Draft revision to approved baseline and monitoring methodology AM0035

"SF_6 Emission Reductions in Electrical Grids"

I. SOURCE AND APPLICABILITY

Source

This methodology is based on the project activity "Reducing SF_6 Emissions in High-Voltage Transmission/Distribution Systems in Nigeria", whose baseline and monitoring methodology and project design document were prepared by Quality Tonnes and World Bank Carbon Finance Unit.

For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0135: "SF_6 Emission Reductions for Electrical Grids" on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

This methodology also refers to the latest version of the "Tool for the demonstration and assessment of additionality".

Selected approach from paragraph 48 of the CDM modalities and procedures

"Actual or historical emissions, as applicable".

Applicability

The methodology is applicable to project activities:

- To recycle SF_6 and/or reduce SF_6 leaks implemented at an electric utility;
- Implemented either in the entire electrical grid or a verifiable distinct geographic portion of an electrical grid of the electric utility;
- Where documented proof is available to confirm that reduction in emissions of SF_6 from replaced or repaired equipment is not claimed by any other CDM project. The DOE shall verify the documentation at validation as well as at verification.

II. BASELINE METHODOLOGY

Project boundary

The physical boundary is the electrical grid or subset of electrical grid where the project activity of recycling and leak reduction program is implemented. The greenhouse gas included is SF_6, which is commonly used as an insulator in electrical transmission and distribution grids. ~~Any part of the grid where SF_6 leak reduction and recycling was being implemented prior to the start of project activity shall be excluded from the project boundary.~~ If further emission reductions are achievable through improvement of efficiency in certain part of the grid even if SF_6 leak reduction and recycling was being implemented prior to the start of project activity, it can be included in the project boundary.

NOTE: In defining the project boundary it shall be ensured that all quantity of SF_6 gas moving in and out of the project boundary shall be well documented and these documents made available for audit by the DOE. The DOE shall check that these documents are consistent with the financial accounts of the project participants.

Table 1: Summary of gases and sources included/excluded in the project boundary.

	Source	Gas	Included?	Justification / Explanation
Baseline	SF_6 emissions from utility equipment (trans-formers, circuit breakers, etc.	SF_6	Yes	The project activity is prevention of SF_6 release into atmosphere.
		CO_2	No	No CO_2 emissions occur
		CH_4	No	No CH_4 emissions occur
Project Activity	SF_6 emissions from utility equipment (trans-formers, circuit breakers, etc.	SF_6	Yes	The project activity is prevention of SF_6 release into atmosphere.
		CH_4	No	No CO_2 emissions occur
		CH_4	No	No CH_4 emissions occur

Procedure for the selection of the most plausible baseline scenario

The methodology covers the following categories of SF_6 emissions reductions from the equipment within the project boundary:

- Recycling SF_6 encapsulated in existing equipment during repairs;
- Recycling SF_6 encapsulated in existing equipment during decommissioning; and
- Reduction in leaks by repairing the equipment;
- Recycling SF_6 encapsulated in existing equipment during routine inspection (Appendixes II and III of this methodology).

The baseline scenario shall be determined by analyzing the following potential alternatives

- Implementing the project activity without CDM; and
- Continuation of the current present practice, which shall be described in the CDM-PDD.

Step 1: Assessment of National Policy/regulations on SF_6

- List national or regional policies/regulation that either require reduction of SF_6 emissions from the power sector or prescribe maintenance standards that affects SF_6 release to atmosphere.
  - If such policies exist, assess the enforcement of the policies;
  - If above-mentioned policies/regulations exist and are enforced, then the project activity implemented without CDM is the baseline scenario.

Step 2: Assess if implementation of SF_6 recycling by any utility or by the utility in any part of its electrical grid is being undertaken.

- Identify and list the level and extent of SF_6 recycling being undertaken within the region or country where the project activity is implemented;
- If some utilities do undertake SF_6 recycling, are there factors that prevent the implementation of the same activity within the project boundary of the project activity. If not then the project activity implemented without CDM is the baseline scenario. If factors do prevent implementation of the same

activity then documented evidence for these factors preventing implementation shall be reported in the CDM-PDD and validated by the DOE.

~~Note: If the baseline is continuation of the present practice, then any existing efforts to recycle SF_6 shall not be included in the project boundary.~~

This methodology is applicable only if the baseline scenario is continuation of the current ~~present~~ practice.

Additionality

Additionality shall be demonstrated using the latest version of the latest version of the "Tool for the demonstration and assessment of additionality". In addition, it must be shown that no sectoral or regional/national-level policies exist that require the recycling or leak management of SF_6 in electric utility infrastructure.

The barriers listed below should be evaluated as part of the application of the latest version of the ~~"tool for the demonstration and assessment of additionality"~~ "Guidelines for objective demonstration and assessment of barriers":

- Investment barriers, other than the economic/financial barriers, e.g.:
    - Real and/or perceived risks associated with the technology or process are too high to attract investment;
    - Funding is not available for innovative projects.
- Technological barriers, e.g.:
    - Skilled and/or properly trained labour to operate and maintain the technology is not available, leading to equipment disrepair and malfunctioning;
- Barriers due to prevailing practice, e.g.:
    - Developers lack familiarity with state-of-the-art technologies and are reluctant to use them;
    - The project is the "first of a kind";
    - Management lacks experience using state-of-the-art technologies, so that the project receives low priority by management;
    - Perceived technical and financial risks to enterprises (fears that a new technology may not work, could interrupt production, take time to perfect, or will not actually result in financial savings);
    - Real and perceived insignificance of many investments – for example, if energy efficiency (or SF_6) projects are relatively small and the value of the savings achieved typically is only a small percentage of enterprise operating costs.

These identified barriers are to be considered only if they would prevent potential project proponents from carrying out the proposed project activity were it not registered as a CDM activity.

Baseline emissions

The baseline emissions are the total SF_6 emitted from both leaks and non-recycling of SF_6 during repair and maintenance of the equipment in the baseline. The methodology provides two options to determine baseline emissions depending on the availability of historical information.

Option 1: Historical data is available

The calculations of SF_6 emitted shall be made in accordance with the 2006 IPCC SF_6 electric utility methodology guidelines, using the Tier 3 method.[1]

Data for at least three years prior to the start of the project shall be used to establish the baseline. The data shall be based on inventory and all the purchase records and use data according to the steps described below.[2] In order to be conservative, the year with the lowest SF_6 emissions of the three or more years will be taken for the baseline.

The yearly emissions of SF_6 of year y are estimated using the following equation:

~~The baseline emissions of SF_6 are estimated using the following equation:~~

$$AE_X = DI_X + AI_X - SI_X + REC_X - NEC_X \quad (1)$$

Where:

AE_x	=	Annual SF_6 emissions in year x prior the implementation of the project activity (Kg SF_6)
DI_x	=	Decrease in inventory during the year (kg SF_6)
AI_x	=	Additions to inventory during the year (kg SF_6)
SI_x	=	Subtractions from inventory during the year (kg SF_6)
REC_x	=	Retired Equipment Capacity expressed as nameplate capacity of retired equipment (kg SF_6)
NEC_x	=	New Equipment Capacity expressed as nameplate capacity of new equipment (kg SF_6)

The baseline emissions of SF_6 are estimated using the following equation:

~~$$BE_y = (DI_x + AI_x - SI_x + REC_x - NEC_x) \times \frac{GWP_{SF6}}{1000} \quad (1)$$~~

$$BE_y = \min(AE_{X-1}; AE_{X-2}; AE_{X-3}) \times \frac{GWP_{SF6}}{1000} \quad (2)$$

Where:

BE_y	=	Baseline emissions during the year *y* (tCO_2/yr)
AE_{x-1} AE_{x-2} AE_{x-3}	=	Annual SF_6 emissions in in the three years prior the implementation of the project activity(KgSF_6)

[1] The 2006 IPCC Guidelines for National Greenhouse Gas Inventories, in its Volume 3 (Industrial Processes and Product Use), chapter 8, outlines a methodology to determine SF6 emissions from individual utilities as part of a methodology to calculate the national level emissions of SF6. Generally, emissions estimates developed using the Tier 3 method, which is implemented at the facility level, will be the most accurate, and as such should be used or otherwise well justified. Simply put, if a utility purchased 2000 kg of SF6 in the baseline year to recharge leaking circuit breakers, but is able to reduce those purchases to 1000 kg the following year by recycling SF6 before maintenance and repairing leaks, the utility can claim 1000 kg of emissions reductions.

~~[2] In cases where three years of data do not exist, the project developer will need to demonstrate that the data does not exist and explain the steps being taken to ensure that the baseline year data is not being manipulated. This would likely include a detailed description of normal operating practices over the past three year period and a detailed description of activities using the order of magnitude test described in the 'Linkage Between Project Activities and Emission Reduction Results' section.~~

DI_x	=	Decrease in inventory in the baseline year (only cylinders; from beginning of baseline year until end; number can be negative. This is expressed as "cylinders at the beginning of the year less that at the end of the year in the inventory.) (kg SF_6)
AI_x	=	Additions to Inventory in baseline year (cylinder purchases, recycled SF_6 returned to inventory (captured from retiring equipment) and any SF_6 included in new equipment fully charged by manufacturer) (kg SF_6)
SI_x	=	Subtractions from inventory in baseline year (only cylinders; sold back to supplier, or sent for recycling) (kg SF_6)
REC_x	=	Retired Equipment Capacity expressed as nameplate capacity of retired equipment (kg SF_6)
NEC_x	=	New Equipment Capacity expressed as nameplate capacity of new equipment (kg SF_6)
GWP_{SF6}	=	Global warming potential of SF_6 (tCO_2e/tSF_6)

Note: Any Force Majeure events that affect the measurement of inventory will be factored out of the baseline. This will be done in a conservative manner as follows: if a piece of SF_6 containing equipment is destroyed by a force majeure event, releasing all of its SF_6, the project developer will calculate the inventory change as an emissions-neutral event. This means that the nameplate capacity of the old equipment will be calculated as equal to the new equipment. This is conservative, since it assumes that all the SF_6 in the name plate capacity of the equipment destroyed was actually present at the time of destruction (i.e. no leaks).

The data inventory should be maintained in a the same or similar format to that provided in the Annex Appendix I to this methodology.

The inventory estimates shall be cross-checked with estimation of emissions based on the: (i) inventory of all SF_6 containing equipment within the project boundary; and (ii) all actions used to reduce SF_6 emissions. This is called the order of magnitude test and is described in the monitoring methodology section.

Option 2: No historical data is available

In case that there is no historical information available, project proponents shall identify all the devices that use SF6 in the project activity and estimate a conservative baseline emissions using default factor for SF6 emissions in the absence of the project activity.

The baseline emissions of SF_6 are estimated using the following equation:

$$BE_y = E_{rate} \times \frac{GWP_{SF6}}{1000} \sum_1^N C_i \quad (3)$$

Where:

BE_y	=	Baseline emissions during the year *y* (tCO_2/yr)
E_{rate}	=	Default baseline emission rate
C_i	=	Nameplate capacity for the gas insulated equipment (kg SF_6)
GWP_{SF6}	=	Global warming potential of SF_6 (tCO_2e/tSF_6)

Project Emissions

$$PE_y = \left(DI_y + AI_y - SI_y + REC_y - NEC_y\right) \times \frac{GWP_{SF6}}{1000} \quad (4)$$

Where:

PE_y	=	Project emissions during the year *y* (tCO_2/yr)
DI_y	=	Decrease in inventory in year y ~~(only cylinders; from beginning of year until end; number can be negative)~~ (kg SF_6)
AI_y	=	Additions to Inventory in year y ~~(cylinder purchases, recycled SF_6 returned to inventory and any SF_6 included in new equipment fully charged by manufacturer)~~ (kg SF_6)
SI_y	=	Subtractions from inventory in year y ~~(only cylinders; sold back to supplier, or sent for recycling)~~ (kg SF_6)
REC_y	=	Retired Equipment Capacity, expressed as nameplate capacity of retired equipment, in year y (kg SF_6)
NEC_y	=	New Equipment Capacity, expressed as nameplate capacity of new equipment, in year y (kg SF_6)
GWP_{SF6}	=	Global warming potential of SF_6 (tCO_2e/tSF_6)

The inventory estimates shall be cross-checked with estimation of emissions based on the: (i) inventory of all SF_6 containing equipment within the project boundary; and (ii) all actions used to reduce SF_6 emissions. This is called the order of magnitude test and is described in the monitoring methodology section.

Leakage

There is no consideration of leakage as leakage is not likely to occur.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \textbf{(5)}$$

Where:

ER_y	=	Emission reductions during the year *y* (tCO_2/yr)
BE_y	=	Baseline emissions during the year *y* (tCO_2/yr)
PE_y	=	Project emissions during the year *y* (tCO_2/yr)

Changes required for methodology implementation in 2nd and 3rd crediting periods

Project proponents shall use the latest version of the tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" when considering the necessary changes in the 2nd and 3rd crediting period.

~~No changes are required for consideration of the methodology in future crediting periods. It should be noted that the project developer will need to check on national and regional policies at the renewal of each crediting period, in case these have changed. In case the project, or part of the project activity, has become part of the baseline due to changes in policies, the project developer will have to redefine the baseline as appropriate or potentially withdraw the project from consideration for a new CDM project period.~~

~~At the renewal of crediting period, the guidance provided in Annex 7 of the report of the Board's twentieth meeting or any revisions of it shall be taken into account while assessing the continued validity of the baseline and updating the baseline.~~

Data and parameters not monitored

Use the following table for each data/parameter

Data / parameter:	**GWP_{SF6}**
Data unit:	tCO_2e/tSF_6
Description:	Global warming potential for SF_6
Source of data:	IPCC
Measurement procedures (if any):	23,900 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	

Data / parameter:	**E_{rate}**
Data unit:	
Description:	Default baseline emission rate
Source of data:	The default baseline emission rate will vary every year. In year 2012 the rate will be 10% and then it will decrease every year until it reaches a final value of 1% in year 2021. The value of 1% will remain constant after 2020, as provided in the following table: (see table below)
Measurement procedures (if any):	None
Any comment:	

Year	**E_{rate} value**
2012	10%
2013	9%
2014	8%
2015	7%
2016	6%
2017	5%
2018	4%
2019	3%
2020	2%
2021	1%

III. MONITORING METHODOLOGY

Monitoring procedures

The methodology is based on a mass-balance approach following 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, Chapter 8, using Tier 3 Method. The project developer must document changes in SF_6 inventories in a baseline year (at least three years of data required with the lowest of the three years being the baseline) that would point to its use to recharge equipment due to leaks and emissions during maintenance. The reduced demand of SF_6, as identified from the data provided in the inventory during project crediting period, will be used to calculate the reduction of emissions resulting from repaired leaks and recycling.

The following steps are followed in estimating the SF_6 needed every year and, hence, the emissions:

1. Estimate the net decrease in the amount of SF_6 inventory over the baseline year;
2. Add the amount purchased including SF_6 contained in purchased equipment;
3. Subtract any SF_6 returned to supplier;
4. Add any recycled SF_6 returned to inventory;
5. Subtract any SF_6 sent to recycling firms, sold to other entities, destroyed by the utility; or installation, or returned to the supplier;
6. Add the nameplate capacity of the retired equipment;
7. Subtract nameplate capacity of new equipment.

Good records required for the effective management of SF6 inventories.

The following should be recorded:

- The location and identification reference of the equipment;
- The make and type of the equipment;
- The quantity of SF_6 installed in each item when first commissioned;
- The quantity of SF_6 added;
- Any quantity of SF_6 recovered during servicing, maintenance and final disposal;
- Establish and maintain a current and complete GIS equipment inventory, which includes the following information for each piece of equipment:
    - Manufacturer serial number;
    - Equipment type (e.g., circuit breaker, transformer, etc.);
    - Seal type (hermetic or non-hermetic);
    - Equipment manufacturer name;
    - Date equipment was manufactured;
    - Equipment voltage capacity;
    - Equipment SF_6 nameplate capacity;
    - A chronological record of the dates on which SF_6 was transferred into or out of active GIS equipment;
    - The amount of SF_6 transferred into or out of the active GIS equipment;
    - Equipment status (active or inactive);
    - Equipment location;
- Establish and maintain a current and complete inventory of gas containers;
- Retain SF_6 gas and equipment purchase documentation (such as contracts, material invoices, receipts, etc.).

SF_6 Inventory Measurement Procedures

- Establish and adhere to written procedures to track all gas containers as they are leaving and entering storage;
- Weigh all gas containers on a scale that is certified by the manufacturer to be accurate to within one percent of the true weight;
- Establish and maintain a log of all measurements required;
- Record the scale calibration methods used;
- Retain all documents and records required for a minimum of three years;
- Improved filling procedures on site;
- Use of sealed pressure systems, where available;
- Better monitoring in service (for closed pressure systems);

- Target older existing equipment with known leakage problem for repair/replacement;
- Improved maintenance procedures, including RCM (Reliability Centered Maintenance);
- Improved end-of-life recovery and recycling (in co-operation with specialised disposal/recycling entities);
- Human resources:
    - Ensure that only certified personnel are used for any activity involving the recovery of SF_6;
    - Make sure all personnel (both in-house and contractors) working on switchgear containing SF_6 understand the environmental impacts of emitting SF_6 to the atmosphere. Initial filling of equipment is an area where significant emissions can occur. Ensure all personnel are properly trained to minimize emissions, especially on initial filling of equipment.

Linkage Between Project Activities and Emission Reduction Results

An Order of Magnitude check[3] shall be performed each year.

To implement this order of magnitude check a continuous and detailed record of all repairs, rehabilitations, and recycling included in the project activity shall be recorded. For each activity, the documentation should cover the equipment involved, the type of action, and the estimated amount of SF_6 involved. An example below presents the data to be stored for an order of magnitude test.

[3] Described in Chapter 8, Volume 3, of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Description of Project Activities	Description of Equipment Involved in the activity (including nameplate capacity of SF_6)	Force Majeure event	Best Estimate of SF_6 Inventory Increase (+) or Decrease (-): Please include reasons for estimates
Recycled SF_6 from decommissioned Circuit breaker	GE High Voltage Circuit Breaker 250 kV 250kg SF_6 Capacity		+250kg Based on number of tanks filled
Repair SF_6 leak in High Voltage Circuit Breaker	ABB High Voltage Circuit Breaker 500kV 500kg SF_6 capacity		-25kg Based on estimate of gas injected into circuit breaker following the repair
Performed Basic Maintenance on Circuit Breaker requiring removal of SF_6	Pars Switch High Voltage Circuit breaker 145kV 250kg SF_6 capacity		+250kg - 250kg = 0 SF_6 was recycled from unit and returned after the maintenance was complete. In the baseline scenario this would have likely resulted in a -250kg, since the SF_6 would have been vented before the repair and replaced with new SF_6.
Replaced High Voltage Circuit breaker	Previous: ABB High voltage 250kV SF_6 100kg New: ABB High Voltage 250kV SF_6 25kg	Yes- Lightening and fire destroyed old unit	+100kg leaked +25kg new entering inventory This action would be conservatively factored out of the emission reduction results for the year

The order of magnitude estimate results in a range for SF_6 emissions. This range shall be compared with the results from the mass balance approach described in the baseline methodology ~~(equation 1 and 2)~~. If the mass balance estimate lies outside the range, the reason for differences should be identified and explained. If the difference cannot be explained, CERs for that period cannot be claimed. The data required for order of magnitude test and explanation of any differences with mass balance approach should be documented as part of the monitoring plan and annual monitoring reports submitted for verification.

Box 1. Example of order of magnitude check Based on the mass balance formulas, the emission reductions are estimated to be 1,500 kg of SF_6 (35,850 tCO_2e) in a given year during the crediting period. Typically, an order of magnitude test as described in this methodology provides a range of emissions reductions rather than a precise number. In this example, if the order of magnitude test yielded a range of 1,050 kg to 1,950 kg of savings (i.e. 1,500 kg ±30%), then this check would confirm the mass balance estimate, since the mass balance estimate was within the range. In other words, if the mass balance estimate falls within the range of the order of magnitude check, then this validates the mass balance estimate and CERs can be issued accordingly. If the order of magnitude check leads to an estimate of 100 to 300 kg emissions reductions, then clearly something is wrong. Because the mass balance estimate is higher than the range from the order of magnitude check, no CERs would be awarded to the project. . If the order of magnitude check range is higher than the mass balance estimate of 1,500 kg (e.g. in the range of 2,000-3,000 kg), then the lower 1,500 kg figure would be used in order to be conservative.

Data and parameters monitored

Data / parameter:	**C_i**
Data unit:	Kg SF_6
Description:	Nameplate capacity for the gas insulated equipment
Source of data:	Nameplate or purchase orders
Measurement procedures (if any):	
Monitoring frequency:	At the time of purchase
QA/QC procedures:	

Data / parameter:	**DI_x, DI_y**
Data unit:	kg SF_6
Description:	Decrease in inventory during the year
Source of data:	Project inventory records
Measurement procedures (if any):	Based on number of cylinders in inventory at start and end of year.
Monitoring frequency:	DI_x: at start and end of year for at least three years prior to project start; DI_y: at start and end of each year during project operation
QA/QC procedures:	Metering will rely on the simple counting of cylinders. The cylinders are filled using meters with 99% accuracy, and are double checked by weighing cylinders on scales with 99% accuracy. QA/QC will also include checking purchase records by trained staff. There will be little or no chance for human error given the simple nature of the measuring process and the double checks undertaken. All meters and scales will be calibrated as per manufacturers' recommendations
Any comment:	Number can be negative

Data / parameter:	**AI_x, AI_y**
Data unit:	kg SF_6
Description:	Additions to inventory during the year
Source of data:	Project inventory, purchase records, and supplier and recycler receipts
Measurement procedures (if any):	This includes purchased cylinders, SF_6 included in new equipment, and SF_6 returned from recyclers (where the equipment are sent out of the project boundary for recycling).
Monitoring frequency:	Continuous, as and when purchases or receipt of equipment/recycled SF_6 is realized;
QA/QC procedures:	Metering will rely on the simple counting of cylinders. The cylinders are filled using meters with 99% accuracy, and are double checked by weighing cylinders on scales with 99% accuracy. QA/QC will also include checking purchase records by trained staff. There will be little or no chance for human error given the simple nature of the measuring process and the double checks undertaken. All meters and scales will be calibrated as per manufacturers' recommendations
Any comment:	

Data / parameter:	**SI_x, SI_y**
Data unit:	kg SF_6
Description:	Subtractions from inventory during the year
Source of data:	Supplier receipts and purchase records
Measurement procedures (if any):	This includes cylinders sold back to supplier or equipment sent for recycling contained SF_6
Monitoring frequency:	Continuous, as purchases or changes in equipment happen;
QA/QC procedures:	Metering will rely on the simple counting of cylinders. The cylinders are filled using meters with 99% accuracy, and are double checked by weighing cylinders on scales with 99% accuracy. QA/QC will also include checking purchase records by trained staff. There will be little or no chance for human error given the simple nature of the measuring process and the double checks undertaken. All meters and scales will be calibrated as per manufacturers' recommendations
Any comment:	

Data / parameter:	**REC_x, REC_y**
Data unit:	kg SF_6
Description:	Retired equipment capacity in a given year
Source of data:	Nameplate of equipment or manufacturer's specifications
Measurement procedures (if any):	Nameplate capacity of equipment retired will be recorded
Monitoring frequency:	Continuous, as equipment is retired;
QA/QC procedures:	Inventories will be maintained and regularly checked
Any comment:	

Data / parameter:	**NEC_x, NEC_y**
Data unit:	kg SF_6
Description:	New equipment capacity in a given year
Source of data:	Nameplate of equipment
Measurement procedures (if any):	Nameplate capacity of new equipment will be recorded
Monitoring frequency:	Continuous, as equipment is retired;
QA/QC procedures:	Inventories will be maintained and regularly checked
Any comment:	

Appendix I: A Typical SF_6 Reporting Form

Annual Reporting Form

Name:		Company Name:	
Title:		Month or Year:	
Phone:		Date Completed:	

Change in Inventory (SF_6 contained in cylinders, not electrical equipment)

Inventory (in cylinders, **not** equipment)	AMOUNT (kg)	Comments
1. Beginning of Year		
2. End of Year		
A. Change in Inventory (1 - 2)	-	

Purchases/Acquisitions of SF_6

	AMOUNT (kg)	Comments
3. SF_6 purchased from producers or distributors in cylinders		
4. SF_6 provided by equipment manufacturers with/inside equipment		
5. SF_6 returned to the site after off-site recycling		
B. Total Purchases/Acquisitions (3+4+5)	-	

Sales/Disbursements of SF_6

	AMOUNT (kg)	Comments
6. Sales of SF_6 to other entities, including gas left in equipment that is sold		
7. Returns of SF_6 to supplier		
8. SF_6 sent to other facilities		
9. SF_6 sent off-site for recycling		
C. Total Sales/Disbursements (6+7+8+9)	-	

Change in Nameplate Capacity

	AMOUNT (kg)	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		
D. Change in Capacity (10 - 11)	-	

Total Annual Emissions

	kg SF_6	Tonnes CO_2 equiv. (kglbs. SF_6x1000x23,900/1000)
E. Total Emissions (A+B-C-D)	-	-

Appendix II: Best practices on routine inspections

The maintenance of circuit breakers deserves special consideration because of their importance for routine switching and for protection of other equipment. Electric transmission system breakups and equipment destruction can occur if a circuit breaker fails to operate because of a lack of preventive maintenance. Breakers that remain idle for 6 months or more should be made to open and close several times in succession to verify proper operation and remove any accumulation of dust or foreign material on moving parts and contacts.

a)Maintenance of molded circuit breakers

Frequency of maintenance: Molded case circuit breakers are designed to require little or no routine maintenance throughout their normal lifetime. As an accumulation of dust on the latch surfaces may affect the operation of the breaker, molded case circuit breakers should be exercised at least once per year. Routine trip testing should be performed every 3 to 5 years.

Routine Maintenance test:

- Insulation resistance test;
- Millivolt drop test;
- Connections test;
- Overload tripping test;
- Mechanical operation.

b)Maintenance of low-Voltage circuit breakers

Frequency of maintenance: Low-voltage circuit breakers operating at 600 volts alternating current and below should be inspected and maintained very 1 to 3 years, depending on their service and operating conditions. Conditions that make frequency maintenance and inspection necessary are:

- High humidity and high ambient temperature;
- Dusty or dirty atmosphere;
- Corrosive atmosphere;
- Frequent switching operations;
- Frequent fault operations;
- Older equipment.

Maintenance procedures:

- Initial check;
- Cleaning of insulating parts;
- Checks and adjustments of movable and stationary contacts;
- Checks arc chutes;
- Inspect breaker operating mechanism;
- Clean and relubricate operating mechanism;
- Set breaker operating mechanism adjustments;
- Replaced contacts if in bad condition;
- Inspect wiring connections for tightness;
- Check after servicing circuit breaker.

c) Maintenance of Medium-Voltage Circuit Breakers

Frequency of maintenance: Medium-voltage circuit breakers which operate in the range of 600 to 15,000 volts should be inspected and maintained annually or after every 2,000 operations, whichever comes first. Safety practices: Maintenance procedures include the safety practices indicated in the ROMSS (Reclamation Operation & Maintenance Safety Standards).

d) Maintenance of High-Voltage Circuit Breakers
Frequency of inspections: Most manufacturers recommend complete inspections, external and internal, at intervals of from 6 to 12 months.

Other

The adoptions of tools such as "Failure Modes and Effects Analysis or Reliability Analysis" minimize the need for monitoring and maintenance for modern electrical systems. For SF6 switchgear two classes are available today: sealed and closed pressure systems. For the first one no need for any refilling is required during the whole life cycle; consequently no monitoring or maintenance is needed. In the second case each compartment can be equipped with density monitoring devices alerting and ultimately preventing gas losses.

Appendix III: Standards to be considered

In case of repair, the maintenance operations including SF_6 handling and operational procedures shall be in accordance with IEC 61634 requirements.

Standard Code	Description
IEC 62271-1	Common specifications for SF6-insulated and air-insulated high-voltage switchgear and control gear.
IEC 62271-200	High-Voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-203	High-voltage switchgear and controlgear Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV (Revision published in 9/2011).
IEC 62271-303	High-voltage switchgear and control gear – Part 303: Use and handling of sulphur hexafluoride (SF6) (Revision in progress: IEC 62271-4)
IEC 60376	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment (Maintenance of the standard scheduled until 2014. Target: 1 standard only, SF6-Gas mixtures to be included, recommendation on monitoring).
IEC 60480	Guidelines for the checking and treatment of sulfur hexafluoride (SF6) taken from electrical equipment and specification for its re-use
IEEE C37.122	Gas Insulated Substations
IEEE C37.122.3-2011	Guide for Sulphur Hexaflouride (SF6) Gas Handling for High-Voltage (over 1000Vac) Equipment.
ASTM D2472-00 SF6-gas	
ENA-ER S38	Engineering recommendation in reporting SF6 bank, emissions and recovery
PAS55	Asset management Standard
Cigré. SF6 tightness guide Nº 430	Guarantee of SF6 tightness due to state-of-the-art equipment and testing
Cigré. SF6 handling guide Nº 276	Avoid SF6 handling losses due to stat-of-the-art handling
Cigré. SF6 recycling guide. Nº 234	Assure long term use of SF6

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History of the document

Version	Date	Nature of revision(s)
02.0.0	13 September 2012	EB 69, Annex Revision includes: • Clarify that enhanced SF_6 recovery is allowed as baseline scenario; • Incorporate procedures to determine baseline emissions in case of lack of historical information; • Add a provision for the inclusion of recycling of SF_6 during routine inspection as a project activity.
01	EB 26, Annex 2 29 September 2006	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		