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
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.
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.
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 warranties
- 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

<table>
<thead>
<tr>
<th>Year</th>
<th>Retire, Per Year</th>
<th>Total Retired</th>
<th>System Capacity</th>
<th>New, per year</th>
<th>Total New</th>
<th>Tonnes CO2/yr</th>
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<td></td>
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<td>174,500</td>
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<td>1999</td>
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PG&E Annual Emission Rate

SF6 & CO2 Year

Year

1998 1999 2000 2001 2002 2003 2004 2005

0 50,000 100,000 150,000 200,000 250,000 300,000
Questions?

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