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10 Steps to Help Reduce SF_6 Emissions in T&D

By Robert Mueller, Airgas Inc.

Sulfur hexafluoride (SF_6) is widely used in the electric utility industry for insulating circuit breakers, substations and switchgear in electric power transmission and distribution. Its introduction in the 1950s allowed for the replacement of flammable oils and the use of more compact electrical equipment, particularly in urban areas. Today, according to the Rand Corporation, the industry uses 80 percent of the SF_6 produced worldwide.

However, SF_6 is a highly potent greenhouse gas. It has a global warming potential 23,900 times greater than that of CO_2 and an atmospheric life of 3,200 years. As recently as 2002, the industry released 600 metric tons of SF_6 into the atmosphere—the equivalent of 3,103,896 passenger cars driven for a year or the burning of 72,866 railcars of coal.

The United States Environmental Protection Agency (EPA) introduced a voluntary utility program in 1999 to encourage utilities to reduce SF_6 emissions. Since that time, a number of electric companies have successfully cut their emissions by improving their gas management practices. Reducing emissions is really a win-win situation, as companies that improve their gas management practices not only help the environment, they can reduce their costs as well. The following are 10 steps companies can take to make reduced emissions a reality, as well as eliminate many of the headaches and hassles of procuring and using SF_6.

1. Uncovering the Sources of Emissions

Identifying potential emissions sources is the first step in an effective emissions reduction program. Emissions are generally the result of two sources: leakage through seals in aging equipment and improper gas handling by employees during installation and servicing operations. To determine if your company may have an emissions problem and would be a good candidate for a reduction program, it is important to ask the following questions. If you answer "no" to any of them, or if your equipment requires frequent or excessive SF_6 replenishment, you could be emitting SF_6 into the atmosphere:

- Do I have a leak-checking program in place for gas-insulated equipment?
- Do I have well-written procedures for transferring gas out of or into gas-insulated equipment?
- Do I have an employee-training program in place for proper SF_6 handling?

2. Employee Education

Effective SF_6 management starts with employee awareness, so educating supervisors and line employees about the impact of SF_6 on the environment and proper handling procedures is vital to any program's success. A training program should cover the following:

- Environmental awareness training for employees regarding the greenhouse potential of SF_6,
- The safe handling of cylinders to ensure the safety of employees who may handle high-pressure cylinders, and
- Gas cart operation and maintenance to reduce emissions during gas transfers, as well as from static leaks.

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3. Equipment Upgrades and Maintenance

Older circuit breakers typically contain 800 to 2,000 pounds of SF_6 and have the potential for leakage. Newer "gas tight" breakers require far less gas—200 pounds per breaker—and have tighter leakage specifications. In addition, damaged equipment such as worn bushings, seals, tubing and manifolds can create leaks. Having a system in place to identify equipment that needs replacement or repair can make a significant impact on overall emissions.

4. Monitoring Gas Quality

Under normal arcing conditions, SF_6 will absorb large amounts of energy, causing its molecules to dissociate. While most of it "self-heals," recombination is not always complete. If contaminants such as air, moisture or hydrocarbons are present during arcing, some of the SF_6 will permanently decompose into various byproducts, potentially compromising equipment performance. Using a gas analysis service will allow you to extract a gas sample from the equipment while it is in service and have it tested. It is important to use a service that has the proper laboratory facilities to ensure quick results and the ability to track the gas quality in individual pieces of equipment.

5. Recycling

Before the greenhouse properties of SF_6 were widely known, used gas was commonly returned to cylinders and stored or simply vented into the atmosphere. Storing used gas creates safety hazards and space problems and is another potential emission source. Today, SF_6 can be recycled and reused, offering a socially responsible solution to the problem.

Used gas can be recycled in one of two ways—through processing using gas carts or by removing it to offsite processing facilities. Implementing a recycling program requires partnering with a supplier that offers onsite technical assistance and mobile equipment for onsite purification or packaging for removal to an offsite purification facility.

6. Proper Calibration of Analyzers

During maintenance, SF_6 may be transferred from one piece of equipment to another using a gas cart. Gas purity must be tested using an analyzer to ensure that contaminated or poor quality gas is not transferred into new equipment, but improperly calibrated analyzers can give false readings. In general, hygrometers, oxygen analyzers and ultrasonic detectors should be re-calibrated after every 100 hours of use.

7. Gas Cart Operation and Maintenance

Gas carts are used to off-load and transfer SF_6 for maintenance and recycling operations. These are sophisticated systems that can be major sources of emissions when improperly operated or maintained. Employees need training in maintenance and use to prevent emissions.

Since the purchase of gas carts is a large capital expense, renting them can be a more financially sound option. Renting enables companies to:

- Account for rental costs as operating expenses rather than as capital expenditures,
- Eliminate maintenance responsibility, and
- Have the carts onsite only when needed, saving space.

Industry and Governmental Resources for SF_6 Emissions Reduction

A wealth of government and industry resources and information exists for managers interested in starting an SF_6 emissions reduction program at their companies. The following are some of the resources available:

The United States Environmental Protection Agency (USEPA) runs a voluntary government/industry partnership called the SF_6 Emission Reduction Partnership for Electric Power Systems. The partnership's goals are to prevent global warming by reducing SF6 emissions while helping utilities save money and gain positive public recognition. For more information, visit www.epa.gov/electricpower-sf6.

Airgas offers customized programs designed to provide electric power companies with the tools and knowledge to succeed in the EPA partnership. Offerings are based around providing SF_6 training for managers and employees and providing gas management tools to help companies use SF_6 more efficiently. For more information, email Robert Mueller at Bob.Mueller@airgas.com.

The following additional information on SF_6 and global warming is also available online:

- U.S. Greenhouse Gas Emissions and Sinks: 1990-2002
  http://yosemite.epa.gov/oar/globalwarming.nsf
- USEPA's web page on High GWP Gases and Climate Change
  http://www.epa.gov/highgwp/scientific.html
- For greenhouse gas conversions go to
  http://www.usctcgateway.net
- EEI's Power Partners
  www.eei.org/industry_issues/environment/climate

8. Correct Cylinder Size

Using the correct cylinder size makes supplying gas easier, safer and more cost-effective. As a rule of thumb, larger cylinders weighing 115 to 130 pounds should be used for single site or stationary requirements. Smaller cylinders weighing about 30 pounds are better for mobile requirements. To ensure you have the right cylinders at the right locations, work with your supplier to customize a delivery system that minimizes touch labor, limits cylinder inventories and maximizes gas utilization from each cylinder.

9. Understanding Your Supplier's Filling Procedures

To make sure your supplier takes adequate steps to address SF_6 emissions, it is important to know how it processes the residual SF_6 contained in the cylinders you send back. There are two possibilities:

- Venting and refilling. If your supplier uses this method, it is removing all of the residual and replenishing the cylinder with virgin product. If this is done correctly, the gas is collected, tested and reused. If the supplier is not doing this, then it is likely it is venting it into the atmosphere.
- Using Residual Pressure Valves (RPV). This is a preferred method, since RPVs contain a check valve that is designed to prevent contaminants from backfilling into the cylinder at the point of use. RPVs also enable the supplier to top-fill SF_6 onto the uncontaminated residual.

10. Report Residual Returns

Participants in the SF_6 Emission Reduction Partnership are required to submit an annual report quantifying SF_6 emissions. The reporting form requires an accounting of SF_6 purchases/acquisitions and sales/disbursements. As most cylinders returned to the supplier contain 12 percent to 15 percent residual product (called the "heel"), a certain amount of unused gas will be counted as an emission if not properly reported. For example, a full cylinder containing 115 pounds of SF_6 may be returned to the supplier with 14 pounds of unused product. If the facility uses 100 cylinders a year, the residual product will equal 1,400 pounds, the equivalent of 12 cylinders. To avoid having residual counted as an emission, it is important to work with a company that has a reporting system in place to account for the returns.

Emissions Reductions in Action

Implementing a successful SF_6 emissions program requires customizing a plan to meet your company's needs. This often means working with suppliers to gather information on the sources of leaks and recommend policies and procedures to help make change a reality. This is what Southern California Edison (SCE) discovered in the late 1990s when it embarked on a gas management program to improve its handling procedures to reduce overall emissions.

At that time, SCE had relatively high consumption of SF_6 and maintained an inventory of more than 500,000 pounds of SF_6 in equipment and cylinders. The company also purchased inventory from three separate suppliers, which created variation in gas quality. At the same time, managing large numbers of cylinders created challenges with regard to logistics, safety and onsite storage.

By working with the EPA's Emission Reduction Partnership and Airgas, SCE developed a system to track equipment history to prioritize repairs and replacements. SCE also targeted employee education and established policies and procedures to improve its gas-handling procedures. Over the next six years, SCE made the following specific process improvements:

- Conducted an extensive analysis of equipment leaks, discovering that 64 percent of the leaks came from gas mechanisms, 18 percent from worn or broken bushings and 18 percent from leaky gas tanks;
- Improved tracking and annual reporting of SF_6 to account for residual gas, used gas removed from equipment, recycled gas and new equipment;
- Revised and simplified gas distribution methods for a large gas insulated substation (GIS) retrofit project;
- Implemented a gas recycling program, including gas carts and employee training in gas cart use;
- Partnered with Airgas as a sole supplier of SF_6, reducing ordering, logistical and supply chain management issues, while ensuring a consistently "clean" gas supply; and
- Worked with Airgas to develop an SF_6 reference manual as a resource for employees.

The program achieved measurable results within one year. Between 1998 and 1999, SCE' SF_6 consumption decreased approximately 23 percent. By 2004, its consumption had decreased a total of 40 percent. Today, SCE spends only a fraction of what it previously spent on SF_6 and has been recognized by the EPA for its success in reducing emissions.

Conclusion

SF_6 is a product that presents a double-edged sword. It is indispensable for the safe transmission of electrical power. Yet, due to its global warming potential, it represents a longer-term problem if used carelessly. Through greater awareness and improved gas management techniques, electric companies can not only reduce their emissions, but also save money in the process. Companies can also eliminate many of the hassles of procurement and logistics and concentrate on what they do best-supplying electricity. ‹‹

Robert Mueller is Business Manager, Process Chemicals for Airgas, Inc. He coordinates Airgas' SF_6 Emission Reduction Program.

Call TOLL-FREE 866-924-7427 for the Airgas location nearest you, or visit us online at:
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