

	DEPARTMENT KEARNY MAINTENANCE AND OPERATIONS	DIVISION ELECTRIC TRANSMISSION AND DISTRIBUTION	DOCUMENT SECURITY INTERNAL
	SUBJECT STANDARD OPERATING PRACTICES		EFFECTIVE DATE 10/02/09
TITLE <b>SF6 EMISSIONS REPORTING - SUBSTATIONS</b>			DOCUMENT NUMBER <b>521.166</b>

## 1. PURPOSE

- 1.1. This Standard Operating Practice is applicable to all personnel responsible for the handling, management, and reporting of SF6 in high voltage substations on the SDG&E Electric System.

## 2. REFERENCE

- 2.1. SF6 Emissions Inventory Reporting Protocol and Form

## 3. DEFINITIONS

- 3.1. SF6 – Sulfur hexafluoride
- 3.2. SF6 Bottles – SF6 Compressed Gas Cylinders
- 3.3. GCB - Gas Circuit Breaker
- 3.4. Empty SF6 Bottles – SF6 Compressed Gas Cylinders that have been emptied by a SF6 Recovery System
- 3.5. Partial SF6 Bottles – SF6 Compressed Gas Cylinders that are checked in from the crew trucks, Districts, or SF6 GCB and have not yet been consolidated
- 3.6. SMMS – Substation Management Maintenance System (Cascade)
- 3.7. SSF – Substation Support Facility, Kearny (Dance Hall)

## 4. GENERAL

- 4.1. This report shall be completed by either of the following:
  - 4.1.1. Substation Maintenance Supervisor
  - 4.1.2. Engineering / Business Analyst

- 4.1.3. Substation Construction & Maintenance Engineer
- 4.2. **SF6 Emissions Inventory Reporting Protocol:** This protocol is based on the **EPA mass-balance approach**. This method works by tracking and systematically accounting for all substation uses of SF6 during the reporting year. The quantity of SF6 that cannot be accounted for is then assumed to be emitted to atmosphere. The method has four sub-calculations (A-D), a final total (E), and an optional emission rate calculation (F) as follows:
- 4.2.1. **(A) Change in Inventory:** This is the difference between the quantity of SF6 in storage at the beginning of the year and the quantity in storage at the end of the year. The “quantity in storage” includes SF6 gas contained in bottles, gas carts, and other storage containers. It does not refer to SF6 gas held in electrical equipment. The change in inventory will be negative if the quantity of SF6 in storage increases over the course of the year.
- 4.2.2. **(B) Purchase/Acquisitions of SF6:** This is the sum of SF6 acquired from other entities (both internal and external) during the year either in storage containers and/or in equipment.
- 4.2.3. **(C) Sales/Disbursements of SF6:** This is the sum of SF6 sold or otherwise disbursed to other entities (both internal and external) during the year either in storage containers or in equipment.
- 4.2.4. **(D) Change in Total Nameplate Capacity of Equipment:** This is the net increase of the total SF6 containing capacity (lbs.) in installed equipment during a year. Note, that “total nameplate” capacity refers to the mfg. recommended full and proper charge of the equipment, rather than to the actual charge, which may reflect leakage. This quantity will be negative if the retiring equipment has a total nameplate capacity larger than the total nameplate capacity of the new equipment.
- 4.2.5. **(E) Total Annual Emissions:** This is the total calculated SF6 emission for the inventory year. This emission is calculated using parameters A-D. The emission is presented in pounds of SF6 and in metric tons of CO2-equivalent. CO2 equivalent is 23,900 multiplied by the SF6 emission (multiplier subject to change based on regulatory guidelines, and represents the SF6 emission equivalent environmental impact relative to CO2).
- 4.2.6. **(F) Emissions Rate (optional):** This calculation represents the total SF6 emission as a percentage of nameplate capacity in the system. The emissions rate is equal to the total annual emissions divided by the total nameplate capacity. Total nameplate capacity of the system should reflect the status of the installed SF6 containing equipment in SDGE substations at the end of the reporting year.

- 4.3. **Information for (A) Change in Inventory:** This parameter is calculated with the Beginning of Year minus the End of Year total [4.3.1 - 4.3.2]. SF6 bottles are tracked on a transaction basis in the SMMS with “Check-OUT” and “Check-IN” read sheets designating movement of SF6 bottles between locations and approved entities. If transaction inspections are incomplete, an end of year inventory of every SF6 bottle must be performed to reconcile SF6 cylinders prior to the next reporting year. If a full bottle inventory is not performed, SF6 bottle leaks will be reported in the year the next transaction occurs.
- 4.3.1. Beginning of Year weights: This number will equal the total recorded weights on January 1st of the recordable year. This is taken from the previous report “End of Year” inventory.
- 4.3.2. End of Year weights: This number will equal the total recorded weights on December 31st of the recordable year. This can be calculated by totaling the last known “Check-IN” SF6 gas weights in the SMMS.
- 4.4. **Information for (B) Purchase/Acquisitions of SF6:** This parameter totals acquisition of SF6 gas from all sources both external and internal to SDGE. Addition of all inputs [4.4.1 + 4.4.2 + 4.4.3]
- 4.4.1. SF6 purchased from producers or distributors in cylinders: New cylinders shipped from the factory with circuit breakers will be brought to SSF, properly labeled with an SDGE tracking number, and entered into the SMMS. Note: Any unaccounted SF6 Bottles that do not have an SDGE tracking number are considered an acquisition (considered new) for the current year that the cylinder was found. This prevents inconsistencies in the mass balance equation that will produce a negative emission.
- 4.4.2. SF6 provided by equipment manufacturers with/inside equipment: All 230kV class and below, gas-filled circuit breakers are shipped with approximately 5 PSI of SF6 gas. This prevents air and moisture ingress into the breaker. (Note: 500kV are shipped empty). Calculation of gas quantities acquired in each breaker is found in 4.4.2.1.
- 4.4.2.1. Calculation that shall estimate the given gas contained in a new SF6 GCB.
- $$P2 * C * (329.313 + 1.206 * T1) / (P1 * 329.313 + (1.206 * T2))$$
- P1 = Normal (rated) pressure for GCB  
P2 = added pressure to the GCB  
C = Total (rated) SF6 capacity of the GCB  
T1 = Normalized temperature (rated temp. for rated capacity)  
T2 = GCB Tank temperature

NOTE:  $T1 = T2$  to estimate the lbs of SF6 contained in New GCB simplifying the formula to  $(P2 * C) / P1$ .

4.4.2.1.1. Example:  $P1 = 65$  psi;  $P2 = 5$  psi;  $C = 33$  lbs.  
 $T1 = 293K$ ;  $T2 = 293K$

$$(5 * 33) / 65 = 2.54 \text{ lbs}$$

4.4.2.1.2. Assumption of SF6 gas in Stock Breakers with 5 psi

Siemens

69 kV (C = 33 lbs) = 2.54 lbs

138 kV (C = 58 lbs) = 4.46 lbs

230 kV (C = 161 lbs) = 12.38 lbs

ABB

230kV (C = 270) lbs) = 15.52 lbs

4.4.3. SF6 returned to the site after off-site recycling: Contaminated SF6 gas is periodically shipped to a vendor for off-site purification. Returning SF6 gas is treated as an acquisition. This is calculated by totaling the "Check-IN" read sheets from off-site recyclers.

4.5. **Information for (C) Sales/Disbursements of SF6**: This parameter totals all disbursements of SF6 gas to entities both internal and external to SDGE. Addition of all inputs [4.5.1 + 4.5.2 + 4.5.3 + 4.5.4]

4.5.1. Sales of SF6 to other entities: Any gas in retired or sold equipment are evacuated and stored in SF6 bottles. This field usually equals zero unless exceptions apply.

4.5.2. Returns of SF6 to supplier: A small amount of SF6 gas is returned in cylinders that are shipped back to suppliers. This small amount of SF6 gas is used to maintain positive pressure on the bottle to prevent air and moisture contamination. SF6 gas is generally consolidated and reused, rather than returned to supplier, leaving the quantity shipped back to suppliers very small. SF6 bottles are rarely returned to the supplier, therefore this field is normally zero.

4.5.3. SF6 sent to destruction facilities: A small amount of SF6 gas cylinders are designated for disposal. This small amount of SF6 gas is used to maintain positive pressure on the bottle to prevent air and moisture contamination. This field is calculated by taking the total of "Check-OUT" orders assigned to destruction facilities for the reporting year.

- 4.5.4. SF6 sent off-site for recycling: Contaminated SF6 gas with air or excessive decomposition is sent to a vendor for off-site SF6 restoration. This field is calculated by taking the total of “Check-OUT” orders assigned to SF6 recycling facilities for the reporting year.
- 4.6. **Information for (D) Change in Nameplate Capacity**: New Equipment minus Retired or Sold Equipment. [4.6.1 – 4.6.2]
- 4.6.1. Total nameplate capacity (proper full charge) of NEW equipment: The total of all new SF6 gas equipment nameplate capacity. This is found by totaling the nameplate capacity of all gas circuit breakers with a “New Setup” order closed during the reporting year in the SMMS.
- 4.6.2. Total nameplate capacity (proper full charge) of RETIRED or SOLD equipment: The total of all retired or sold SF6 gas equipment nameplate capacity. This is found by totaling the nameplate capacity of all gas circuit breakers with a “Remove From Service” order closed during the reporting year in the SMMS.
- 4.7. **Information for (E) Total Annual Emissions**: The total fugitive SF6 emission is calculated using the fields found in Section 4.3, 4.4, 4.5, and 4.6 with the given formula [4.3 + 4.4 – 4.5 – 4.6]
- 4.8. **Information for (F) Emissions Rate**: The emissions rate is calculated with the information provided in Section 4.7 and with the known Total Nameplate Capacity at End of Year. [(Section 4.7)/(Total Nameplate Capacity of System)]
- 4.8.1. This is the total nameplate capacity of all ACTIVE equipment installed in SDGE substations. Nameplate information for each piece of equipment is found within the SMMS, under the GCB nameplate information, with the heading “Total SF6 Weight”.
- 4.9. **Other Reporting Criteria**
- 4.9.1. Transaction Recording
- 4.9.1.1. The mass-balance equation reporting method relies on timely transactions. Care must be taken to record balancing transactions in the same reporting year to ensure accurate emission reporting. Examples of these transactions are listed below.
- 4.9.1.2. EX: Transactions required when filling a GCB
- Check-OUT of SF6 bottle to crew (full weight)
  - Addition of GCB nameplate capacity to total
  - Acquisition of SF6 gas contained in GCB (prior to fill)
  - Check-IN of SF6 bottle to storage facility (empty)

- 4.9.1.3. EX: Acquisition of SF6 cylinder from vendor
  - Check-IN of SF6 bottle to storage facility (full weight)
  - Addition of SF6 bottle to inventory (acquisition)

- 4.9.1.4. EX: Disbursement of SF6 cylinder for recycling
  - Check-OUT of SF6 bottle to vendor (full weight)
  - Logged disbursement of SF6 bottle

4.9.2. SF6 Compressed Gas Cylinder Characteristics:

4.9.2.1. Kearny (SSF) stocks 3 standard size bottles with the following assumed TARE weights. Any discrepancy between assumed cylinder Tare weight and actual Tare weight will be eliminated when calculating the change in SF6 cylinder inventory.

Cylinder Size (O.D. x Length)	Cylinder Weight (lbs.)
9 x 56 (80)	115
7.4 x 46.6 (60)	60
7 x 27 (40)	30

**5. ATTACHMENTS**

- 5.1 SF6 Emissions Reduction Partnership for Electric Power Systems Annual Reporting Form

5.1

SF<sub>6</sub> Emissions Reduction Partnership for Electric Power Systems

**Annual Reporting Form**

Name:	<input type="text"/>	Company Name:	<input type="text"/>
Title:	<input type="text"/>	Report Year:	<input type="text"/>
Phone:	<input type="text"/>	Date Completed:	<input type="text"/>

**Change in Inventory (SF<sub>6</sub> contained in cylinders, not electrical equipment)**

Inventory (in cylinders, <b>not</b> equipment)	AMOUNT (lbs.)	Comments
1. Beginning of Year		
2. End of Year		
<b>A. Change in Inventory (1 - 2)</b>	-	

**Purchases/Acquisitions of SF<sub>6</sub>**

	AMOUNT (lbs.)	Comments
3. SF <sub>6</sub> purchased from producers or distributors in cylinders		
4. SF <sub>6</sub> provided by equipment manufacturers with/inside equipment		
5. SF <sub>6</sub> returned to the site after off-site recycling		
<b>B. Total Purchases/Acquisitions (3+4+5)</b>	-	

**Sales/Disbursements of SF<sub>6</sub>**

	AMOUNT (lbs.)	Comments
6. Sales of SF <sub>6</sub> to other entities, including gas left in equipment that is sold		
7. Returns of SF <sub>6</sub> to supplier		
8. SF <sub>6</sub> sent to destruction facilities		
9. SF <sub>6</sub> sent off-site for recycling		
<b>C. Total Sales/Disbursements (6+7+8+9)</b>	-	

**Change in Nameplate Capacity**

	AMOUNT (lbs.)	Comments
10. Total nameplate capacity (proper full charge) of <u>new</u> equipment		
11. Total nameplate capacity (proper full charge) of <u>retired</u> or <u>sold</u> equipment		
<b>D. Change in Capacity (10 - 11)</b>	-	

**Total Annual Emissions**

	lbs. SF <sub>6</sub>	Tonnes CO <sub>2</sub> equiv. (lbs.SF <sub>6</sub> ÷23,900/2205)
<b>E. Total Emissions (A+B-C-D)</b>	-	-

**Emission Rate (optional)**

	AMOUNT (lbs.)	Comments
Total Nameplate Capacity at End of Year		
	PERCENT (%)	
<b>F. Emission Rate (Emissions/Capacity)</b>	-	

## Revision History

Date Issued	Changes Made	By
10/02/09	New Procedure - Rev. 0	S. Muscarella

Titles	Name	Date
AUTHORED BY: C. MITSUI Engineer I		10/2/09
REVIEWED BY: F. BARKER Substation Maint Supv		10-2-09
APPROVED BY: F. JOHNSON Substation Constrn & Maint Mgr		10-2-09
ISSUED BY: S. MUSCARELLA Engineer I		10-2-09