

MONITORING REPORT FORM (CDM-MR) *
Version 01 - in effect as of: 28/09/2010

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* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

MONITORING REPORT
Version 01, 06/01/2011

**Point of Use Abatement Device to Reduce SF6 emissions in LCD Manufacturing Operations in the
Republic of Korea (South Korea)**

Reference number 3440
The 2nd monitoring period, 01/10/2010 – 31/12/2010

SECTION A. General description of the project activity

A.1. Brief description of the project activity: >>

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LG Display (LGD) currently uses SF6 in its LCD manufacturing process in Plant 2/3, Plant 4/5, Plant 6 in Gumi, South Korea and Plant 7 in Paju, South Korea. To destroy much of the SF6 vented from the dry etching process, LG International (LGI) and LGD installed an abatement device at the stack of the dry etching chambers in Plant 6. And additional abatement devices which will have similar technical specification with the existing system will be installed in the other plants in the very near future.

The project activities during this monitoring period includes only Plant 6 and the other Plants mentioned in the registered Project Designed Document will be included from the subsequent monitoring period or thereafter depending on the investment timeline of each abatement system. The emission reductions achieved during this monitoring period comes from the abatement system in Plant 6 and, therefore, all information provided in this report is limited only to that of the existing system in Plant 6.

To decompose SF6 gas, high temperature, around 1,200°C, is necessary and diverse continuous measurements on both inlet and outlet are required to ensure accurate and reliable monitoring outcomes of emission reductions. For this purpose, an end-of-pipe abatement device was selected. And, In order to capture the actual amount of SF6 entering and subsequently leaving the abatement device, the project participants have been undertaking an extensive ongoing monitoring operation. This monitoring operation includes installing and maintaining Fourier Transform Infrared (FTIR) devices on both the inlet and the outlet of the abatement device to continuously monitor the concentration of SF6 and calculate the mass of SF6 destroyed. In addition, two sets of Quadrupole Mass Spectrometer (QMS) were installed to calculate accurate values of dry molecular weights of both the inlet and the outlet gases as the applied methodology requires. This result has been converted into a carbon equivalent value and any emissions resulting from electricity and/or fuel consumption of the abatement device has been subtracted to arrive at the emission reduction value for the project activity.

The following information contains dates of key events of the project

Date	Progress
February 13, 2009	The applied methodology, developed by the project participants, was approved by the CDM EB.
June 1, 2009	An EPC contract was signed and construction was commenced.
July 10, 2010	The project was approved by the CDM EB
July 23, 2010	The commissioning of the abatement system was completed.
August 1, 2010 ~	The crediting period of the project was started and operation was commenced.
December 31, 2010	The 2 nd monitoring period was over and the emission reduction data for the period was confirmed.

The total emission reduction achieved for the 2nd monitoring period, starting from October 1, 2010 and ending on December 31 of the same year, is 216,586 tons of CO2 equivalent.

A.2. Project Participants

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LG International Corp.

LG Display Co., Ltd.

Climate Change Capital Carbon Fund II s.a.r.l.

A.3. Location of the project activity:

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Plant 6, having the GPS coordinates of (36.0944°, 128.4111°), is located at Gumi, Gyeongsangbuk-do, Republic of Korea.



Plant 6,
Gumi, Gyeongsanbuk-do

Plant 6
Gumi, Gyeonsangbuk-

A.4. Technical description of the project

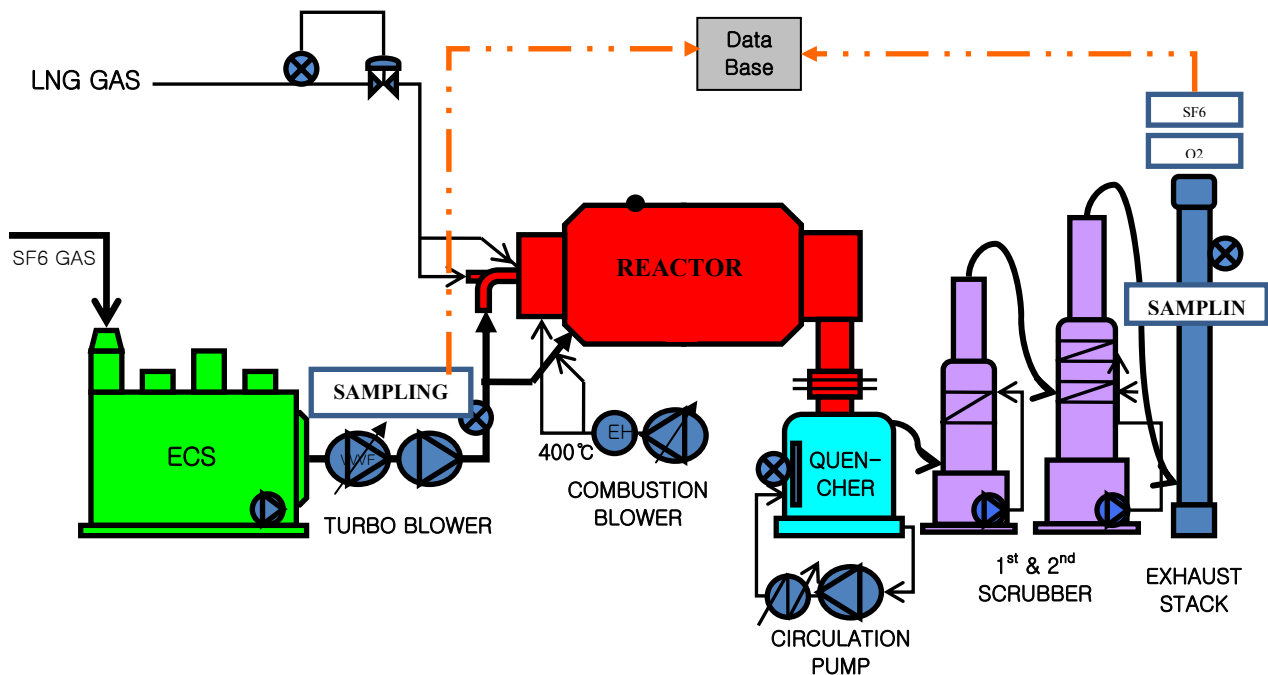
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This project installed the necessary abatement equipments required to destroy SF6 that is vented from the Dry Etching processes in the manufacture of LCD panels. Specifically, the abatement technology requires temperature around 1,200°C to break down and destroy the SF6. The specifications of the abatement device installed in Plant 6 are as follows:

Abatement Device Specifications for P-6 Plant	
ITEM NO.	CO-01
SERVICE NAME	REACTOR
QUANTITY	1 SET Per Plant
TYPE	HORIZONTAL & CYLINDRICAL
HEAT CAPACITY	10.4 GJ/HR (2.5 x10 ⁶ Kcal/hr)

TREATMENT CAPACITY (SF6 GAS)	40.2 Nm ³ /MIN
TOTAL CAPACITY (Overall Gas)	109 Nm ³ /MIN
RESIDENCE TIME	1 SECOND (CHAMBER)
DIMENSION	2,400mm × 7,800mmL

And the following figure shows the configuration of the whole abatement system. The abatement system consists of 4 main devices; ECS, reactor, quencher and scrubbers.



1) ECS (Pre-treatment system)

This Device removes F-compounds such as HF(SF6 is not excluded), water soluble acidic/toxic components and dusts with 1~0.1μ m diameters from inlet gas before the gas enters into the reactor. NaOH is used as a reaction material with HF and HCl and dusts being charged by an ionizer are gathered in a packing bed located at the end of the ionizer.

2) Reactor

The reactor is a core technology of this system. This reactor is operated at 1200℃ and secures the removal efficiency higher than 95%.

3) Quencher

To avoid SF6 recombination, the gas exiting from the reactor should be cooled rapidly to below 70℃. The quencher is made of carbon graphite to stand extreme heat stress and to efficiently cool down the exiting gas.

4) 1st&2nd Scrubber

Two sets of scrubbers were installed to remove hazardous gas components such as HF, SOx and NOx from the treated gas. Each scrubber has 85% removal efficiency, the two sets of scrubbers installed in series, therefore, guarantee 97.7% removal efficiency and ensure that any regulated air pollutants of the ventilated gas are well within legally accepted limit.

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

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“Point of Use Abatement Device to Reduce SF6 emissions in LCD Manufacturing Operations”

Approved baseline and monitoring methodology AM0078 v.1.1

“Combined tool to identify the baseline scenario and demonstrate additionality.” v.2.2

“Tool to calculate the emission factor for an electricity system.” v.2

“Tool to calculate baseline, project and/or leakage emissions from electricity consumption.” v.1

“Tool to calculate project or leakage CO2 emissions from fossil fuel combustion.” v.2

“Guidelines for objective demonstration and assessment of barriers” EB50 Annex 13

“Guidelines on the assessment of investment analysis” EB51 Annex 58

A.6. Registration date of the project activity:

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July 10, 2010

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

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August 1, 2010 – July 31, 2020 (Fixed)

The starting date of the crediting period has been changed from July 10, 2010 to August 1, 2010 following the project participants’ request made on July 22, 2010. The request was sent to the UNFCCC secretariat and subsequently accepted.

A.8. Name of responsible person(s)/entity(ies):

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SEO, Young Suk

LG International Corp.

LG Twin Towers, 20, Yoido-dong, Youngdungpo-gu

Seoul, 150-606

Korea

Tel: +82-2-3773-5298

E-mail: ysseo@lgi.co.kr

SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

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The commissioning of the abatement device installed in Plant 6 was completed on July 23, 2010 and has been operational since August 1, 2010. Any commercial orders for additional sets of abatement devices to be installed in the other plants are yet to be made at the time of writing. As the project participants described in the registered PDD, the other plants will be invested after the performance of the existing abatement system has been confirmed. The project participants expect the expansion will be able to be commenced in 2011.

And the followings are information on special events including overhaul times, downtimes of the system and exchange of any equipment. (Any replacement works of consumables are excluded.)

Events	Date	Duration	Effects on emission reduction
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Inlet FTIR Maintenance	Oct 13, 2010	70 minutes	FTIR maintenance was done and meaning less values of inlet SF6 concentration were recorded during this period. Hence, any reductions calculated during this period were completely deducted from the emission reductions calculation.
Inlet Annubar Maintenance	Oct 21, 2010	40 minutes	The transmitter of the inlet Annubar was substituted with a new one having broader detecting range to ensure more stable measurement. Any reductions calculated during this replacement work were completely deducted from the emission reductions calculation.
Inlet FTIR Maintenance	Oct 22, 2010	170 minutes	Periodic FTIR maintenance was done and meaning less values of inlet SF6 concentration were recorded during that period. Hence, any reductions calculated during this period were completely deducted from the emission reductions calculation.
PLC logic change	Oct 26, 2010	50 minutes	Following the transmitter substitution of the inlet annubar, PLC logic was changed reflecting the changed detecting range of the new transmitter. Communication was disconnected during this work; therefore, any reductions calculated during this period were completely deducted from the emission reductions calculation.
emergency shut-down of the reactor	Oct 28, 2010	50 minutes	While change the set value of the softening system, the lower limit value was set at 99.99% instead of 25.00% by mistake and this caused emergency shut-down of the system. Any reductions during the shut-down were automatically deducted from the emission reductions calculation.
FTIR zero-span check	Oct 29, 2010	240 minutes	A regular FTIR zero-span check (once per 3 months) was done and the emission reductions during the check were manually deleted from the emission reductions calculation.
FTIR Calibration	Nov 8, 2010	320 minutes	A full-scale calibration of both the inlet and the out FTIRs was done and any emission reductions calculated during that period were deducted from the daily emission reduction calculation.
FTIR Analyzing computer error	Nov 17, 2010	40 minutes	The data analyzing computer for the inlet FTIR failed to read real-time data due to a program error. The problem was solved after re-booting the computer. All reductions during this event were manually deleted from the daily emission reductions calculation.
emergency shut-down of the reactor	Nov 20, 2010	30 minutes	While controlling the combustion air pressure, an operator incidentally mistyped 1195 mmH2O instead of 1995mmH2O, which is lower than the lower limit in the interlock logic. Due to the wrong value, the system was shut down. The reactor was re-ignited immediately and all reductions were automatically not counted until the system became stabilized.
emergency shut-down of the reactor	Dec 2, 2010	13 minutes	While duct damper replacement work in dry etching chamber lines done by LG Display, the inlet flow rate increased very rapidly and caused

			flame lost of the reactor. The reactor re-ignited immediately and became normalized in 13 minutes. And reductions during this time were automatically deducted from the emission reductions calculation.
FTIR Calibration	Dec 7, 2010	610 minutes	A full-scale calibration of both the inlet and the out FTIRs was done again to verify the accuracy of the earlier calibration and it was confirmed that there was no meaningful deviation in the calibration curves. Any emission reductions calculated during that period were deducted from the daily emission reduction calculation.

The above events have not had any adverse effects on the applicability of the applied methodology and no other event which may impact the applicability of the methodology has occurred during the monitoring period.

B.2. Revision of the monitoring plan

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No revision on the approved monitoring plan has been made.

B.3. Request for deviation applied to this monitoring period

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No deviation has been made.

B.4. Notification or request of approval of changes

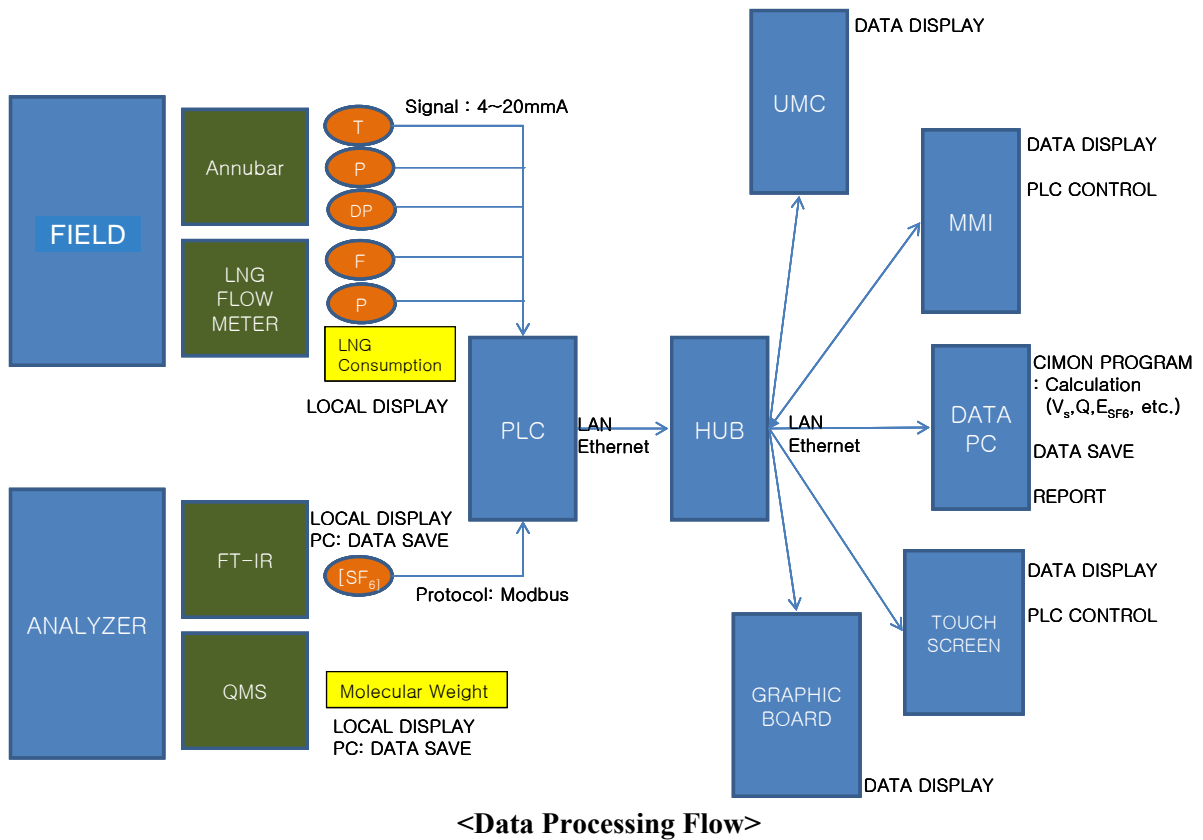
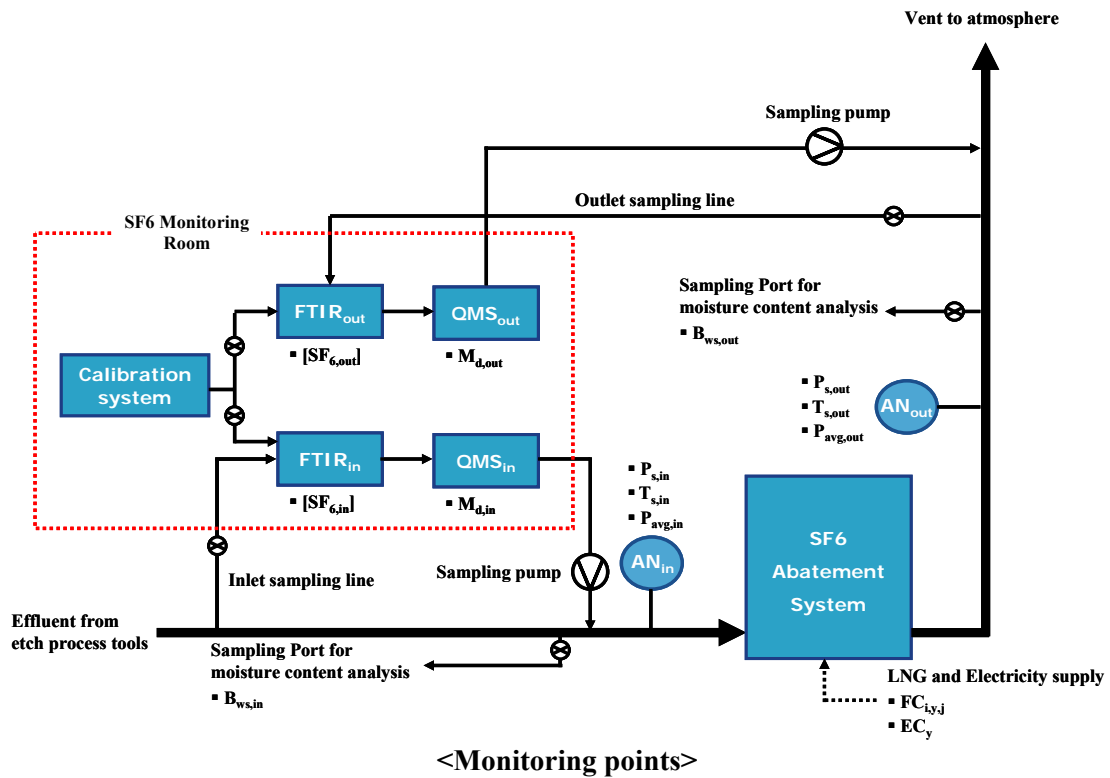
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No notification or request of approval of changes on the project activity has been made.

SECTION C. Description of the monitoring system

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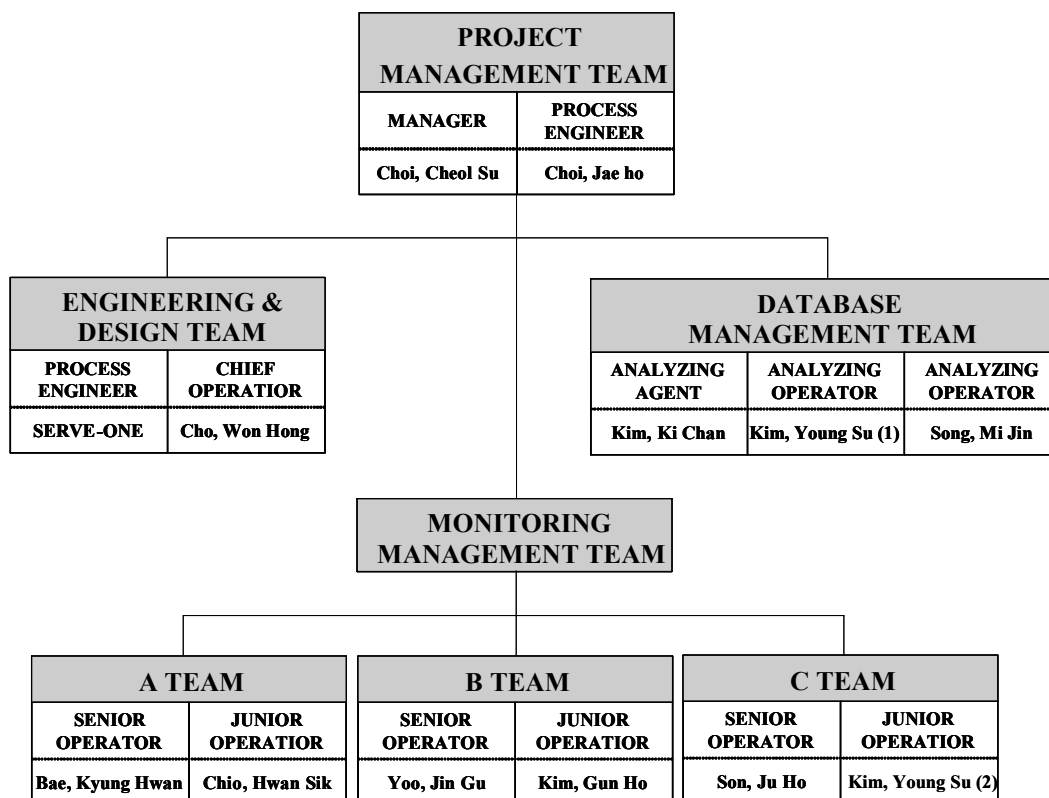
Parameters used in the emission reductions calculation can be classified into 4 groups – continuously monitored group, frequently monitored group, calculated group and externally provided group. The following diagrams show all relevant monitoring points and how the continuously monitored factors and frequently monitored factors are gathered, processed, calculated, recorded and reported.



The continuously monitored parameters including temperature, pressure, velocity head and concentration of SF6 in both inlet and outlet gases are measured by each metering device described in Section D.2. The data is transmitted to PLC through electrical signal and subsequently distributed to other devices such as Main

Monitoring Interface (MMI), Utility Monitoring Center (UMC) and computers to control the whole system and to calculate emission reductions. The emission reduction is calculated by the data processing program and the results are recorded along with other raw data on server computers. The result is reported to the project participant by the operation team on daily, weekly and monthly bases. In case of the externally provided group, the project participants secured accuracy and transparency of data through diverse QA/QC activities. The activities include crosschecking with logbook/SAP data, invoice/letter from suppliers and other reliable measures.

The operation team consists of several sub-teams namely Project Management team, Engineering & Design team, Database Management team and Operation Management team. The following is an organizational structure of the operation team.



Each sub team has following roles and responsibilities;

1) Project Management team's roles and responsibilities

- Responsible for the overall legal affairs for SF6 decomposition facilities
- Secure operations of the SF6 decomposition facilities in accordance with the CDM methodology
- Secure and manage human resources necessary for operations of SF6 decomposition facilities
- Training practice and evaluation of each team member necessary for operations
- Amicable performance over operations of the facilities in cooperation with managers of LG
- Check and supervision over operating conditions for SF6 decomposition facilities
- Responsible supervision for calibrations of metering devices and supervision for suppliers

2) Engineering & Design team's roles and responsibilities

- Designer for the overall operations for SF6 decomposition facilities
- Maintain the proper operating conditions and performance for SF6 decomposition facilities
- Risk management for operations of SF6 decomposition facilities
- System design in accordance with the methodology
- Improvements on equipments for SF6 decomposition facilities and system

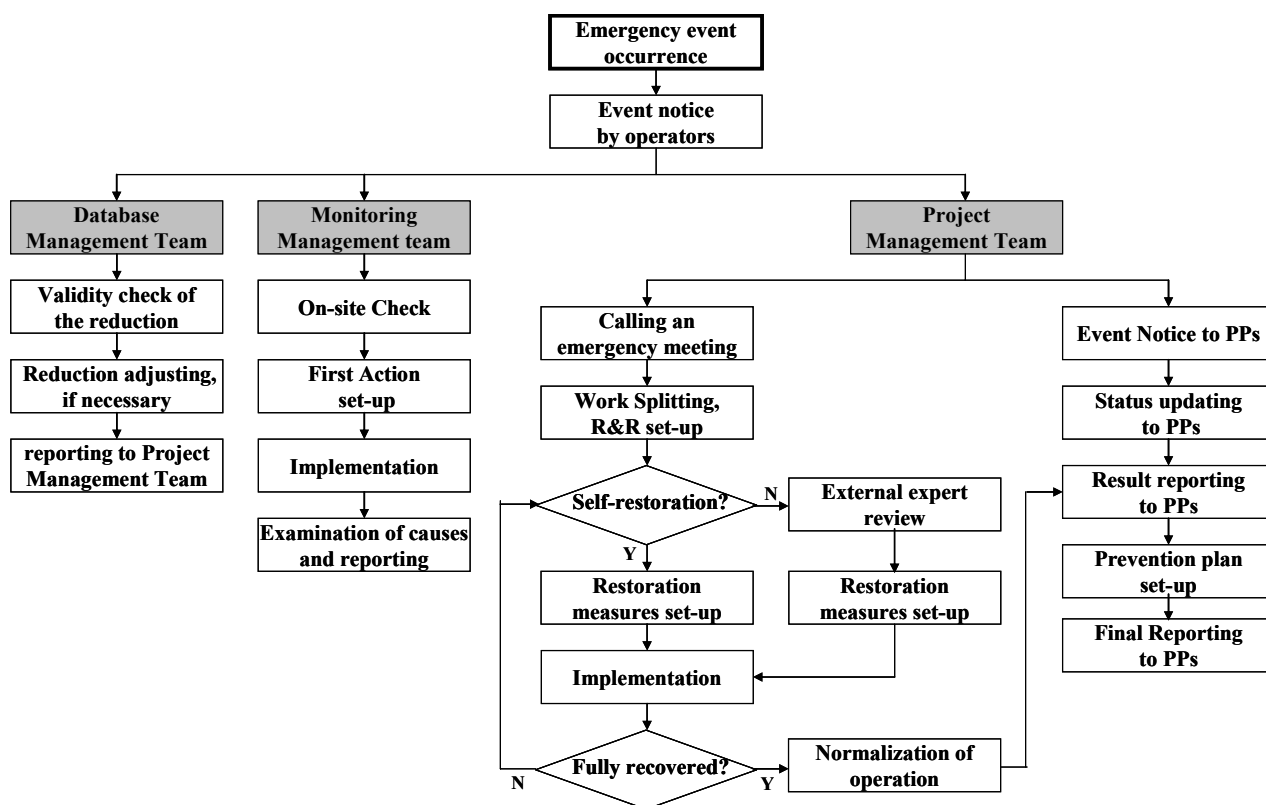
3) Database Management team's roles and responsibilities

- Actual operator of SF6 decomposition facilities
- Data monitoring and record required in the methodology
- Establish alarm values and monitor them
- Regular check on SF6 decomposition facilities

4) Monitoring Management team's roles and responsibilities

- Data measurement and storage necessary for the methodology
- Store measurement data for 2 years after the last credit period
- Calibration of metering device and reporting of calibration results
- Maintenance/repair and report of metering devices
- Accuracy check and result report for measurements
- Check and troubleshooting on any alarm from metering devices
- Daily/weekly/monthly report for measurement data
- Auditing for calibration works on metering devices

The operation team has set up emergency plans for the main system and metering devices. When emergency events occur, the following emergency procedure will be applied.



More detailed information on monitoring system is included in a Data Management Manual which has been provided to DOE for verification purpose.

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

(Copy this table for each data and parameter. To report multiple values, a table may be used)

Data / Parameter:	GWP of SF ₆
Data unit:	tCO ₂ eq/tSF ₆
Description:	Global Warming Potential of SF ₆

Source of data used:	IPCC default value
Value(s) :	23,900
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline calculation.
Additional comment:	Provided by the IPCC to calculate the global warming potential of SF ₆

Data / Parameter:	Design capacity for existing Abatement Device ($CAP_{SF6, ex}$)
Data unit:	Tonnes/year
Description:	Design capacity should be based on the maximum flow allowed for normal operation of abatement device, based on the assumption that the existing abatement device is operating at full design capacity for the entire period of the year (i.e. 8760 hours).
Source of data used:	Historic operation design of existing plants
Value(s) :	None- Not applicable
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline calculation.
Additional comment:	There is no abatement device on the existing lines of production or plants included in this project.

Data / Parameter:	Historical SF ₆ consumption (<i>CSF</i> 6, <i>hist</i>)																	
Data unit:	Tonnes																	
Description:	Historical SF ₆ consumption of Plant 6, calculated as the three years maximum consumption prior the implementation of the project activity before 31 January 2009. Consumption is defined as the total SF ₆ purchased in a year, taking into account the change in inventory in a specific year.																	
Source of data used:	Record of purchase and inventory																	
Value(s) :	<div>19.213 tonnes</div> <div>This value is the maximum consumption of SF6 in Plant 6 over the three year historic period.</div> <table><tr><td rowspan="2">Fab</td><td colspan="3">Yearly SF6 consumption (kg)</td></tr><tr><td>'06</td><td>'07</td><td>'08</td></tr><tr><td>P6 (in the PDD)</td><td>55,024</td><td>73,990</td><td>76,226</td></tr><tr><td>P6 (adjusted)</td><td>13,869</td><td>18,650</td><td>19,213</td></tr></table> <div>For this monitoring purpose, only 92 days of C_{SF6,hist} is necessary. Therefore, the values presented in the PDD are re-calculated on a pro-rata basis.</div>			Fab	Yearly SF6 consumption (kg)			'06	'07	'08	P6 (in the PDD)	55,024	73,990	76,226	P6 (adjusted)	13,869	18,650	19,213
Fab	Yearly SF6 consumption (kg)																	
	'06	'07	'08															
P6 (in the PDD)	55,024	73,990	76,226															
P6 (adjusted)	13,869	18,650	19,213															
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline calculation.																	
Additional comment:	For this monitoring period, only Plant 6 is operational. Therefore, only the data for Plant 6 is included.																	

Data / Parameter:	Historical production of LCD substrate (SP-i)
Data unit:	m ²
Description:	Historical production of LCD substrate (m ²) of Plant 6 during year i (where i = -1, -2, -3) prior to the implementation of the project activity

	before January, 31, 2009 (values of 92 days, for this monitoring purpose)																	
Source of data used:	Production record																	
Value(s) :	<table border="1"> <thead> <tr> <th rowspan="2">Fab</th><th colspan="3">Glass input(m2)</th></tr> <tr> <th>'06</th><th>'07</th><th>'08</th></tr> </thead> <tbody> <tr> <td>P6 (in the PDD)</td><td>4,078,800</td><td>5,252,354</td><td>5,680,338</td></tr> <tr> <td>P6 (adjusted)</td><td>1,028,081</td><td>1,323,881</td><td>1,431,756</td></tr> </tbody> </table> <p>For this monitoring purpose, only 92 days of SP_i is necessary. Therefore, the values presented in the PDD are re-calculated on a pro-rata basis.</p>			Fab	Glass input(m2)			'06	'07	'08	P6 (in the PDD)	4,078,800	5,252,354	5,680,338	P6 (adjusted)	1,028,081	1,323,881	1,431,756
Fab	Glass input(m2)																	
	'06	'07	'08															
P6 (in the PDD)	4,078,800	5,252,354	5,680,338															
P6 (adjusted)	1,028,081	1,323,881	1,431,756															
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline calculation.																	
Additional comment:	For this monitoring period, only Plant 6 is operational. Therefore, only the data for Plant 6 is included.																	

Data / Parameter:	Maintenance schedule for abatement device
Data unit:	List of maintenance requirements and checking frequency
Description:	Complete maintenance schedule for the device
Source of data used:	Yearly plan of Operation & Maintenance team
Value(s) :	A summary of this information has been submitted to the DOE for verification purpose.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable
Additional comment:	This data is not used for calculating emission reduction. However, reporting this data is required by the applied methodology.

Data / Parameter:	Maintenance schedule for FTIR measurement devices
Data unit:	List of maintenance requirements and checking frequency
Description:	Complete maintenance schedule for the device
Source of data used:	Yearly plan of Operation & Maintenance team
Value(s) :	A summary of this information has been submitted to the DOE for verification purpose.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable
Additional comment:	This data is not used for calculating emission reduction. However, reporting this data is required by the applied methodology.

Data / Parameter:	Maintenance schedule for QMS measurement devices
Data unit:	List of maintenance requirements and checking frequency
Description:	Complete maintenance schedule for the device
Source of data used:	Yearly plan of Operation & Maintenance team
Value(s) :	A summary of this information has been submitted to the DOE for verification purpose.
Indicate what the data are used for (Baseline/ Project/ Leakage emission	Not applicable

calculations)	
Additional comment:	This data is not used for calculating emission reduction. However, reporting this data is required by the applied methodology.

Data / Parameter:	Maintenance schedule for Annubar devices
Data unit:	List of maintenance requirements and checking frequency
Description:	Complete maintenance schedule for the device
Source of data used:	Yearly plan of Operation & Maintenance team
Value(s) :	A summary of this information has been submitted to the DOE for verification purpose.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable
Additional comment:	This data is not used for calculating emission reduction. However, reporting this data is required by the applied methodology.

Data / Parameter:	$EF_{grid,CM,y}$
Data unit:	tCO ₂ /MWh
Description:	Combined margin CO ₂ emission factor for grid connected power generation using ex-ante option of three most recent years of available data for the OM and the most recent information available at the time of submission for validation to the DOE for BM.
Source of data used:	Values have been calculated using the “Tool to calculate the emission factor for an electricity system v.2”
Value(s) :	0.5708 TCO ₂ /MWh
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project calculation.
Additional comment:	This data has been verified by the DOE which validated the project and will be used for the whole crediting period of the project.

Data / Parameter:	$C_{p,in}$
Data unit:	dimensionless
Description:	Pitot tubes or Averaging Pitot Tube coefficient of the inlet Annubar device
Source of data used:	Annubar device manufacturer specification
Value(s) :	1
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project calculation.
Additional comment:	As specified in the registered PDD, This data is applicable only to Plant 6 and values applicable to the other plants will be verified at the following verification or thereafter when each plant becomes operational and included in the monitoring period thereof.

Data / Parameter:	$C_{p,out}$
Data unit:	dimensionless
Description:	Pitot tubes or Averaging Pitot Tube coefficient of the outlet annubar device
Source of data used:	Annubar device manufacturer specification
Value(s) :	1
Indicate what the data are	This data is used for the project calculation.

used for (Baseline/ Project/ Leakage emission calculations)	
Additional comment:	As specified in the registered PDD, This data is applicable only to Plant 6 and values applicable to the other plants will be verified at the following verification or thereafter when each plant becomes operational and included in monitoring period thereof.

Data / Parameter:	Cross sectional area of the inlet stack (A_{in})
Data unit:	m^2
Description:	The cross sectional of the circular inlet stack, which should be greater than 0.3 m in diameter.
Source of data used:	Supplier's specification
Value(s) :	0.0961625
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project calculation.
Additional comment:	0.175m * 0.175m*3.14 (Diameter of the inlet stack is 0.35m) As specified in the registered PDD, This data is applicable only to Plant 6 and values applicable to the other plants will be verified at the following verification or thereafter when each plant becomes operational and included in monitoring period thereof.

Data / Parameter:	Cross sectional area of the outlet stack (A_{out})
Data unit:	m^2
Description:	The cross sectional of the circular outlet stack, which should be greater than 0.3 m in diameter.
Source of data used:	Supplier's specification
Value(s) :	0.2826
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project calculation.
Additional comment:	0.3m * 0.3m*3.14 (Diameter of the outlet stack is 0.6m) As specified in the registered PDD, This data is applicable only to Plant 6 and values applicable to the other plants will be verified at the following verification or thereafter when each plant becomes operational and included in monitoring period thereof.

D.2. Data and parameters monitored	
<i>(Copy this table for each data and parameter. To report multiple values, a table may be used)</i>	
Data / Parameter:	ESF _{6,in,y}
Data unit:	tonnes
Description:	Mass of SF ₆ gas entering the abatement device in year y (From October 1, 2010 to December 31, 2010, for this monitoring purpose)
Measured /Calculated /Default:	Calculated
Source of data:	Data processing program and Daily/weekly/monthly logs
Value(s) of monitored parameter:	10.0399 tonnes
Indicate what the data are	This data is used for the Baseline emission calculation.

used for (Baseline/ Project/ Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	This value is a sum of daily $E_{SF6, in}$ values for the monitoring period. For the monitoring equipment information of $E_{SF6, in}$, please refer to the $E_{SF6, in}$ table in this section.
Measuring/ Reading/ Recording frequency:	Once per year or a monitoring period, whichever is shorter.
Calculation method (if applicable):	Sum of daily $E_{SF6, in}$
QA/QC procedures applied:	Daily sum of $E_{SF6, in}$ value is automatically calculated by a data processing program and recorded in a daily log by operators. The log is double- checked by the head of O&M team and sum of weekly and monthly data are reported to the project participants periodically. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.

Data / Parameter:	$C_{SF6, y}$
Data unit:	Tonnes
Description:	Annual consumption of SF ₆ during the project year y, defined as the total SF ₆ purchased in a specific project year y taking into account the change in inventory in the same year. (From October 1, 2010 to December 31, 2010, for this monitoring purpose)
Measured /Calculated /Default:	Calculated
Source of data:	Purchase records, monthly records on SF ₆ inventory change and cylinder replacement records.
Value(s) of monitored parameter:	21.286 tonnes
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	Once per year or a monitoring period, whichever is shorter.
Calculation method (if applicable):	(Total SF ₆ purchase Amount – Inventory change) * 10% of heel value
QA/QC procedures applied:	This data is cross-checked with official purchase records and inventory data is measured and recorded at the beginning and end of each month. Residual gas quantity (Heel value), which is smaller than 10%, is measured and recorded every replacement. The average value of the residual gas quantity during the monitoring period is 5.9%. However, for more conservative calculation, 10% of heel value is applied in the emission reduction calculation.

Data / Parameter:	$SP_{project, y}$
Data unit:	m^2

Description:	Production of LCD substrate during the project year y (From October 1, 2010 to December 31, 2010, for this monitoring purpose)
Measured /Calculated /Default:	Measured
Source of data:	Manufacturing Execution system of LG Display
Value(s) of monitored parameter:	1,565,247 m ²
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	This data comes from the Manufacturing Execution System of LG Display, which is a computerized system commonly used in the manufacturing industry.
Measuring/ Reading/ Recording frequency:	Once per year or a monitoring period, whichever is shorter.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Cross check with LGD's monthly & annual production summary reports

Data / Parameter:	ESF _{6,in}
Data unit:	Gram / second
Description:	Emissions of SF ₆ gas measured at the inlet of the SF ₆ abatement system
Measured /Calculated /Default:	Calculated
Source of data:	From inlet QMS, FTIR and inlet Annubar devices
Value(s) of monitored parameter:	Sums of the daily, weekly and monthly data of E _{SF₆, in} are recorded and reported.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	1.37 gram / second This is the average value during the monitoring period.
Measuring/ Reading/ Recording frequency:	Once per second
Calculation method (if applicable):	Equation 14 in the applied methodology $E_{SF6in} = 65.18Q_{in}[SF_{6in}]$
QA/QC procedures applied:	Daily sum of E _{SF₆,in} value is automatically calculated by a data processing program and recorded in a daily log by operators. The log is double- checked by the head of O&M team and sum of weekly and monthly data are reported to the project participants periodically. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.

Data / Parameter:	ESF _{6,out}
Data unit:	Gram / second

Description:	Emissions of SF ₆ gas measured at the outlet of the SF ₆ abatement system
Measured /Calculated /Default:	Calculated
Source of data:	Data processing program
Value(s) of monitored parameter:	Sums of the daily, weekly and monthly data of E _{SF₆, out} are recorded and reported.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	0.01 gram / second This is the average value during the monitoring period.
Measuring/ Reading/ Recording frequency:	Once per second
Calculation method (if applicable):	Equation 15 in the applied methodology $E_{SF6out} = 65.18Q_{out}[SF_{6out}]$
QA/QC procedures applied:	Daily sum of E _{SF₆,out} value is automatically calculated by a data processing program and recorded in a daily log by operators. The log is double- checked by the head of O&M team and sum of weekly and monthly data are reported to the project participants periodically. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.

Data / Parameter:	M_{s,in}
Data unit:	g/mole
Description:	Maximum molecular weight of inlet stack gas, wet basis
Measured /Calculated /Default:	Calculated
Source of data:	Data processing program, inlet QMS and water vapour measurement report
Value(s) of monitored parameter:	28.175 g/mole (for the period from Aug 20, 2010 to Oct 29, 2010) 28.474 g/mole (for the period from Oct 30, 2010 to Dec 31, 2010)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable This is a calculated data.
Measuring/ Reading/ Recording frequency:	Once per year, at least
Calculation method (if applicable):	Equation 8 in the applied methodology $M_{s,in} = M_{d,in} \cdot (100 - B_{ws,in}) \div 100 + 0.18B_{ws,in}$
QA/QC procedures applied:	This is a calculated data through measured M _{d,in} and B _{ws,in} . Therefore, QA/QC procedures for M _{s,in} follow those of M _{d,in} and B _{ws,in} .

Data / Parameter:	M_{s,out}
Data unit:	g/mole

Description:	Minimum molecular weight of outlet stack gas, wet basis
Measured /Calculated /Default:	Calculated
Source of data:	Data processing program, outlet QMS and a water vapour measurement report
Value(s) of monitored parameter:	27.889 g/mole (for the period from Aug 20, 2010 to Oct 29, 2010) 28.810 g/mole (for the period from Oct 30, 2010 to Dec 31, 2010)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the Project emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable This is a calculated data.
Measuring/ Reading/ Recording frequency:	Once per year, at least
Calculation method (if applicable):	Equation 9 in the applied methodology $M_{s,out} = M_{d,out} \cdot (100 - B_{ws,out}) \div 100 + 0.18B_{ws,out}$
QA/QC procedures applied:	This is a calculated data through measured $M_{d,out}$ and $B_{ws,out}$. Therefore, QA/QC procedures for $M_{s,out}$ follow those of $M_{d,out}$ and $B_{ws,out}$.

Data / Parameter:	M _{d,in}	
Data unit:	g/mole	
Description:	Molecular weight of inlet stack gas (dry basis)	
Measured /Calculated /Default:	calculated	
Source of data:	From inlet QMS and an analyzing result report	
Value(s) of monitored parameter:	28.850 g/mole (for the period from Aug 20, 2010 to Oct 29, 2010) 28.910 g/mole (for the period from Oct 30, 2010 to Dec 31, 2010)	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	inlet QMS	
	Type	Quadruple Mass spectrometry
	Accuracy class	±3%
	Serial number	2X31131
	Calibration frequency	Once per year
	Date of last Calibration	19/08/2010
	Validity	18/08/2011
Measuring/ Reading/ Recording frequency:	Once per year, at least	
Calculation method (if applicable):	Equation 6 in the applied methodology and relevant clauses thereof. M _{d,in} = 1.460[SF _{6in}] + 0.440[CO _{2in}] + 0.320[O _{2in}] + 0.280[N _{2in}] + 0.399[Ar _{in}] + 1.021[SO ₂ F _{2in}] + 0.040[He _{in}]	
QA/QC procedures applied:	QMS was calibrated with all components having more than 100 ppmv concentrations in inlet gas, which include SF ₆ , CO ₂ , O ₂ , N ₂ , Ar, SO ₂ F ₂ and He. And the applied value of M _{d,in} is higher than the actual maximum value of M _{d,in} (rounded up) during the 6 hours measuring period and this makes the emission reduction result more conservative. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.	

Data / Parameter:	M _{d,out}															
Data unit:	g/mole															
Description:	Molecular weight of outlet stack gas (dry basis)															
Measured /Calculated /Default:	calculated															
Source of data:	From outlet QMS and an analyzing result report															
Value(s) of monitored parameter:	29.249 g/mole (for the period from Aug 20, 2010 to Oct 29, 2010) 29.060 g/mole (for the period from Oct 30, 2010 to Dec 31, 2010)															
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.															
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<table><tr><td colspan="2">outlet QMS</td></tr><tr><td>Type</td><td>Quadruple Mass spectrometry</td></tr><tr><td>Accuracy class</td><td>±3%</td></tr><tr><td>Serial number</td><td>2X31132</td></tr><tr><td>Calibration frequency</td><td>Once per year</td></tr><tr><td>Date of last Calibration</td><td>19/08/2010</td></tr><tr><td>Validity</td><td>18/08/2011</td></tr></table>		outlet QMS		Type	Quadruple Mass spectrometry	Accuracy class	±3%	Serial number	2X31132	Calibration frequency	Once per year	Date of last Calibration	19/08/2010	Validity	18/08/2011
outlet QMS																
Type	Quadruple Mass spectrometry															
Accuracy class	±3%															
Serial number	2X31132															
Calibration frequency	Once per year															
Date of last Calibration	19/08/2010															
Validity	18/08/2011															
Measuring/ Reading/ Recording frequency:	Once per year, at least															
Calculation method (if applicable):	Equation 7 in the applied methodology and relevant clauses thereof. M _{d,out} = 0.440[CO _{2out}] + 0.320[O _{2out}] + 0.280[N _{2out}] + 0.399[Ar _{out}] + 0.040[He _{out}]															
QA/QC procedures applied:	QMS was calibrated with all components having more than 100 ppmv concentrations in outlet gas, which include CO ₂ , O ₂ , N ₂ , Ar and He. And the applied value of M _{d,out} is lower than the actual maximum value of M _{d,out} (rounded down) during the 6 hours measuring period and this makes the emission reduction result more conservative More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.															

Data / Parameter:	B _{ws,in}	
Data unit:	dimensionless (percentage volume fraction)	
Description:	The proportion of water in the inlet gas stream measured using EPA method 4, and used to calculate the inlet gas molecular weight.	
Measured /Calculated /Default:	Measured	
Source of data:	a measurement report	
Value(s) of monitored parameter:	6.220 % (for the period from Aug 20, 2010 to Oct 29, 2010) 4.000 % (for the period from Oct 30, 2010 to Dec 31, 2010)	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	This data was measured by an independent measurement company in accordance with the EPA method.	
	Inlet water proportion analyzer	
	Type	Gas Sampling Analyzer
	Accuracy class	±5%
	Serial number	80-091100-1
	Calibration frequency	Once per 2 years

	Date of last Calibration	24/11/2008
	Validity	23/11/2010
Measuring/ Reading/ Recording frequency:	Once per year, at least	
Calculation method (if applicable):	This value was measured by an independent measuring and analyzing company and the entire measurement procedure followed EPA method 4.	
QA/QC procedures applied:	This measurement was done for 6 hours during normal manufacturing conditions. The averaged proportion of water during the 6 hours period is used to calculate the inlet gas stream density. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.	

Data / Parameter:	$B_{ws,out}$	
Data unit:	dimensionless (percentage volume fraction)	
Description:	The proportion of water in the outlet gas stream measured using EPA method 4, and used to calculate the outlet gas molecular weight.	
Measured /Calculated /Default:	Measured	
Source of data:	a measurement report	
Value(s) of monitored parameter:	12.090 % (for the period from Aug 20, 2010 to Oct 29, 2010) 11.300 % (for the period from Oct 30, 2010 to Dec 31, 2010)	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	This data was measured by an independent measurement company in accordance with the EPA method.	
	outlet water proportion analyzer	
	Type	Gas Sampling Analyzer
	Accuracy class	±5%
	Serial number	601023
	Calibration frequency	Once per 2 years
	Date of last Calibration	17/03/2010
	Validity	16/03/2012
Measuring/ Reading/ Recording frequency:	Once per year, at least	
Calculation method (if applicable):	This value was measured by an independent measuring and analyzing company and the entire measurement procedure followed EPA method 4.	
QA/QC procedures applied:	This measurement was done for 6 hours during normal manufacturing conditions. The averaged proportion of water during the 6 hours period is used to calculate the inlet gas stream density. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.	

Data / Parameter:	Absolute inlet stack pressure ($P_{s,in}$)	
Data unit:	mmHg	
Description:	The inlet stack pressure measured during manufacturing operations	
Measured /Calculated /Default:	measured	
Source of data:	From inlet annubar	

Value(s) of monitored parameter:	834 mmHg This is the average value during the monitoring period.												
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.												
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(inlet annubar device) <table border="1"> <tr> <td>Type</td><td>Differential Pressure-Pitot tube</td></tr> <tr> <td>Accuracy class</td><td>±3%</td></tr> <tr> <td>Serial number</td><td>69453A</td></tr> <tr> <td>Calibration frequency</td><td>Once per year</td></tr> <tr> <td>Date of last Calibration</td><td>23/06/2010, newly installed</td></tr> <tr> <td>Validity</td><td>22/06/2011</td></tr> </table>	Type	Differential Pressure-Pitot tube	Accuracy class	±3%	Serial number	69453A	Calibration frequency	Once per year	Date of last Calibration	23/06/2010, newly installed	Validity	22/06/2011
Type	Differential Pressure-Pitot tube												
Accuracy class	±3%												
Serial number	69453A												
Calibration frequency	Once per year												
Date of last Calibration	23/06/2010, newly installed												
Validity	22/06/2011												
Measuring/ Reading/ Recording frequency:	This value is monitored for every second and used to calculate $E_{SF6,in}$.												
Calculation method (if applicable):	Not applicable												
QA/QC procedures applied:	This value is measured in accordance with the EPA guideline.												

Data / Parameter:	Absolute outlet stack pressure ($P_{s,out}$)												
Data unit:	mmHg												
Description:	The outlet stack pressure measured during manufacturing operations												
Measured /Calculated /Default:	measured												
Source of data:	From outlet annubar												
Value(s) of monitored parameter:	758 mmHg This is the average value during the monitoring period.												
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.												
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(outlet annubar device) <table border="1"> <tr> <td>Type</td><td>Differential Pressure-Pitot tube</td></tr> <tr> <td>Accuracy class</td><td>±3%</td></tr> <tr> <td>Serial number</td><td>69453B</td></tr> <tr> <td>Calibration frequency</td><td>Once per year</td></tr> <tr> <td>Date of last Calibration</td><td>23/06/2010, newly installed</td></tr> <tr> <td>Validity</td><td>22/06/2011</td></tr> </table>	Type	Differential Pressure-Pitot tube	Accuracy class	±3%	Serial number	69453B	Calibration frequency	Once per year	Date of last Calibration	23/06/2010, newly installed	Validity	22/06/2011
Type	Differential Pressure-Pitot tube												
Accuracy class	±3%												
Serial number	69453B												
Calibration frequency	Once per year												
Date of last Calibration	23/06/2010, newly installed												
Validity	22/06/2011												
Measuring/ Reading/ Recording frequency:	This value is monitored for every second and used to calculate $E_{SF6,out}$.												
Calculation method (if applicable):	Not applicable												
QA/QC procedures applied:	This value is measured in accordance with the EPA guideline.												

Data / Parameter:	Absolute inlet stack temperature ($T_{s,in}$)
Data unit:	K
Description:	The inlet stack temperature measured during manufacturing operations
Measured /Calculated /Default:	Measured
Source of data:	From inlet annubar
Value(s) of monitored parameter:	309 K This is the average value during the monitoring period.
Indicate what the data are used for (Baseline/ Project/ Leakage emission)	This data is used for the baseline emission calculation.

calculations)		
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(inlet annubar device)	
	Type	Standard Platinum Resistance Thermometer
	Accuracy class	±3%
	Serial number	69453A
	Calibration frequency	Once per year
	Date of last Calibration	23/06/2010, newly installed
	Validity	22/06/2011
Measuring/ Reading/ Recording frequency:	This value is monitored for every second and used to calculate $E_{SF6,in}$.	
Calculation method (if applicable):	Not applicable	
QA/QC procedures applied:	This value is measured in accordance with the EPA guideline.	

Data / Parameter:	Absolute outlet stack temperature ($T_{s,out}$)	
Data unit:	K	
Description:	The outlet stack temperature measured during manufacturing operations	
Measured /Calculated /Default:	Measured	
Source of data:	From outlet annubar	
Value(s) of monitored parameter:	317 K This is the average value during the monitoring period.	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(outlet annubar device)	
	Type	Standard Platinum Resistance Thermometer
	Accuracy class	±3%
	Serial number	69453B
	Calibration frequency	Once per year
	Date of last Calibration	23/06/2010, newly installed
	Validity	22/06/2011
Measuring/ Reading/ Recording frequency:	This value is monitored for every second and used to calculate $E_{SF6,out}$.	
Calculation method (if applicable):	Not applicable	
QA/QC procedures applied:	This value is measured in accordance with the EPA guideline.	

Data / Parameter:	Velocity head measurement by inlet Annubar device ($p_{avg,in}$)	
Data unit:	mmH ₂ O	
Description:	The averaged velocity head measurement used to calculate the inlet gas velocity	
Measured /Calculated /Default:	Measured	
Source of data:	From inlet annubar	
Value(s) of monitored parameter:	1.56 mmH ₂ O This is the average value during the monitoring period.	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.	

Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(inlet annubar device)	
	Type	Differential Pressure-Pitot tube
	Accuracy class	±3%
	Serial number	69453A
	Calibration frequency	Once per year
	Date of last Calibration	23/06/2010, newly installed
	Validity	22/06/2011
Measuring/ Reading/ Recording frequency:	This value is monitored for every second and used to calculate $E_{SF6,in}$.	
Calculation method (if applicable):	Not applicable	
QA/QC procedures applied:	This value is measured in accordance with the EPA guideline.	

Data / Parameter:	Velocity head measurement by outlet Annubar device ($p_{avg,out}$)	
Data unit:	mmH ₂ O	
Description:	The averaged velocity head measurement used to calculate the outlet gas velocity	
Measured /Calculated /Default:	Measured	
Source of data:	From outlet annubar	
Value(s) of monitored parameter:	0.67 mmH ₂ O This is the average value during the monitoring period.	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	(outlet annubar device)	
	Type	Differential Pressure-Pitot tube
	Accuracy class	±3%
	Serial number	69453B
	Calibration frequency	Once per year
	Date of last Calibration	23/06/2010, newly installed
	Validity	22/06/2011
Measuring/ Reading/ Recording frequency:	This value is monitored for every second and used to calculate $E_{SF6,out}$.	
Calculation method (if applicable):	Not applicable	
QA/QC procedures applied:	This value is measured in accordance with the EPA guideline.	

Data / Parameter:	Inlet gas velocity ($v_{s,in}$)	
Data unit:	m/sec	
Description:	Inlet gas velocity	
Measured /Calculated /Default:	Calculated	
Source of data:	Data processing program	
Value(s) of monitored parameter:	4.99 m/sec This is the average value during the monitoring period.	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last	Not applicable This is a calculated data	

calibration, validity)	
Measuring/ Reading/ Recording frequency:	This value is calculated for every second and used to calculate $E_{SF6,in}$.
Calculation method (if applicable):	Equation 10 in the applied methodology $v_{s,in} = K_p \cdot C_{p,in} \sqrt{P_{avg,in}} \sqrt{\frac{T_{s,in}}{P_{s,in} \cdot M_{s,in}}}$
QA/QC procedures applied:	Any SF ₆ emitted during periods of times where the gas velocity measured at the inlet decreases by more than 5%, compared to the averaged velocity, is completely discounted from the baseline emission. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.

Data / Parameter:	Outlet gas velocity ($v_{s,out}$)
Data unit:	m/sec
Description:	Outlet gas velocity
Measured /Calculated /Default:	Calculated
Source of data:	Data processing program
Value(s) of monitored parameter:	3.50 m/sec This is the average value during the monitoring period.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable This is a calculated data.
Measuring/ Reading/ Recording frequency:	This value is calculated for every second and used to calculate $E_{SF6,out}$.
Calculation method (if applicable):	Equation 11 in the applied methodology $v_{s,out} = K_p \cdot C_{p,out} \sqrt{P_{avg,out}} \sqrt{\frac{T_{s,out}}{P_{s,out} \cdot M_{s,out}}}$
QA/QC procedures applied:	Any SF ₆ emitted during periods of times where the gas velocity measured at the outlet increases by more than 5%, compared to the averaged velocity, is completely discounted from the baseline emission. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.

Data / Parameter:	Inlet stack volumetric flow rate (Q_{in})
Data unit:	m ³ /sec
Description:	Inlet volumetric flow rate
Measured /Calculated /Default:	Calculated
Source of data:	Data processing program
Value(s) of monitored parameter:	0.48 m ³ /sec This is the average value during the monitoring period.
Indicate what the data are	This data is used for the baseline emission calculation.

used for (Baseline/ Project/ Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable This is a calculated data.
Measuring/ Reading/ Recording frequency:	This value is calculated for every second and used to calculate E _{SF6,in} .
Calculation method (if applicable):	Equation 12 in the applied methodology $Q_{in} = \{(100 - B_{ws,in}) \div 100\} V_{s,in} \cdot A_{in} \left[\frac{T_{std} \cdot P_{s,in}}{T_{s,in} \cdot P_{std}} \right]$
QA/QC procedures applied:	Any SF6 emissions measured when the value of the gas flow measured at the inlet of the abatement system during the monitoring period decreases by more than 5%, compared to the baseline flow rate measured, is discounted from the baseline emission. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.

Data / Parameter:	Outlet stack volumetric flow rate (Q _{out})
Data unit:	m ³ /sec
Description:	Outlet volumetric flow rate
Measured /Calculated /Default:	Calculated
Source of data:	Data processing program
Value(s) of monitored parameter:	0.81 m ³ /sec This is the average value during the monitoring period.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable This is a calculated data
Measuring/ Reading/ Recording frequency:	This value is calculated for every second and used to calculate E _{SF6,out} .
Calculation method (if applicable):	Equation 13 in the applied methodology $Q_{out} = \{(100 - B_{ws,out}) \div 100\} V_{s,out} \cdot A_{out} \left[\frac{T_{std} \cdot P_{s,out}}{T_{s,out} \cdot P_{std}} \right]$
QA/QC procedures applied:	Any SF6 emissions measured when the value of the gas flow measured at the outlet of the abatement system during the monitoring period increases by more than 5%, compared to the baseline flow rate measured, is discounted from the baseline emission. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.

Data / Parameter:	Inlet SF ₆ concentration
Data unit:	ppm

Description:	Inlet SF ₆ concentration measured by FTIR	
Measured /Calculated /Default:	Measured	
Source of data:	From inlet FTIR	
Value(s) of monitored parameter:	440.4 ppm This is the average value during the monitoring period.	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the baseline emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Inlet FTIR	
	Type	FT-IR spectrometry
	Accuracy class	±2%
	Serial number	580
	Calibration frequency	Once per year
	Date of last Calibration	07/12/2010
Validity	06/12/2011	
Measuring/ Reading/ Recording frequency:	Once per 10 seconds	
Calculation method (if applicable):	Not applicable	
QA/QC procedures applied:	FTIR shall be calibrated in accordance with the Methodology requirement. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.	

Data / Parameter:	Outlet SF ₆ concentration	
Data unit:	ppm	
Description:	Outlet SF ₆ concentration measured by FTIR	
Measured /Calculated /Default:	Measured	
Source of data:	From outlet FTIR	
Value(s) of monitored parameter:	2.1 ppm This is the average value during the monitoring period.	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	outlet FTIR	
	Type	FT-IR spectrometry
	Accuracy class	±2%
	Serial number	581
	Calibration frequency	Once per year
	Date of last Calibration	08/11/2010
Validity	07/11/2011	
Measuring/ Reading/ Recording frequency:	Once per 10 seconds	
Calculation method (if applicable):	Not applicable	
QA/QC procedures applied:	FTIR shall be calibrated in accordance with the Methodology requirement. The average SF ₆ concentration in the outlet of the abatement system is lower than 0.1 ppm which is confirmed by sampling & analyzing result implemented through more sensitive FTIR that can detect 0.1ppm of	

	<p>SF₆. However, considering that the SF₆ detection range of the installed outlet FTIR is 2 ppm, any values below 2 ppm in outlet is counted as 2 ppm for more conservative calculation.</p> <p>More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.</p>
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Data / Parameter:	FC_{i,j,y} volume unit per year of natural gas consumed by the abatement device.	
Data unit:	Nm ³	
Description:	Quantity of natural gas combusted in the abatement process during the year y (From October 1, 2010 to December 31, 2010, for this monitoring purpose)	
Measured /Calculated /Default:	Measured	
Source of data:	a LNG flow-meter	
Value(s) of monitored parameter:	310,257 Nm ³	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	LNG flow meter	
	Type	LNG flow meter
	Accuracy class	± 2% (Grade 2, certified by Youngnam Energy Service)
	Serial number	606920
	Calibration frequency	Once per 8 years
	Date of last Calibration	21/07/2010
	Validity	20/07/2018
Measuring/ Reading/ Recording frequency:	Recording Frequency: Once per second Calculating Frequency: Once per the given monitoring period	
Calculation method (if applicable):	Not applicable	
QA/QC procedures applied:	<p>The flow meter will be maintained by Korea Gas Corporation (a public enterprise).</p> <p>The value recorded in the system is 305,504 Nm³ and the applied value comes from daily log book manually recorded by operators. The latter data has human errors as checking time of the meter cannot be exactly same for everyday. Nevertheless, the latter value is applied as it is higher than the system value. This is one of conservative approaches made for the emission reductions calculation.</p>	

Data / Parameter:	WC_{i,y}
Data unit:	tC/tLNG
Description:	Weighted average mass fraction of carbon in natural gas in year y
Measured /Calculated /Default:	Default
Source of data:	Information provided by Korea Gas Corporation
Value(s) of monitored parameter:	0.752 tC/tLNG
Indicate what the data are used for (Baseline/ Project/	This data is used for the project emission calculation.

Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable This is an externally provided data.
Measuring/ Reading/ Recording frequency:	Once per year
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	This is a standard value provided by Korea Gas Corporation and an official letter from Korean Gas Corporation regarding the above value has been provided to the DOE for verification purpose.

Data / Parameter:	$\rho_{i,y}$
Data unit:	t natural gas/ m ³ natural gas
Description:	Weighted average density of natural gas in year y
Measured /Calculated /Default:	Default
Source of data:	Korea Gas Corporation
Value(s) of monitored parameter:	$0.7976 * 10^{-3}$ t natural gas/ m ³ natural gas
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable This is an externally provided data.
Measuring/ Reading/ Recording frequency:	Once per year
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	This is a standard value provided by Korea Gas Corporation and an official letter from Korean Gas Corporation regarding the above value has been provided to the DOE for verification purpose.

Data / Parameter:	$EC_{i,y}$
Data unit:	kWh
Description:	Electricity Consumption in year y (From October 1, 2010 to December 31, 2010, for this monitoring purpose)
Measured /Calculated /Default:	Measured
Source of data:	Logbooks and 6 electricity meters
Value(s) of monitored parameter:	311,099 kWh
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This data is used for the project emission calculation.
Monitoring equipment (type, accuracy class, serial	Meter #1

number, calibration frequency, date of last calibration, validity)

Type	Electric meter
Accuracy class	$\pm 2\%$ (Grade 2, Certified by KEPCO)
Serial number	97001891
Calibration frequency	Once per 8 years
Date of last Calibration	20/12/2009
Validity	19/12/2017

Meter #2

Type	Electric meter
Accuracy class	$\pm 2\%$ (Grade 2, Certified by KEPCO)
Serial number	90064842
Calibration frequency	Once per 10 years
Date of last Calibration	10/12/2009
Validity	09/12/2019

Meter #3

Type	Electric meter
Accuracy class	$\pm 2\%$ (Grade 2, Certified by KEPCO)
Serial number	98001026
Calibration frequency	Once per 8 years
Date of last Calibration	30/09/2009
Validity	29/09/2017

Meter #4

Type	Electric meter
Accuracy class	$\pm 2\%$ (Grade 2, Certified by KEPCO)
Serial number	9084449
Calibration frequency	Once per 8 years
Date of last Calibration	13/01/2009
Validity	12/01/2017

Meter #5

Type	Electric meter
Accuracy class	$\pm 2\%$ (Grade 2, Certified by KEPCO)
Serial number	90064836
Calibration frequency	Once per 10 years
Date of last Calibration	10/12/2009
Validity	09/12/2019

Meter #6

Type	Electric meter
Accuracy class	$\pm 2\%$ (Grade 2, Certified by KEPCO)
Serial number	90004868
Calibration frequency	Once per 10 years
Date of last Calibration	10/10/2009
Validity	09/10/2019

Measuring/ Reading/ Recording frequency:	Recording Frequency: Once per second Calculating Frequency: Once per the given monitoring period
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Data from logbooks and electrically gathered data from each electricity meter may be different from each other due to communication noise or transmission errors. If both data do not perfectly match, higher value shall be applied for more conservative outcome. The value recorded in the system is 311,067 kWh and the applied value comes from daily log book manually recorded by operators. The latter data has human errors as six(6) meters cannot be checked at the same time. Nevertheless, the latter value is applied as it is higher than the system value. This is one of conservative approaches made for the emission reductions calculation.

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

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The Baseline emissions calculation is as follows;

$$BE_{in,y} = k \cdot E_{SF6,y} \cdot GWP_{SF6} \quad ; \text{Equation (1) in the methodology}$$

Facility	$E_{SF6,y}$ (Oct 1, 2010~Dec 31, 2010)	k	GWP_{SF6}	$BE_{in,y}$ (Oct 1, 2010~Dec 31, 2010)
P6	9.2223	0.9920	23,900	218,649

where

;Equation (4) in the methodology

$$k = \begin{cases} 1 & ; SF_{6,ratio} \geq C_{SF6,y} \div SP_{project,y} \\ \frac{SF_{6,ratio}}{C_{SF6,y} \div SP_{project,y}} & ; SF_{6,ratio} < C_{SF6,y} \div SP_{project,y} \end{cases}$$

Facility	$SF_{6,ratio}$	$C_{SF6,y}$	$SP_{project,y}$	k
P6	0.0000134902	21.286	1,565,247	0.9920

where

$$SF_{6,ratio} = \min(C_{SF6,-1} \div SP_{-1}; C_{SF6,-2} \div SP_{-2}; C_{SF6,-3} \div SP_{-3}) \quad ; \text{Equation (3) in the methodology}$$

Facility	$C_{SF6,-3}$	$C_{SF6,-2}$	$C_{SF6,-1}$	SP_{-3}	SP_{-2}	SP_{-1}	$SF_{6,ratio}$
P6	13.869	18.650	19.213	1,028,081	1,323,881	1,431,756	0.0000134902

And

$$E_{SF6,y} = \min\{E_{SF6in,y}; 0.48 \times C_{SF6,y}; 0.48 \times C_{SF6,hist}\} \quad ; \text{Equation (2) in the methodology}$$

Facility	$E_{SF6,in,y}$ (Oct 1, 2010~	0.48 x $C_{SF6,y}$	$C_{SF6,y}$ (Oct 1, 2010~	0.48 x $C_{SF6,hist}$	$C_{SF6,hist}$	$E_{SF6,y}$ (Oct 1, 2010~
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	Dec 31, 2010)		Dec 31, 2010)			Dec 31, 2010)
P6	10.0399	10.2172	21.2859	9.2223	19.2131	9.2223

where

$$E_{SF6in,y} = \text{annual(periodic) sum of } E_{SF6,in}$$

$E_{SF6,in}$ is automatically calculated for every second by the data processing program in accordance with the methodology and daily sum of $E_{SF6,in}$ is also recorded in a form of electronic files along with other values of key parameters used in the $E_{SF6,in}$ calculation. The O&M team records the daily sum in a logbook and periodically reports a weekly and a monthly sums of $E_{SF6,in}$ to the project participants. The followings are the formulas used in the calculation.

$$M_{d,in} = 1.460[SF_{6in}] + 0.440[CO_{2in}] + 0.320[O_{2in}] + 0.280[N_{2in}] + 0.399[Ar_{in}] + 1.021[SO_2F_{2in}] + 0.040[He_{in}]$$

;Equation (6) in the methodology modified in accordance with the relevant clauses thereof

$$M_{s,in} = M_{d,in} \cdot (100 - B_{ws,in}) \div 100 + 0.18B_{ws,in} \quad ;\text{Equation (8) in the methodology}$$

$$v_{s,in} = K_p \cdot C_{p,in} \sqrt{P_{avg,in}} \sqrt{\frac{T_{s,in}}{P_{s,in} \cdot M_{s,in}}} \quad ;\text{Equation (10) in the methodology}$$

$$Q_{in} = \{(100 - B_{ws,in}) \div 100\} V_{s,in} \cdot A_{in} \left[\frac{T_{std} \cdot P_{s,in}}{T_{s,in} \cdot P_{std}} \right] \quad ;\text{Equation (12) in the methodology}$$

$$E_{SF6in} = 65.18Q_{in}[SF_{6in}] \quad ;\text{Equation (14) in the methodology}$$

E.2. Project emissions calculation

>>

The Project emissions calculation is as follows;

$$PE_y = BE_y(1 - DRE_y) + C_{CO2,y} \quad ;\text{Equation (17) in the methodology}$$

Facility	BE _y (Oct 1, 2010~ Dec 31, 2010)	DRE _y (Oct 1, 2010~ Dec 31, 2010)	C _{CO2,y} (Oct 1, 2010~ Dec 31, 2010)	PE _y (Oct 1, 2010~ Dec 31, 2010)
P6	218,649	0.9922	364	2,063

Where

$$DRE_y = 1 - \frac{E_{SF6,out,y}}{E_{SF6,in,y}} \quad ;\text{Equation (16) in the methodology}$$

Facility	E _{SF6,in,y} (Oct 1, 2010~Dec 31, 2010)	E _{SF6,out,y} (Oct 1, 2010~Dec 31, 2010)	DRE _y (Oct 1, 2010~Dec 31, 2010)
P6	10.0399	0.0780	0.9922

where

$$E_{SF6out,y} = \text{annual(periodic) sum of } E_{SF6,out}$$

As well as $E_{SF6,in,y}$, $E_{SF6,in}$ is automatically calculated for every second by the data processing program in accordance with the methodology and daily sum of $E_{SF6,out}$ is also recorded in a form of electric files along with other values of key parameters used in the $E_{SF6,out}$ calculation. The O&M team records the daily sum in a logbook and periodically reports a weekly and a monthly sum of $E_{SF6,out}$ to the project participants. The followings are the formulas used in the calculation.

$$M_{d,out} = 0.440[CO_{2out}] + 0.320[O_{2out}] + 0.280[N_{2out}] + 0.399[Ar_{out}] + 0.040[He_{out}]$$

;Equation (7) in the methodology modified in accordance with the relevant clauses thereof

$$M_{s,out} = M_{d,out} \cdot (100 - B_{ws,out}) \div 100 + 0.18B_{ws,out}$$

;Equation (9) in the methodology

$$v_{s,out} = K_p \cdot C_{p,out} \sqrt{P_{avg,out}} \sqrt{\frac{T_{s,out}}{P_{s,out} \cdot M_{s,out}}}$$

;Equation (11) in the methodology

$$Q_{out} = \{(100 - B_{ws,out}) \div 100\} V_{s,out} \cdot A_{out} \left[\frac{T_{std} \cdot P_{s,out}}{T_{s,out} \cdot P_{std}} \right]$$

;Equation (13) in the methodology

$$E_{SF6out} = 65.18Q_{out} [SF_{6out}]$$

;Equation (15) in the methodology

And $C_{CO2,y}$ (for the period beginning from Oct 1,2010 and ending at Dec 31,2010) is calculated as follows;

$$C_{CO2,y} = tCO2_{electricity,y} + tCO2_{LNG,y}$$

Where,

$tCO2_{electricity,y}$: GHG emission from electricity consumption by the abatement system during the monitoring period (tCO2)

$tCO2_{LNG,y}$: GHG emission from LNG consumption by the abatement system during the monitoring period (tCO2)

Facility	$tCO2_{electricity,y}$ (Oct 1, 2010~Dec 31, 2010)	$tCO2_{LNG,y}$ (Oct 1, 2010~Dec 31, 2010)	$C_{CO2,y}$ (Oct 1, 2010~Dec 31, 2010)
P6	178	186	364

where

$$tCO2_{electricity,y} = EC_y \cdot EF_{grid,CM,y}$$

Facility	EC_y (Oct 1, 2010~Dec 31, 2010)	$EF_{grid,CM,y}$	$tCO2_{electricity,y}$ (Oct 1, 2010~Dec 31, 2010)
P6	311.099	0.5708	178

And where

$$tCO2_{LNG,y} = FC_{i,j,y} \cdot wc_{i,y} \cdot \rho_{i,y}$$

Facility	$FC_{i,i,v}$ (Oct 1, 2010~Dec 31, 2010)	$wc_{i,y}$	$\rho_{i,y}$	$tCO2_{LNG,y}$ (Oct 1, 2010~Dec 31, 2010)
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P6	310,257	0.752	0.0007976	186
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E.3. Leakage calculation

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According to the methodology applied, there is no leakage from the project activity.

E.4. Emission reductions calculation / table

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The Emission reductions calculation is as follows;

$$ER_y = BE_y - PE_y \quad ; \text{Equation (18) in the methodology}$$

Facility	BE _y (Oct 1, 2010~Dec 31, 2010)	PE _y (Oct 1, 2010~Dec 31, 2010)	ER _y (Oct 1, 2010~Dec 31, 2010)
P6	218,649	2,063	216,586

*No leakage occurs from the project activity.

Therefore, the total emission reductions achieved during the monitoring period is 216,586 tCO₂e.

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

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Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO ₂ e)	124,537 (equivalent to 92/365 of 494,087 tCO ₂ e which is the reduction estimated for the Year 1.)	216,586

E.6. Remarks on difference from estimated value in the PDD

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According to the methodology applied, actually measured data should be used for calculation emission reductions. However, at the time of requesting registration for the PDD of this project activity, the abatement system in Plant 6 was under construction so there was no way to obtain reliable data necessary to calculate emission reductions to be achieved by this project. Instead, to estimate emission reductions acceptable to the CDM Executive Board and satisfactory to its criteria, the project participants used IPCC default values. In the registered PDD, SF₆ etch utilization efficiency of 70% and heel value of 10% is applied for estimating emission reductions, particularly calculations of E_{SF6,in} and E_{SF6,out}. IPCC default values, including aforementioned values, are generally more conservative than reasonably expected values; therefore, it is not an unexpected result that the actually measured emission reduction is higher than the estimated figures in the PDD. The following table shows differences between IPCC default values used in the ex-ante emission reductions calculation of the registered PDD and the actual values achieved through project implementation.

Parameters	IPCC default value /Assumed value	Actual Value	Effect on the emission reductions
C _{SF6,y} (P6)	21,756 kg (92/365 of the annual value, 86,313 kg derived	21,286 kg	The actual value is slightly lower than the business plan set up in 2009. This increase led to small

	from the biz plan)		decrease of the baseline emission.
SF6 etch utilization efficiency	70.0%	52.8%	Actual value is lower than IPCC default value. While the methodology used 60% SF6 utilization efficiency and 20% uncertainty (equation 2), the more conservative value of 70% (Tier2.b) was used for the calculation of $E_{SF6,in,y}$ in the PDD to ensure conservativeness on projection. The lower value of utilization efficiency led to greater baseline emission as it directly affect to the mass of SF6 entering into the system. While $E_{SF6,in,y}$ is smaller than $0.48 \cdot C_{SF6,hist}$ in the PDD, $E_{SF6,in,y}$ is greater than $0.48 \cdot C_{SF6,hist}$ due to the decreased SF6 etch utilization efficiency and $0.48 \cdot C_{SF6,hist}$ becomes $E_{SF6,in}$ of this monitoring period. This is a major reason of the increase.
heel value	10%	10%	In this monitoring report, 10% heel value is used although the actual heel value recorded (5.9%) is much lower than 10%. It was done for a conservative approach to the emission reductions.
DRE	90.00%	99.22%	90% DRE was used for the ex-ante calculation as it is generally used in performance projection of uninstalled systems. Therefore it is easily expected that the actual performance of installed systems should be different from the projection. The applied system has much higher DRE and it led to the smaller project emission.

In the PDD, The value of $E_{SF6,in,y}$ was calculated by multiplying SF6 etch utilization efficiency of 70% and heel value of 10% to Expected $C_{SF6,y}$ while $E_{SF6,out,y}$ was simply derived by multiplying DRE of 10% to $E_{SF6,in,y}$. This calculation was a kind of reverse operation and used only for the ex-ante calculation purpose.

The following table shows values of $E_{SF6,in,y}$ and $E_{SF6,out,y}$ projected in the PDD and the real achievement. The differences between values are caused by the abovementioned conservative projection.

Parameters	Projected in the PDD	Real achievement
$E_{SF6,in,y}$	5,874 kg (92/365 of the estimated value on annual basis, 23,305 kg)	10,039.9 kg
$E_{SF6,out,y}$	587 kg (92/365 of the estimated value on annual basis, 2,330 kg)	78.0 kg

In conclusion, the increase of emission reductions achieved during the monitoring period is mainly caused by the conservative SF6 etch utilization efficiency used in the ex-ante calculation of the PDD and higher actual DRE of the applied system.

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History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory Document Type: Guideline, Form Business Function: Issuance		