

# RECLAMATION

*Managing Water in the West*

**Facilities Instructions, Standards, and Techniques  
Volume 5-9**

## **MANAGEMENT AND SAFE HANDLING PROCEDURES FOR SULFUR HEXAFLUORIDE (SF<sub>6</sub>) GAS**

Insert photo



**U.S. Department of the Interior  
Bureau of Reclamation  
Denver, Colorado**

**Month Year**

# REPORT DOCUMENTATION PAGE

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**Facilities, Instructions, Standards, and Techniques  
Volume**

**MANAGEMENT AND SAFE HANDLING PROCEDURES  
FOR SULFUR HEXAFLUORIDE (SF<sub>6</sub>) GAS**

**Power Resources Office**



**U.S. Department of the Interior  
Bureau of Reclamation  
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# CONTENTS

	<i>Page</i>
1. Introduction.....	1
2. Scope .....	2
3. Responsibility .....	2
4. Management Plan.....	3
5. Emission Reduction Goals.....	4
6. Equipment Inventory .....	4
7. Emission Measurement .....	5
8. Reporting Requirements .....	5
9. Safe Handling Procedures for SF <sub>6</sub> Gas .....	5
10. Training.....	6
11. Catastrophic Release Plan.....	7
12. Risk Assessment and Mitigation.....	8
13. Recycling, Disposal, Environmental Protection, Transportation, and Storage.....	9
14. Procurement of SF <sub>6</sub> Equipment .....	9
15. Gas Carts.....	9
Appendix A: SF <sub>6</sub> Location at Reclamation Facilities - 2003.....	11
Appendix B: SF <sub>6</sub> Emissions Inventory Reporting Protocol and Form .....	15

## 1.0 Introduction

Bureau of Reclamation (Reclamation) facilities have more than 1,000 power circuit breakers; the most modern of them use sulfur hexafluoride (SF<sub>6</sub>) gas as an arc-interrupting/quenching and insulating agent. Breakers of this design are now the standard; for some applications, they are the only power circuit breakers available in the industry. Reclamation currently has some 65 power circuit breakers of the SF<sub>6</sub> design, as well as other SF<sub>6</sub> equipment (Appendix A). Reclamation plans to procure more SF<sub>6</sub> breakers in the future to meet its needs.

According to the Electric Power Research Institute (EPRI)<sup>1</sup>, SF<sub>6</sub> is a synthetic gas that was developed for use as an electrical insulating medium for the power industry. Originally, its outstanding insulation characteristics were used primarily to reduce power circuit breaker interruption time; reducing interruption time enhances power system stability. As concerns escalated regarding poly-chlorinated biphenyls (PCBs) that were found in insulating oil used in older breakers, the use of SF<sub>6</sub> insulated breakers grew.

SF<sub>6</sub> is chemically inert, nonflammable, and nontoxic. Although SF<sub>6</sub> gas is not detrimental to the ozone layer, it is a highly potent greenhouse gas. It is 23,900 times more effective at trapping infrared radiation than carbon monoxide and is stable in the atmosphere for some 3,200 years. Although the percentage of SF<sub>6</sub> found in the atmosphere is relatively small, the rate of growth is alarming.

The largest use of SF<sub>6</sub>, both in the United States and internationally, is as an electrical insulator and interrupter in equipment that transmits and distributes electricity (RAND 2004). The gas has been employed by the electric power industry in the United States since the 1950s because of its dielectric strength and arc-quenching characteristics. It is used in gas-insulated substations, circuit breakers, other switchgear, and in gas-insulated lines. Sulfur hexafluoride has replaced flammable insulating oils in many applications and allows for more compact substations in dense urban areas. Currently, there are no available substitutes for SF<sub>6</sub> in high voltage applications.

EPA is requiring electric power systems to report all SF<sub>6</sub> and PFC emissions, including those from equipment installation (once the title of equipment has been transferred to the equipment user), equipment use, and equipment decommissioning and disposal.

Fugitive emissions of SF<sub>6</sub> can escape from gas-insulated substations and switch gear through seals, especially from older equipment. The gas can also be released during equipment manufacturing, installation, servicing, and disposal.

Currently, there is no Federal legislation curtailing the use of SF<sub>6</sub>. However, the Environmental Protection Agency (EPA) sponsors and facilitates a program for a voluntary reduction of SF<sub>6</sub> emissions within the electric power industry. This program provides a forum for EPA and the electric power industry to work together to reduce SF<sub>6</sub> emissions to technically and economically feasible levels, thereby helping to reduce global climate change. Implied is that if voluntary programs are not successful, legislation may be required

to restrict the use of SF6. Restricting the use of SF6 would be extremely inconvenient to the power industry, including Reclamation and the Federal Power Marketing Administrations.

Although Reclamation has not signed a memorandum of understanding with EPA establishing official compliance with the program, Reclamation will voluntarily pursue a program of SF6 management and handling that will help reduce SF6 emissions and promote safety for employees and the public.

For more information on EPA's High Global Warming Potential (GWP) Gases, visit its website at [www.epa.gov/highgwp1/index.html](http://www.epa.gov/highgwp1/index.html).

<sup>1</sup>“SF6 Gas Condition Assessment and Decontamination – Technical Report,” June 2000, and “Practical Guide to SF6 Handling Practices,” February 2002, both by the Electric Power Research Institute, Palo Alto, California.

## **2.0 Scope**

Use of SF6 circuit breakers and other SF6 equipment does not come without consequences. In addition to the environmental concerns addressed in the Introduction, SF6 gas and gas byproducts pose some risk to personnel.

SF6 gas is heavier than air. In enclosed areas, such as in powerplants, it can displace breathable air. The toxic byproducts released when SF6 gas interrupts the arc plasma in a circuit breaker are also of concern. Decomposition products in the form of metallic fluoride powder are toxic to humans who breathe or touch them, and adequate personal protective equipment (PPE) and training are essential for personnel safety.

This FIST volume outlines the basic requirements for SF6 management and handling at Reclamation power facilities to address environmental and safety issues. Key elements include:

- Establishing and progressing toward local and Reclamation SF6 emission reduction goals that meet EPA guidelines
- Developing and maintaining local records and reporting annually
- Developing and maintaining a local gas-handling plan that minimizes release of SF6
- Following guidelines developed and used by most of the power industry worldwide
- Providing proper training in recycling, using, handling, transporting, containing spills, and reporting SF6 releases
- Developing and maintaining a local SF6 and SF6 byproduct catastrophic release emergency action plan
- Developing and using an SF6 risk assessment and mitigation strategy

- Procuring electrical equipment that is “ultra-low leakage” and performing site installation that follows all environmental and safety considerations

Although most Reclamation SF6 equipment currently in service is located outside of powerplants and, therefore, may result in lower gas concentrations, safety and environmental precautions still apply, and a local SF6 plan is essential.

### **3.0 Responsibility**

The Power Resources Office, D-5400, is Reclamation’s lead office for addressing corporate SF6 management issues and any coordination with EPA. Area and project offices are responsible for implementing adequate SF6 management and handling practices to comply with this FIST volume and any applicable State and Federal regulations and statutes. Specific responsibilities are listed below.

#### **3.1 Power Resources Office, D-5400**

Provide corporate guidance to field offices on current SF6 regulations, statutes, policy, and practices

- C. Provide liaison with EPA, power marketing administrations, and other utilities as part of Reclamation’s voluntary and unofficial participation in the EPA “SF6 Emissions Reduction Partnership for Electric Power Systems”
- D. Establish Reclamation SF6 emission reduction goals
- E. Report Reclamation’s SF6 status to EPA, including emission reductions, when appropriate

#### **3.2 Area/Project/Regional Office**

- A. Establish and accomplish office SF6 emission reduction goals
- B. Develop, maintain, and execute a local SF6 Management and Safe Handling Plan in accordance with this FIST volume and EPA requirements
- C. Report annually to the Power Resources Office the status of the local SF6 program
- D. Establish a schedule for accomplishing the requirements of this FIST volume and a process for peer reviewing generated documents

### **4.0 Management Plan**

Each Reclamation facility with SF6 equipment will develop an SF6 Management and Handling Plan that clearly defines how SF6 is to be managed locally. The plan will include:

- An SF6 emission reduction goal and a strategy for accomplishing it
- An inventory of all SF6 equipment
- A strategy for measuring changes in SF6 inventory (and, thus, leakage) for tracking and reporting purposes
- A reporting process to advise the Power Resources Office, D-5400, of the current status of the local SF6 plan
- An SF6 Gas Safe Handling Procedure that is compliant with EPRI guidelines
- A training plan for staff engaged in SF6-related work
- A catastrophic-release plan
- A risk assessment and mitigation strategy
- A commitment to recycling, disposal, environmental protection, transportation, and storage consistent with applicable regulations, laws, and industry best practices

The existence and adequacy of SF6 Management Plans will be verified under the management portion of the Reclamation Power Review of Operation and Maintenance (O&M) Program.

## **5.0 Emission Reduction Goals**

A recent study indicated that Reclamation annually loses to emissions approximately 1,300 pounds of SF6, out of a nameplate and storage capacity of some 16,500 pounds (or approximately 7.9 percent). Emissions result from properly functioning equipment (because of static and dynamic operation), from leakage (because of old or deteriorated gaskets and seals), and from gas escaping into the atmosphere when gas is either transferred into equipment or extracted from it for disposal, recycling, or storage.<sup>2</sup>

Reclamation's goal is a 10-percent annual reduction in emissions from 2003 levels (a 40-percent reduction by 2007), where technically and economically feasible. This reduction will be achieved by replacing existing SF6 breakers with "ultra-low" leakage breakers and by using more effective handling practices. Emission reduction goals beyond 2007 will be based on progress to date and emerging utility practices developed before that year.

Each Reclamation office with SF6 equipment will establish written emission reduction goals and a strategy to support the Reclamation goal, including:

- Achieving a 10-percent annual reduction in leakage (from 2003 levels), where technically and economically feasible
- Replacing older, higher-emission SF6 equipment with newer, “ultra-low” leakage designs
- Refurbishing existing equipment to meet “ultra-low” leakage criteria
- Improving maintenance and construction practices to control or reduce emissions
- Replacing or repairing existing equipment seals, gaskets, alarms, gages, monitoring devices, etc., to reduce leakage and allow for proper monitoring

<sup>2</sup>Definitions of emission sources are from Bonneville Power Administration.

## **6.0 Equipment Inventory**

Each Reclamation office with SF6 equipment will inventory all SF6 equipment—including gas carts—to identify equipment designation, location, and nominal quantity of SF6 in pounds. Equipment that is “sealed for life” or contains less than 15 pounds of SF6 is exempt from this inventory.

**7.0** Appendix A is a recent inventory of SF6 equipment known to be at Reclamation facilities. This list should be considered informational only and must be supplemented with an official inventory.

## **8.0 Emission Measurement**

According to EPRI, leakage for a sound SF6 installation should be less than 1 percent annually. At least annually, each Reclamation office with SF6 equipment will perform the required SF6 inventory measurement using the protocol defined in Appendix B.

## **9.0 Reporting Requirements**

Each Reclamation office with SF6 equipment will report annually, by January 1, the status of the local SF6 program, including the amount of emission in pounds and details of any catastrophic release. The reporting protocol and form found in Appendix B should be used for reporting purposes.

The Power Resources Office, D-5400, will report the status of the Reclamation SF6 program to EPA using the same protocol and format as shown in Appendix B.

**10.0** In the first annual report to the Power Resources Office, due June 1, 2004, each office with SF6 equipment will provide an update to the inventory in Appendix A. The update will establish a baseline of Reclamation’s SF6 equipment.

## **11.0 Safe Handling Procedures for SF6 Gas**

To achieve SF6 emission reduction goals and to enhance employee and public safety, safe handling procedures must be developed and followed.

Existing SF6 circuit breakers at Reclamation facilities were bought and installed with little consideration beyond that found in the manufacturer's instruction book and the limited information in the previous version of this FIST volume. Existing maintenance practices have developed in accordance with this limited knowledge. Better construction and maintenance handling procedures for SF6 must be developed using today's accepted practices.

There are many technical considerations and procedures that must be taken into account for handling SF6 gas safely. A comprehensive discussion of these requirements is included in a document entitled, "Practical Guide to SF6 Handling Practices – Technical Report," Electric Power Research Institute, Palo Alto, California (February 2002).

Rather than re-creating extensive SF6 handling procedures in this FIST volume, Reclamation endorses the EPRI document as the basis for safe handling procedures for SF6 gas. Local SF6 management programs should incorporate all considerations from the EPRI document including:

- Equipment classification
- Risks, warning signs, and written instructions
- Handling procedures
- Personal protective equipment
- Disposal and environmental protection
- Transportation and storage

Copies of the EPRI "Practical Guide to SF6 Handling Practices" were made available to Reclamation power offices with the distribution of the 2004 revised version of this FIST volume. Additional copies of the EPRI document may be acquired by contacting:

EPRI 3412 Hillview Avenue, Palo Alto, CA 94304 PO Box 10412, Palo Alto CA, 94303 1-800-313-3774 (select option 2) <askepri@epri.com> <www.epri.com>

Mention that you are with the Bureau of Reclamation, which is a member of EPRI through the Western Area Power Administration. Please reference Report No. 100945. There is no charge for EPRI documents produced in membership target areas. EPRI documents may also be obtained online at <www.epri.com>. If you are not presently an EPRIWEB user, you can request a password at <www.epri.com> by clicking on the "New Users Register" area (below the customer log-in box). At the next screen, follow the directions and fill in the information requested. EPRI documents acquired in this way are for Reclamation and Reclamation-contractor use only.

In addition to the above EPRI document, reference should be made to manufacturers' instructions when adopting an SF6 safe handling plan.

## 12.0 Training

Only properly qualified and trained personnel should work with SF<sub>6</sub> and SF<sub>6</sub> equipment. Each Reclamation office with SF<sub>6</sub> equipment will develop and maintain an SF<sub>6</sub> training plan.

Training in proper handling procedures should always be provided by the contractor who furnishes and installs SF<sub>6</sub> equipment. SF<sub>6</sub> training in operation, maintenance, and safety procedures is available from the power marketing administrations (Western Area Power Administration and Bonneville Power Administration), who deal with SF<sub>6</sub> equipment extensively. Third-party commercial providers of SF<sub>6</sub> training include, but are not limited to:

- DILO Company, Inc. <[www.dilo.com](http://www.dilo.com)>
- AVO Training Institute <[www.avotraining.com](http://www.avotraining.com)>
- Associated Training Corp. <[www.atc-trng.com](http://www.atc-trng.com)>
- Mitsubishi Electric Power Products, Inc. <[www.meppi.com/service.asp](http://www.meppi.com/service.asp)>

Refresher training in SF<sub>6</sub> handling procedures should be accomplished annually after initial comprehensive training.

Since SF<sub>6</sub> enclosures should be treated as confined space, training in confined space practices is required to ensure that staff are aware of the risks and take proper precautions. Confined space training is available from established Reclamation sources.

## 13.0 Catastrophic Release Plan

A catastrophic release of SF<sub>6</sub> is the result of sudden, severe failure—and possible destruction—of the equipment containing the gas. Catastrophic release will introduce into the environment SF<sub>6</sub> gas and SF<sub>6</sub> decomposition byproducts, in gaseous and powder form, complicating what might already be a bad situation, such as explosive porcelain failure, fire and smoke, debris, and unit outage.

A catastrophic release of SF<sub>6</sub> may be caused by an incident that requires reporting under the Reclamation Power O&M Incident Evaluation and Reporting Program (Directive and Standard FAC 04-02). The incident should also be reported immediately through proper channels via the Reclamation Emergency Notification Systems (ENS).

In addition to protective and mitigation measures described in EPRI's "Practical Guide to SF<sub>6</sub> Handling Practices" (section 5.4), each office with SF<sub>6</sub> equipment must have a plant-specific SF<sub>6</sub> Catastrophic Release Plan, including:

- Location and use of protective clothing and self-contained breathing apparatus
- Location and awareness of material safety data sheets (MSDS)
- Identification of areas where gas and powder might collect

- Location of air intakes and an evaluation of their potential to spread gases
- Consideration of additional ventilation to offset the presence of decomposition gases
- References to the Reclamation Emergency Notification System, the responsible Hazardous Materials and Safety Offices, and to a qualified industrial hygienist that is knowledgeable and trained in SF6 hazard evaluation and clearance re-entry criteria.
- A list of contractors able to provide cleanup, decontamination, and disposal
- Identification of the appropriate state environmental office for notification of release, where required
- Decontamination and neutralization procedures and materials and identification of sources of these materials or locations where they are stockpiled. As a minimum, these procedures must include decontaminating plant and power equipment and personnel, including neutralizing wash; vacuuming powder from clothing; neutralizing all test and maintenance equipment; and appropriately disposing of clothing and wipes. Decontamination procedures must be adequate to return the equipment, the plant, and all personnel to a decontaminated state

#### **14.0 Risk Assessment and Mitigation**

Each Reclamation office with SF6 equipment will develop and execute an SF6 risk assessment and mitigation strategy. This assessment and strategy will include:

- Risk of SF6 emission (leakage and catastrophic release) to plant staff by identifying how and where gas could collect
- Review and proper distribution of MSDS for SF6 and SF6 decomposition products and communication of risks to staff
- Use of adequate, properly calibrated SF6 gas detectors by maintenance staff to indicate presence or absence of SF6 and SF6 byproducts. The slight reduction of oxygen, measured by an oxygen meter, may not reflect the concentration of hazardous byproducts that may be present
- Permanent installation and use of SF6 gas monitoring alarms, located where SF6 gas could accumulate
- Proper use and response to SF6 gas pressure or density alarms that are furnished with SF6 equipment

- Strategy for evacuating SF6 gas from accumulation locations
- Use of SF6 warning signage in accordance with Section 4 of EPRI’s “Practical Guide to SF6 Handling Practices”
- Adequacy and availability of PPE, including protective clothing and respiratory devices. See Section 6 and Appendix B of the EPRI guide

### **15.0 Recycling, Disposal, Environmental Protection, Transportation, and Storage**

Where technically and economically feasible, Reclamation offices will recycle (recover and reuse) SF6 gas.

Reclamation will comply with all applicable Federal and State regulations and laws regarding disposal, environmental protection, transportation, and storage of SF6 gas, gas byproducts, and contaminated equipment, tools, materials, clothing, and PPE. Refer to Sections 7 and 8 of the EPRI “Practical Guide to SF6 Handling Practices” and Reclamation Safety and Health Standards for guidance.

### **16.0 Procurement of SF6 Equipment**

When procuring SF6 equipment, consideration must be given to mitigating future gas leakage. Procurements should address the following:

- Acquisition of sealed-for-life and “ultra-low-leakage” equipment, where feasible
- Acquisition and application of all available gas leakage monitoring systems, such as overpressure, refilling, and low-pressure alarms
- Acquisition and application of SF6 gas and SF6 decomposition product detectors, both portable (for maintenance use) and permanently installed (for plant alarm)
- Acquisition of an adequate “gas cart” for proper filling and evacuating of SF6 equipment
- Provision by the contractor of adequate training in SF6 operation and maintenance
- Provision by the contractor of appropriate leakage and spill containment and cleanup equipment and supplies

### **17.0 Gas Carts**

Gas handling apparatus (i.e., gas carts) are essential for filling and evacuating SF6 equipment. See EPRI “Practical Guide to SF6 Handling Practices,” section 5.1.1 for more information. Reclamation SF6 gas carts should conform to EPRI guidelines in construction and be operated and maintained using EPRI’s recommendations.

Care should be exercised when handling and transporting gas bottles and carts because residual gas can be present. Proper evacuation procedures should be followed.

Gas carts require adequate maintenance and testing. Gas carts should be identified in MAXIMO as an individual piece of equipment requiring preventive maintenance. Job plans and work orders should be developed, with maintenance steps, in accordance with section 5.1.1 of the EPRI guidelines, including:

- Cart preparation and conditioning
- Loss of pressure check
- Loss of vacuum check
- Scrubber testing
- Flowmeter testing
- Vacuum pump maintenance
- Moisture testing
- SF6 percentage testing
- Byproduct tube inspection

Maintenance of gas carts will be verified under the electrical portion of the Reclamation Power Review of O&M Program.

## APPENDIX A SF<sub>6</sub> Location At Reclamation Facilities – 2003

Table 1.—SF<sub>6</sub> Location in and Near Reclamation Facilities - 2003

<b>Region</b>	<b>Plant</b>	<b>Equipment Type</b>	<b>Equipment Designation</b>	<b>Pounds of SF<sub>6</sub></b>	<b>Maintained By</b>
PN	Coulee 500 switchyard	Circuit breaker	PCB 2092 G-20	1,570	Reclamation
PN	Coulee 500 switchyard	Circuit breaker	PCB 2192 G-21	1,570	Reclamation
PN	Coulee 500 switchyard	Circuit breaker	PCB 2292 G-22	1,570	Reclamation
PN	Coulee 500 switchyard	Circuit breaker	PCB 2496 G-24	1,570	Reclamation
PN	Coulee 500 switchyard	Gas cart	Limco PET2015	200	Reclamation
PN	Coulee 500 switchyard	Gas cylinders	UN 1080	30x115	Reclamation
PN	Coulee 230 switchyard	Circuit breaker	PCB 6084 Bus Tie	330	Reclamation
PN	Coulee 230 switchyard	Circuit breaker	PCB 6582 CSY #1	330	Reclamation
PN	Coulee 115 switchyard	Circuit breaker	PCB 2172 Trans. Bkr.	200	Reclamation
PN	Coulee 115 switchyard	Circuit breaker	PCB 2372 LC #6	200	Reclamation
PN	Coulee 115 switchyard	Gas cylinder	UN 1080	115	Reclamation
PN	Coulee PG Plant	GIS	KP10A 3080, 3180, 3280, 3081, 3181	400	Reclamation
PN	Coulee PG Plant	Gas cylinders	UN 1080	2x115	Reclamation
PN	Coulee industrial area	Switch	UIAHA2	13.1	Reclamation
PN	Coulee industrial area	Gas cylinders	UN 1080	2x115	Reclamation
PN	Green Springs	Circuit breaker	JX1A	25	Reclamation
PN	Palisades	Circuit breaker	1062	115	Reclamation
PN	Minidoka	Circuit breaker	562	80	Reclamation
PN	Minidoka	Circuit breaker	662	80	Reclamation
PN	Minidoka	Gas Cart			Reclamation



LC					
LC	Hoover	Circuit breaker	UA5A / A524	100	Reclamation
LC	Hoover	Circuit breaker	UA6A / A624	100	Reclamation
LC	Hoover	Circuit breaker	UA7A / A724	100	Reclamation
LC	Hoover	Circuit breaker	UA8A / A824	100	Reclamation
LC	Hoover	Circuit breaker	UA9A / A924	100	Reclamation
LC	Hoover	Circuit breaker	A136	100	Reclamation
LC	Hoover	Circuit breaker	UN1A / N124	100	Reclamation
LC	Hoover	Circuit breaker	UN2A / N224	100	Reclamation
LC	Hoover	Circuit breaker	UN3A / N324	100	Reclamation

Table 1.—SF<sub>6</sub> Location in and Near Reclamation Facilities – 2003

<b>Region</b>	<b>Plant</b>	<b>Equipment Type</b>	<b>Equipment Designation</b>	<b>Pounds of SF<sub>6</sub></b>	<b>Maintained By</b>
LC	Hoover	Circuit breaker	UN4A / N424	100	Reclamation
LC	Hoover	Circuit breaker	UN5A / N524	100	Reclamation
LC	Hoover	Circuit breaker	UN6A / N624	100	Reclamation
LC	Hoover	Circuit breaker	UN7A / N724	100	Reclamation
LC	Hoover	Circuit breaker	UN8A / N824	100	Reclamation
LC	Hoover	Circuit breaker	N136	100	Reclamation
LC	Hoover	Circuit breaker	Spare		Reclamation
LC	Hoover	Gas cylinder		119.1	Reclamation
LC	Hoover	Gas cylinder		117.3	Reclamation
LC	Hoover	Gas cylinder		116.5	Reclamation
LC	Hoover	Gas cylinder		50.5	Reclamation
LC	Hoover	Gas Cart	Cryoquip		Reclamation
LC	Hoover	2,000 lb. Gas Storage Trailer	Dilo		Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
	Glen Canyon	Circuit breaker		36.74	Reclamation

UC					
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker	Dilo D320		Reclamation
UC	Glen Canyon	Gas cart			Reclamation
UC	Glen Canyon	Gas cylinder		90	
UC	Glen Canyon	Gas cylinder		5	Reclamation
UC	Pinabete Substation	Circuit switch		15	BIA
UC	Gallegos PP	Circuit switch		15	BIA
UC	Gallegos PP	Circuit switch		15	BIA
UC	Gallegos PP	Circuit switch		15	BIA

Table 1.—SF<sub>6</sub> Location in and Near Reclamation Facilities – 2003

<b>Region</b>	<b>Plant</b>	<b>Equipment Type</b>	<b>Equipment Designation</b>	<b>Pounds of SF6</b>	<b>Maintained By</b>
UC	PP A0.8L	Breaker		15	BIA
UC	PP A0.8L	Breaker		15	BIA
UC	PP A0.8L	Breaker		15	BIA
UC	PP A0.8L	Gas cylinder		12	BIA
UC	PP A0.8L	Gas cylinder		13	BIA
GP	Mt. Elbert	Circuit breaker	U1A	15.8	Reclamation
GP	Mt. Elbert	Circuit breaker	U2A	15.8	Reclamation
GP	Mt. Elbert	Circuit breaker	JV2A	132	WAPA
GP	Mt. Elbert	Circuit breaker	JV3A	132	WAPA
GP	Mt. Elbert	Gas cart	Cryoquip 2BC	115 capacity	Reclamation
GP	Green Mountain	Circuit breaker	JZ1A	15	Reclamation
GP	Green Mountain	Circuit breaker	JZ2A	15	Reclamation
GP	Green Mountain	Circuit breaker	JZ3A	15	Reclamation
GP	Green Mountain	Circuit breaker	JZ5A	15	Reclamation
GP	Green Mountain	Gas cylinder	Four cylinders	4x20	Reclamation
	Flatiron	Circuit breaker	U1A2	15.8	Reclamation

GP					
GP	Flatiron	Circuit breaker	U1A3	15.8	Reclamation
GP	Flatiron	Circuit breaker	U2A2	15.8	Reclamation
GP	Flatiron	Circuit breaker	U2A3	15.8	Reclamation
GP	Flatiron	Gas cart	Cryoquip HC series	0	Reclamation
GP	Flatiron	Gas cylinders	Two cylinders	2x5	Reclamation
GP	Mary's Lake	Circuit breaker	JYA	77	Reclamation
GP	Seminole	Circuit breaker	JY2A	60	WAPA
GP	Seminole	Gas cart		115 capability	Reclamation
GP	Seminole	Gas cylinders		2x115	Reclamation
GP	Kortes	Circuit breaker	JY1A	60	WAPA
GP	Kortes	Circuit breaker	JY4A	60	WAPA
GP	Kortes	Gas cylinders		2x115	Reclamation

## APPENDIX B

### SF<sub>6</sub> Emissions Inventory Reporting Protocol and Form

This protocol provides a template for reporting annual SF<sub>6</sub> emissions based on annual changes in SF<sub>6</sub> inventory. Use of the protocol to complete the SF<sub>6</sub> Emissions Reporting Form requires the following data:

- SF<sub>6</sub> gas in inventory at the beginning of the reporting year
- SF<sub>6</sub> gas in inventory at the end of the reporting year
- SF<sub>6</sub> gas additions to the inventory (e.g., purchases)
- SF<sub>6</sub> gas subtractions from the inventory (e.g., sales or returns)
- Changes in nameplate capacity

Gas in inventory refers to SF<sub>6</sub> gas contained in storage cylinders, gas carts, and other storage containers. It does not refer to SF<sub>6</sub> gas held in operating equipment.<sup>3</sup>

Gas additions and subtractions refer to SF<sub>6</sub> gas placed in or removed from the stored inventory, respectively. Gas additions also include SF<sub>6</sub> provided by equipment manufacturers with or inside new equipment.

- Complete tables 1 and 2 to estimate annual emissions. Use the Comments box to describe the means used to obtain a specific quantitative value (e.g., measured, estimated using rough data, or other comments including perceived accuracy of the form entries). Add additional comment sheets if necessary.

## Accounting for Acts of Nature and Other Non-Preventable Events

- An act of nature (e.g., lightning or earthquake) or other nonpreventable event of equipment failure (e.g., from a severe electrical fault) that destroys or damages a piece of equipment might result in a sudden, “catastrophic” loss of SF<sub>6</sub> to the atmosphere.<sup>4</sup> If SF<sub>6</sub> loss to the atmosphere occurs as a result of an act of nature or other non-preventable event, this loss should be reported on the form kept separate from normal annual emissions.<sup>5</sup>
  
- <sup>3</sup> **Reporting is required only on the change in inventory, not the absolute value. This method assumes gas is being added to equipment as needed to ensure adequate insulation.**

<sup>4</sup> The term “non-preventable” does not include releases from properly functioning equipment (caused by static and dynamic operation) or leakage (e.g., caused by deteriorated and leaking gaskets or seals).

<sup>5</sup> Such an event may also require reporting according to the Power Operation and Maintenance Incident Evaluation and Reporting Program and the Emergency Notification System.

### SF<sub>6</sub> Emissions Reporting Form

Date:	Office:	Contact:
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**Table 1**

Inventory		Amount (lbs)	Comments
A	Beginning of Year		
B	End of Year		

**Table 2  
Additions to Inventory**

	Amount (lbs)	Comments
1. Purchases of SF <sub>6</sub> (including SF <sub>6</sub> provided by equipment manufacturers with or inside new equipment)		
2. SF <sub>6</sub> returned to the site after off-site recycling		
<b>C: Total Additions (add items 1 and 2)</b>		

**Subtractions from Inventory**

	Amount (lbs)	Comments
3. Sales of SF <sub>6</sub> (to other entities, including gas left in retired equipment)		
4. SF <sub>6</sub> returned to supplier		
5. SF <sub>6</sub> taken from storage or equipment and disposed of		
6. SF <sub>6</sub> taken from storage or equipment and sent off site for recycling		
<b>D. Total Subtraction (add items 3 and 4)</b>		

**Change to Nameplate Capacity**

	Amount (lbs)	Comments
7. Total nameplate capacity of new equipment		
8. Total nameplate capacity of retiring equipment		
<b>E. Change to Nameplate Capacity (subtract item 8 from item 7)</b>		

<b>Total Annual Emissions = A – B + C - D – E</b>		
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**Release from Act of Nature or Other Unpreventable Event**

Type of Event <sup>1</sup>	Equipment Damage	Amount Released (lbs)	Comments