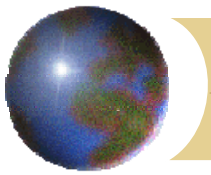


International Conference on SF₆ and the Environment: Electric Power Systems - Partnership Update

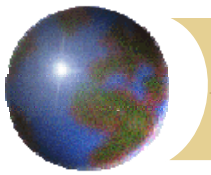
Jerome Blackman, Program Manager
SF₆ Emissions Reduction Partnership
November 28, 2006



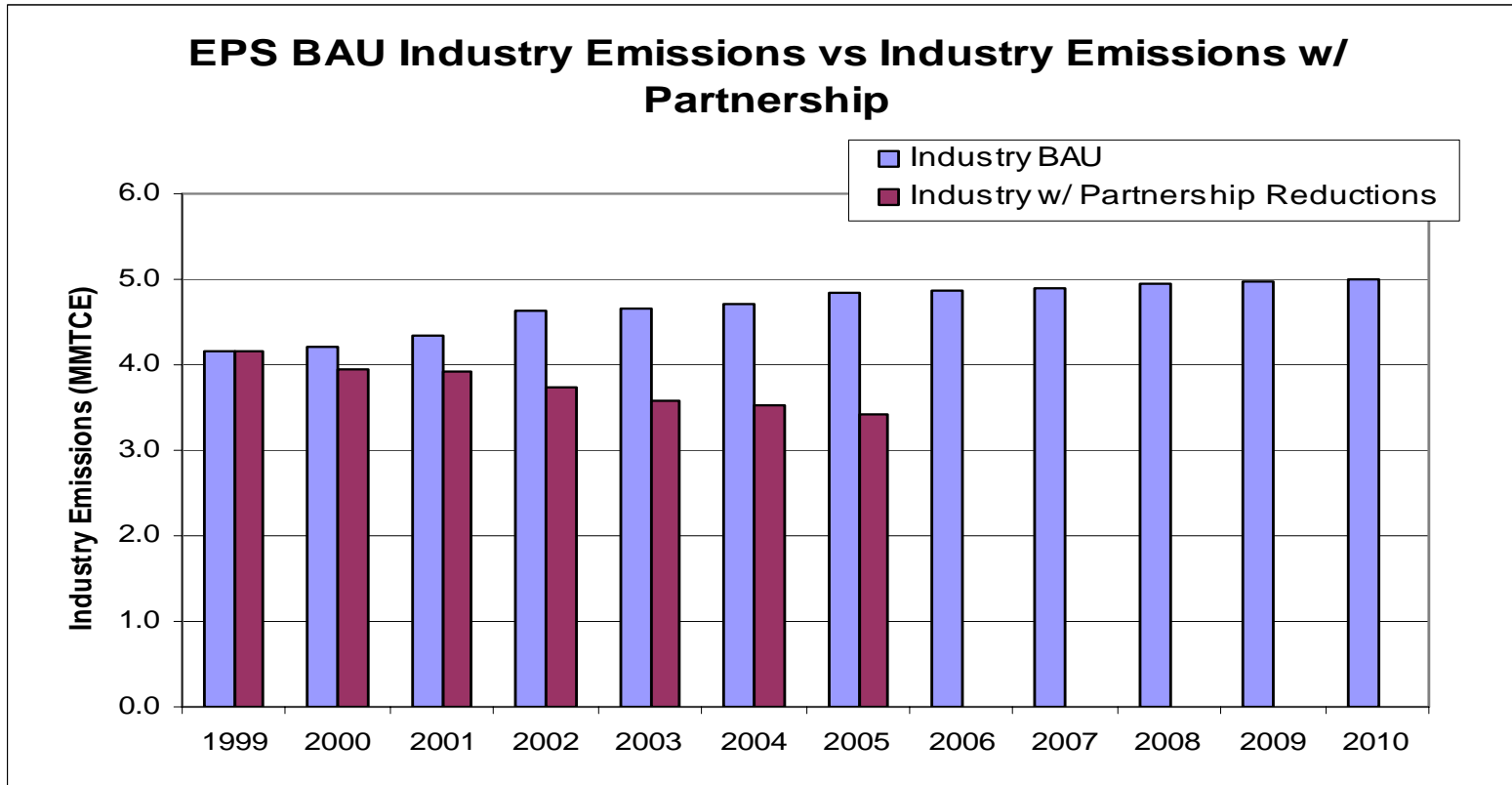


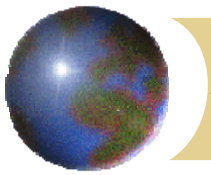
Organization

- Review of U.S. Electric Power Partnership
 - Accomplishments & Highlights
- Equipment Leak Study
 - Findings & Recommendations
- Conclusion & Questions



EPS: U.S. SF₆ Emission Reductions



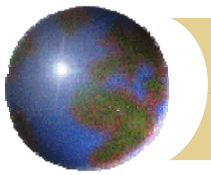


2005 Data: Accomplishments

Electric Power Systems

- Number of U.S. Partners 80
- Partners Reporting 87%
- Emission Rate: (average) 8.3%
 - Median 2%
- Emission Reduction 1.4 MMTCE

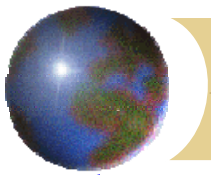
Total SF₆ Emissions 415,000 lbs



Accomplishments - continued

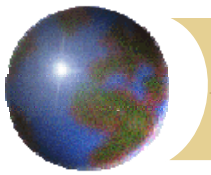
Electric Power Systems

- Partnership Annual Report (revised Aug. 2006)
- **Duquesne Light** Substation Decommissioning Project
 - Under Case Studies on Web site
- Partner “Benchmark” Reports; Updating Goals
 - Use past experience, knowledge, etc. to revise Goal;
 - Extend Commitment Period to Year 2012



Electric Power Systems: New Partners - 2006

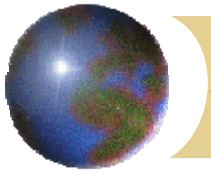
- City of Palo Alto, CA
- Ottertail Power, MN
- Oglethorpe Power, GA
- PNM Resources, NM
- Seattle City Light, WA
- NSTAR Electric and Gas, MA
- Montana-Dakota Utilities, ND



New Equipment Leak Study

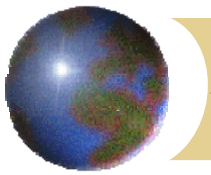
- ***Study Objective: To investigate and increase industry knowledge concerning SF₆ leak rates from newly manufactured circuit breakers (CBs)***

- NEMA Guidelines: 0.1 percent/year
- IEC Standard for new equipment leakage (IEC 62271-1-2004, pg. 55): 0.5 percent/year



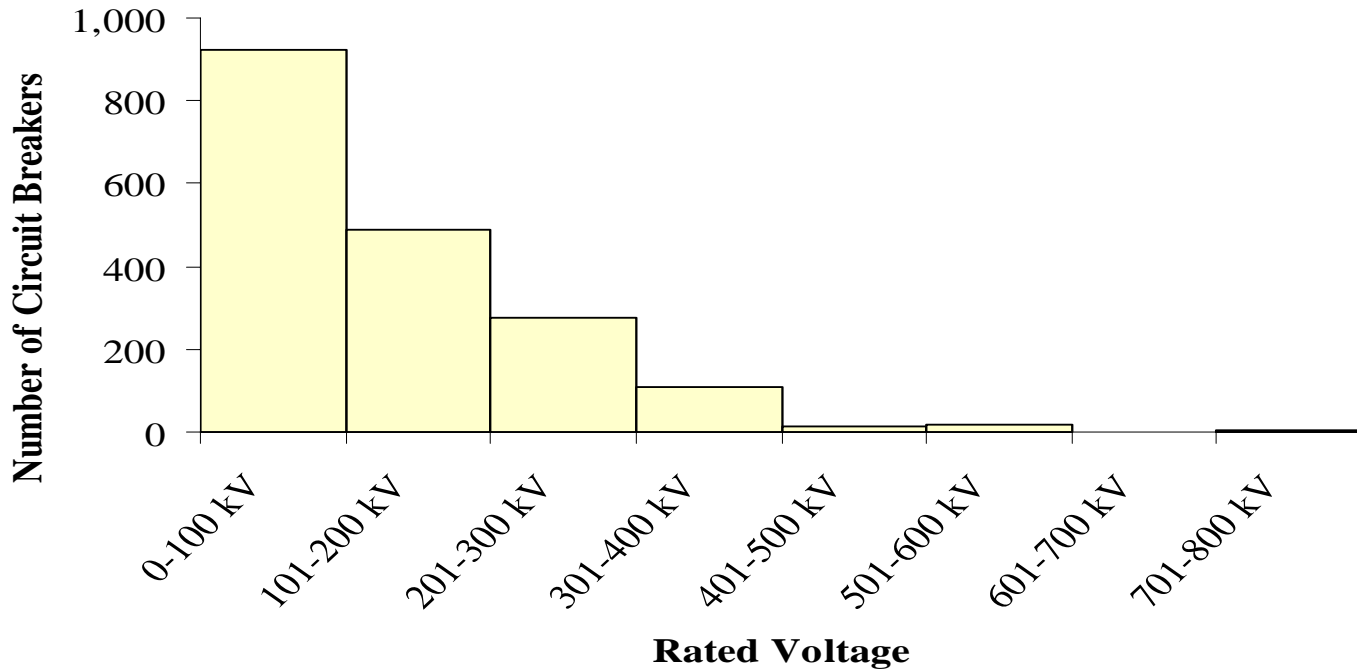
New Equipment Leak Study - continued

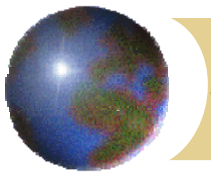
- Data from log books of 2,329 Circuit Breakers (CBs)
- SF₆ leakage assessed from years 1998 through 2005
- CBs manufactured between the years 1998 and 2002
- CBs belonging to 3 Partner Utilities



New Equipment Leak Study

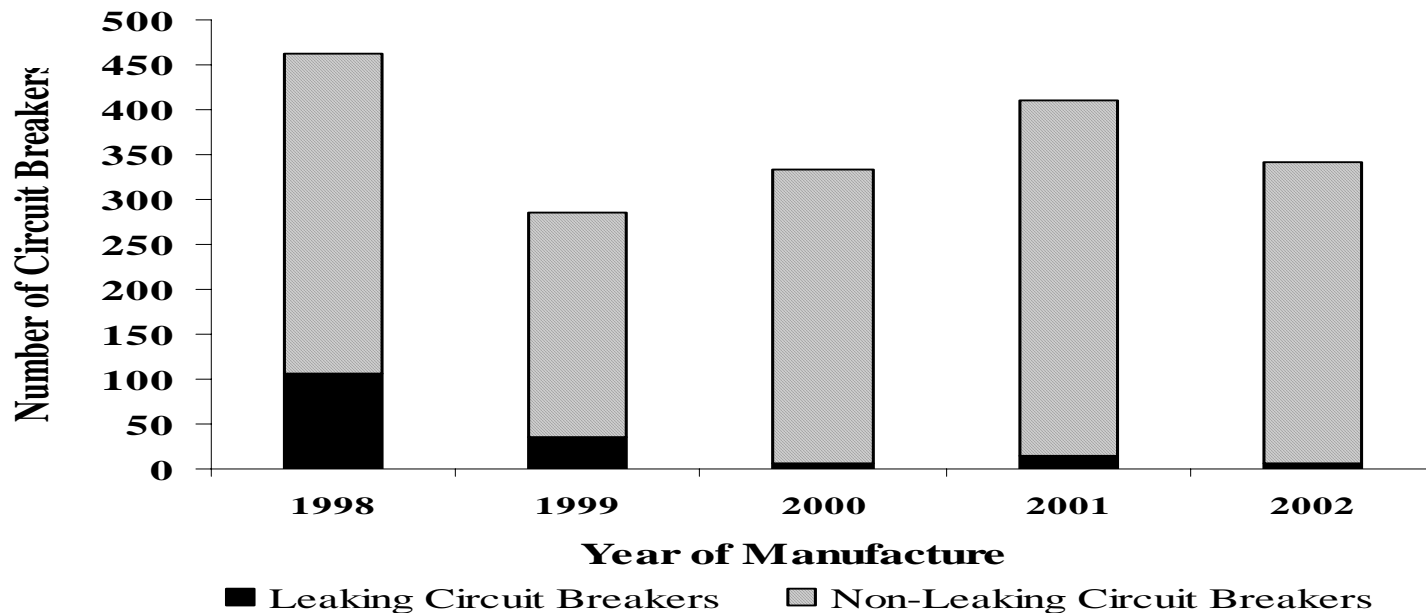
Original Equipment Manufacturers: ABB, Siemens, GE-Hitachi, MEPPPI

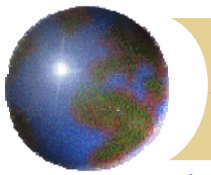




Data Summary and Observations

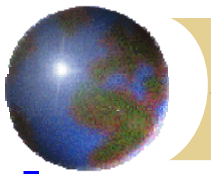
- 7.3 percent (170 CBs) of 2,329 CBs classified as leaking;
- Total SF₆ emissions: 3,407 lbs





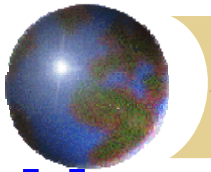
Technical Issues: New Equipment Leak Study

- Breakers defined as leaking if density alarm indicated **10 percent** loss of total SF₆ capacity;
 - CB classified as leaking if it had a documented “top-up” of SF₆
- Data set relatively small;
- Majority of equipment fell into the lower rated voltage category (<200 kV);



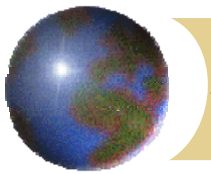
Lower Bound: weighted average leak rate = 0.22 percent

- **Leaking CBs:** Assumed that no additional “top-ups” have occurred after last service reported.
 - Any leakage occurring after last reported top-up not included in estimate.
- **Other CBs:** Assumed that CBs with no reported “top-ups” have zero emissions.
 - Any emissions less than the 10 percent needed to trigger alarm are not included.



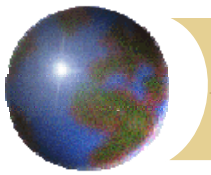
Upper Bound: weighted average leak rate = 2.5 percent

- **Leaking CBs:** Assumes that all leaking CBs have leaked an additional 10 percent between their last service call and 2005
- **Other CBs:** Assumes that all “non-leaking” CBs (those that have not tripped the density alarm), have leaked slightly less than 10 percent of their total gas volume between installation and 2005



Findings & Recommendations

- 7% of circuit breaker population leaked (170);
- SF₆ Leakage for Total Population (2,329) ranged from 0.22 to 2.5 percent per year;
- Better Monitoring Technologies Needed to Verify Low Leak Claims
 - Density monitors not very useful in detecting small leaks.



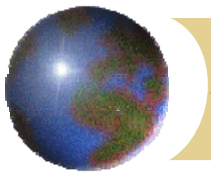
Recommendations - continued

For Equipment Manufacturers (OEMs):

- ❑ Incorporate “continuous” monitoring systems into new breaker designs;
- ❑ Develop an industry-wide standard leak test protocol for new equipment.

For Utilities:

- ❑ Consider adjusting density alarm to lower set point on new equipment;
- ❑ Contact equipment manufacturer as soon as you notice loss of gas.



Conclusion – You Have the Power

Trust, but Verify!

Paper available on Web Site:

www.epa.gov/electricpower-sf6/pdf/leakrates_circuitbreakers.pdf