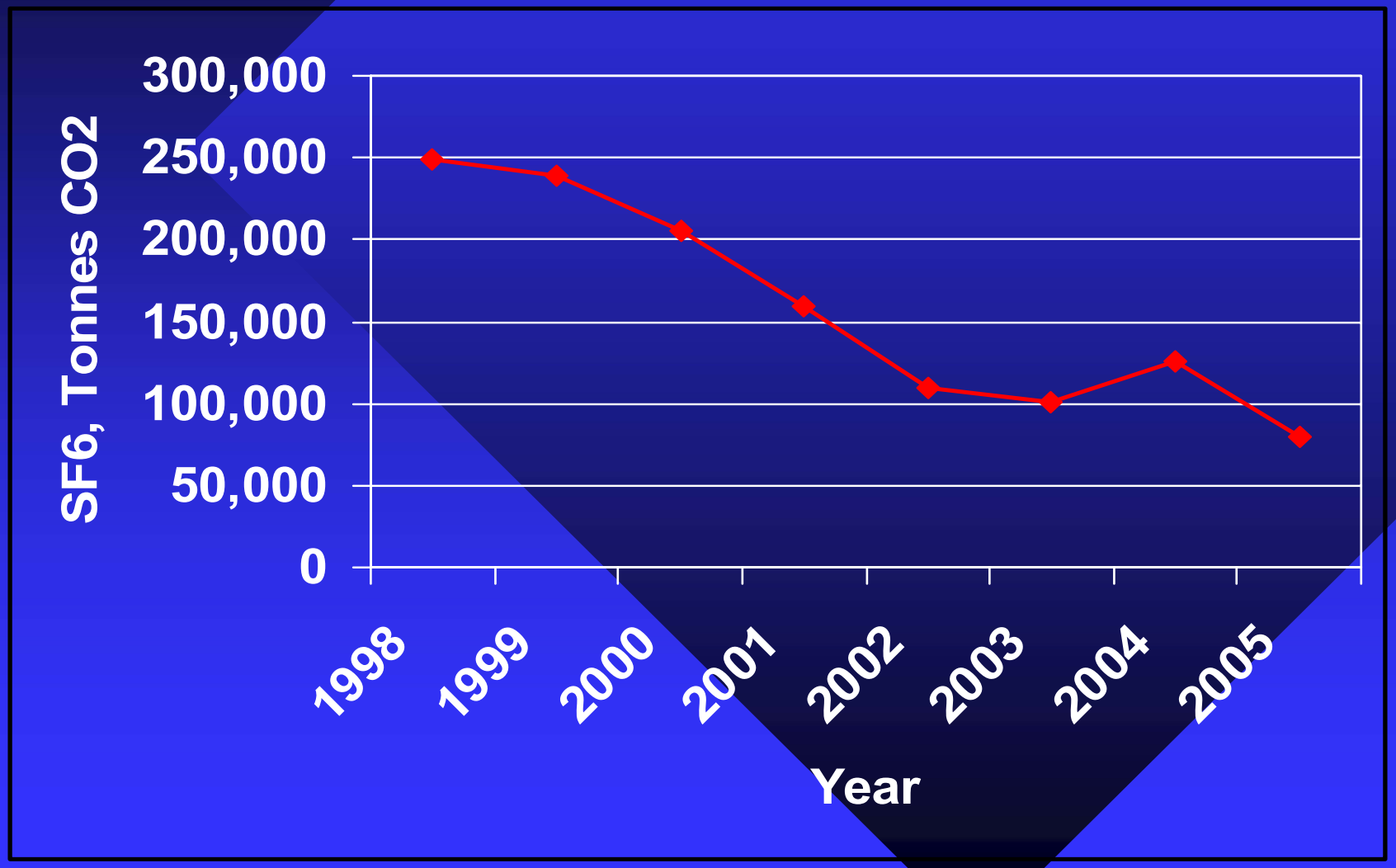
Older Buggies were:

- Not really designed to remove gas from breakers
- Sources of SF6 leaks

6. PG&E Results

Year	Retire, Per Year	Total Retired	System Capacity	New, per year	Total New	Tonnes CO2/yr
1997			174,500			
1998			190,266	15,766	15,766	249,297
1999			197,966	7,700	23,466	238,499
2000	1,800	1,800	210,894	14,728	38,194	205,312
2001	14,120	15,920	225,097	28,323	66,517	159,545
2002	10,886	26,806	260,257	46,046	112,563	109,051
2003	9,700	36,506	253,333	20,970	133,533	101,128
2004	16,430	52,936	273,072	36,169	169,702	125,212
2005	17,690	70,626	279,974	24,592	194,294	80,165

PG&E Annual Emission Rate



Questions?

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