SCE's EXPERIENCE WITH SF_6

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Abstract - Because of the potential impact of the Kyoto Protocol, which classifies SF_6 as a greenhouse gas, electric utilities are concerned with the possible implications to the industry. SCE has taken a proactive approach to managing SF_6 by reviewing every aspect of its use. Emission reduction, transportation, storage, recycling, handling equipment, and gas management are some of these important issues. Through the efforts of an internal resource team, SCE has effectively implemented several processes that have reaped substantial benefits. Replacing antiquated equipment and repairing known problem areas has minimized SF_6 emissions. Additionally, properly managing SF_6 inventories and tracking usage has reduced operating and maintenance costs.

INTRODUCTION

Presently, SF_6 (sulfur hexafluoride) gas is used as a dielectric in gas-insulated switchgear (GIS), gas-insulated bus (GIB), and gas-insulated transmission line (GITL) equipment, and is the dielectric/interrupting medium of choice in high-voltage power circuit breakers. The electric utility industry and SCE have successfully used SF_6 for more than 40 years in these applications.

Recently, the cost of SF_6 has risen sharply and this, coupled with the fact that SF_6 has been identified as a "greenhouse" gas, provides incentive to identify opportunities to improve management of this valuable resource.

This paper discusses SCE's experience with SF_6 and illustrates how this commodity can be effectively managed in a way that has a positive affect on the environment and economic benefits to the utility.

ENVIRONMENTAL IMPACT

SF_6, an essential material for high-voltage electrical equipment, has been identified as a greenhouse gas with a long atmospheric lifetime. Greenhouse gases absorb a portion of the infrared radiation emitted by the earth and re-radiate it back to the earth. Life on Earth depends on a natural greenhouse effect to provide the appropriate temperature for its support. However, an imbalance in the normal greenhouse effect of the earth occurs when human-made emissions of greenhouse gases contribute to enhance this effect. Because SF_6 purchased by the electrical industry is for use in newly installed sealed electrical power equipment, its contribution to the global emission rate is negligible. Nevertheless, SF_6 emissions from electrical power equipment should be minimized through systematic recycling and avoidance of deliberate release.

Memorandum of Understanding

The U.S. Environmental Protection Agency (EPA) has taken a leading role in developing a voluntary memorandum of understanding (MOU) between electric utilities and the EPA. EPA is the primary environmental governing agency in the United States. SCE and other leading U.S. electric utilities were instrumental in its initial development. Electric utilities and EPA recognize that the primary purpose of this agreement is to achieve environmental and economic benefits by reducing

emissions of SF_6 from equipment used in the transmission and distribution of electricity. SCE is planning to adopt the MOU and work with EPA toward achieving these common goals.

SF_6 GAS TEAM

Because of the potential impact of the Kyoto Protocol, SCE has taken a proactive approach to managing this valuable resource. To effectively accomplish this task, a team was formed consisting of management, field supervisors, engineers, and strategic suppliers. The goal of the team was to address issues such as environmental impact pricing, safety, transportation, training, equipment, recycling, and establish uniformity.

Handling Equipment

Generally, there are two types of SF_6 processing systems available for gas handling: high-pressure and refrigeration-assisted. Both systems are capable of evacuating, processing, and storing large quantities of gas.

Refrigeration-assisted systems typically are equipped with a storage tank, a compressor, filters, and a vacuum pump. In this system, a refrigeration unit liquefies SF_6 in the storage tank and during the transfer operation. However, if the refrigeration system is not maintained properly, the system may fail to operate, which limits the storage capacity. Moreover, the storage tank usually does not have a DOT (Department of Transportation) approved rating, which is required when transporting SF_6 on public highways. Although these systems were not designed to transport gas, following gas handling, some residual gas remains in the tank.

High-pressure systems contain the same equipment with two major differences. Because high-pressure systems use pressure for liquefaction, refrigeration systems are not necessary. The second difference allows cylinders to be used for storage, which provides flexibility for transportation. Furthermore, manifolds can be used to connect multiple cylinders, which can create unlimited storage when necessary. Team members have analyzed and tested both systems and determined that high-pressure systems allow flexibility and comply with transportation regulations. In addition, using oil-less compressors and self-sealing connections significantly improves gas quality and helps minimize accidental emissions.

Strategic Sourcing

The SF_6 gas team was instrumental in conducting a market survey to address current gas prices, which was used to compare with our strategic supplier. By conducting this survey, the SF_6 team was successful in proving that the market value was significantly lower than what SCE was currently paying. The result was a more than a 50 percent price reduction from the previous year, which equals about $1 million in savings. In addition, tracking residual product and receiving credit for product returned rendered further savings.

Resource Guide

The team has been very effective in resolving several issues and has developed a resource guide to assist field personnel. The purpose of this guide is to assist in properly managing SF_6 and provides important information and resources. The intent is not to make SF_6 management experts of substation personnel, but rather to provide practical knowledge.

GAS MANAGEMENT

Because of the emphasis on gas emission reduction, the need to improve gas administration processes has become more evident. Proper documentation and control of SF_6 inventories, whether in equipment or in cylinders for use, is an essential part of the administration process. Gas management consists of many aspects that include installation, recovery, storage, recycling, and disposal. All of these processes exist in the life cycle of SF_6-filled switchgear/equipment.

A three-part gas management process was developed by SCE to properly manage inventories, which also includes tracking residual product returned to the gas supplier. The first part of this process began with determining gas quantities in equipment. The current estimate of SF_6 in equipment at SCE is approximately 500,000 pounds. Eighty-eight percent is in 1,419 circuit breakers ranging in voltages from 33 kV to 500 kV. The remaining 12 percent is in two GIS facilities.

The second part encompasses managing inventories, which involves tracking gas purchases and weighing gas cylinders before returning to the supplier. Cylinders that contain a net weight of more than 15 pounds are not returned, but are consolidated. These data are recorded and reviewed quarterly and are used for forecasting future SF_6 purchases and trending leaks in equipment.

The third part involves reclaiming and recycling used and contaminated gas. Most contaminants such as moisture and decomposition products can easily be removed by gas processing units equipped with onboard filters. Additional filters are commonly used when handling gas with high decomposition and moisture content. However, when gas contains contaminants such as air and carbon tetrafluoride, specialized equipment is required. This gas is sent to a vendor for processing and then returned to SCE for reuse.

The development of this process has also provided direction for managing SF_6 for new and retired equipment. By negotiating with manufacturers to fill new equipment with used and recycled SF_6, about $1.5 million was saved in SF_6 replacement costs during a two-year period.

CIRCUIT BREAKER REPLACEMENTS

SCE is currently engaged in an aggressive circuit breaker replacement program that is targeting two-pressure gas dead-tank circuit breakers and air-blast live-tank circuit breakers. Air blast circuit breakers have SF_6-insulated current transformers. Circuit breakers of this type historically leak due to the failure of mechanical seals. Replacement of this equipment not only reduces SF_6 emissions, but also significantly reduces maintenance costs. Reduction in spare parts inventory, increased reliability, and improved performance are some additional advantages.

LEAK DETECTION

Leak detection is an important component of the overall scope of emission reduction. Conventional leak detection methods encompass gas density monitoring, liquid soap, and halogen detectors. Some U.S. utilities are implementing new technologies such as on-line systems and ultra-sonic and laser detectors. Although these new technologies have demonstrated significant improvements in leak detection, additional work is necessary to improve accuracy, practicality, and cost-effectiveness. Because gas leaks are typically in areas such as manifolds, valves, and gauges, most leaks can be eliminated by making minor repairs. In some cases, extensive repair and/or replacement are necessary.

SUMMARY

During the past two years, SCE has made significant strides in effectively managing SF_6 gas as an asset. In addition, by linking with electric utilities, industry experts, and equipment manufacturers, SCE has participated in changes in the industry that will have definite environmental and economic benefits. Moreover, recent efforts by equipment manufacturers to move closer toward leak-free and maintenance-free equipment will further solidify this progress.

Although SCE's policy for SF_6 handling has always been to recover gas for reuse, closely monitoring and managing SF_6 has reduced leaks in equipment and helped minimize costs and emissions.

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