Monitoring report form (Version 03.1)

Monitoring report

Title of the project activity	Point of Use Abatement Device to Reduce SF6 emissions in LCD Manufacturing Operations in the Republic of Korea (South Korea)
Reference number of the project activity	3440
Version number of the monitoring report	1
Completion date of the monitoring report	25/01/2013
Registration date of the project activity	10/07/2010
Monitoring period number and duration of this monitoring period	8th Monitoring period 4 months(01/09/2012 - 31/12/2012)
Project participant(s)	LG International Corp. LG Display Co., Ltd. Climate Change Capital Carbon Fund II s.a.r.l.
Host Party(ies)	Republic of Korea
Sectoral scope(s) and applied methodology(ies)	(4) Manufacturing industries (11) Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride "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
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	330,914 (tCO_2e)
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	563,386 (tCO_2e)

SECTION A. Description of project activity

A.1. Purpose and general description of 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 device which has similar technical specifications with the existing system was installed in the plant 7 in Paju in late January 2012.

The project activities during this monitoring period includes Plant 6 and 7, 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 7 and, therefore, all information provided in this report is limited only to those of the existing system in Plant 6 and 7.

To decompose SF6 gas, high temperature, around 1,200℃, 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.

In conclusion, this monitoring report for the 8th verification was prepared for the period from 01/09/2012 to 31/12/2012. During this period, the project has achieved net anthropogenic GHG removals of 563,386 (tCO_2e).

The following information contains dates of key events of the project in chronological order.

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 for an abatement system to be installed at P6 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 at P6 was completed.
August 1, 2010 ~	The crediting period of the project was started and operation was commenced.
May 24, 2011	An EPC contract for a new abatement system to be installed at P7 was signed and construction was commenced.
June 22, 2011	CDM EB approved the 1st monitoring report and issued CERs. (144,222 CERs)
August 29, 2011	CDM EB approved the 2nd monitoring report and issued CERs. (214,847 CERs)
January 25, 2012	The commissioning of the abatement system at P7 was completed.
March 1, 2012 ~	The operation at P7 was commenced.
June 15, 2012	CDM EB approved the 3rd monitoring report and issued CERs. (197,984 CERs)
September 27, 2012	CDM EB approved the 4th monitoring report and issued CERs. (171,600 CERs)
January 10, 2013	CDM EB approved the 5th monitoring report and issued CERs. (264,637 CERs)

A.2. Location of project activity

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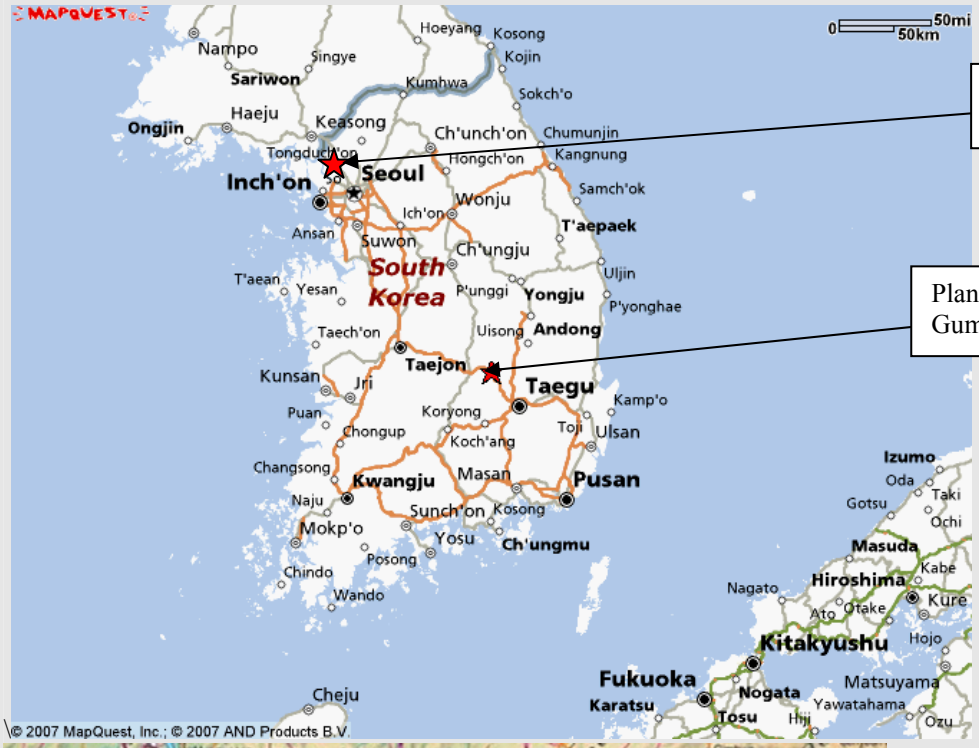
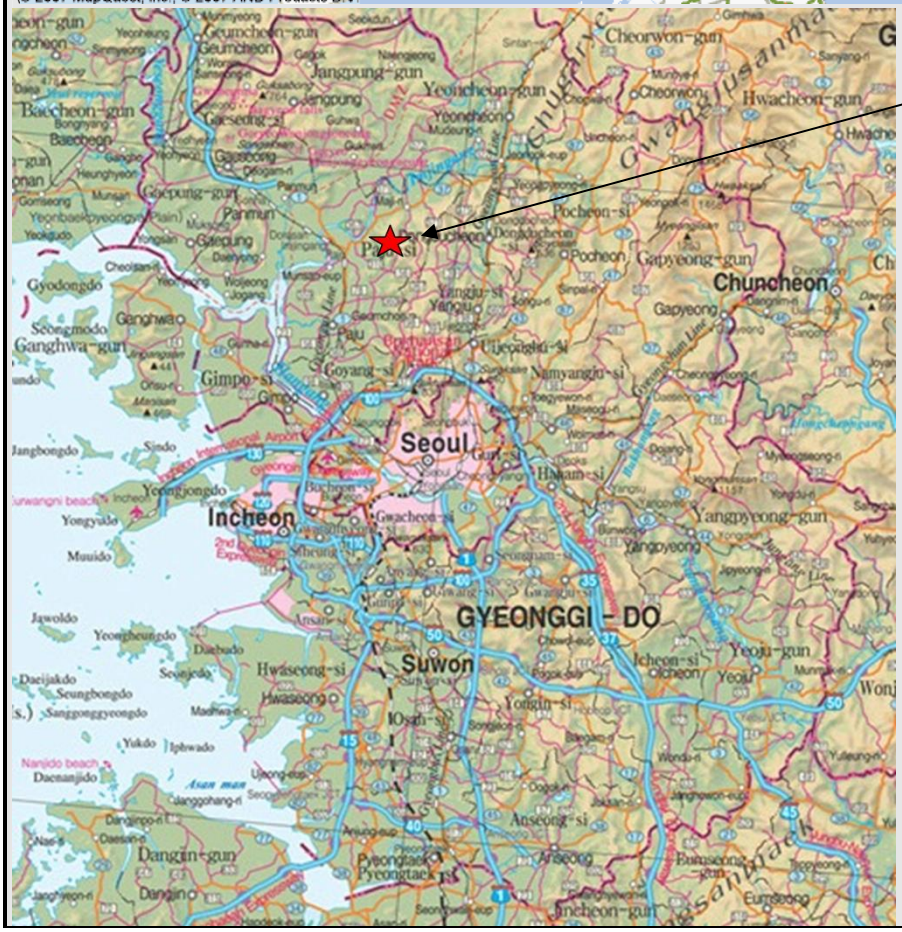
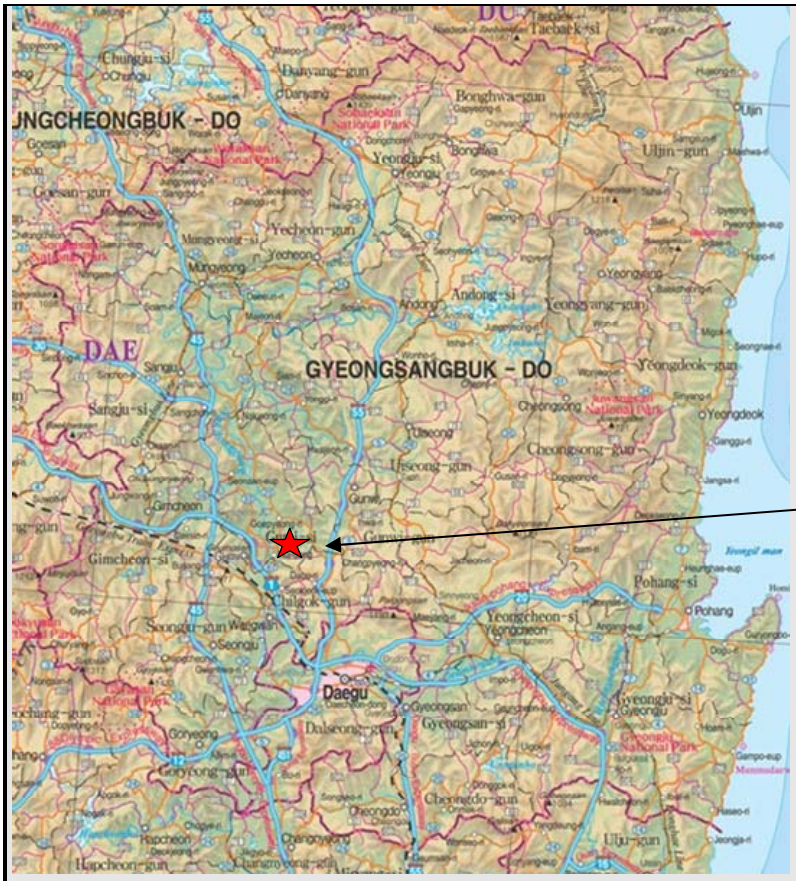
The Plant 6 is based in Gumi which is located in the western part of Korea's North Gyeongsang Province, 277.5 km. south of Seoul and 167 km. north of Busan and Plant 7 is located in Paju, Gyeonggi Province, 50 km. west of Seoul. .







A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Korea (host)	LG International Corp. LG Display Co., Ltd.	No
United Kingdom	Climate Change Capital Carbon Fund II s.a.r.l.	No

A.4. Reference of applied methodology

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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.5. Crediting period of project activity

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01/08/2010 – 31/07/2020 (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.

SECTION B. Implementation of project activity

B.1. Description of implemented registered 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. The second investment for a new SF6 abatement system to be installed in Plant 7 was approved by the executives in March, 2011 and an EPC contract was signed on 24 May, 2011. The construction was completed in January, 2012, and it started to generate ERs from February, 2012. Commercial orders for additional sets of abatement devices to be installed in other than plant 6 and 7 are yet to be made at the time of writing. As the project participants described in the registered PDD, the other plants will be successively invested after the performance of the existing abatement system has been confirmed.

And the followings are information on special events including overhaul times, system-rebooting, and replacement of any equipment. (None of these events happened in a brought-off line manner.)

[Plant 6 in Gumi]

Events	Date	Duration	Effects on emission reduction
Transmission error of relevant data	16/10/2012	11:46:08-11:48:18 13:46:17-13:48:28 15:46:28-15:48:38 17:46:42-17:49:29	The pressure differential value was suddenly represented as zero(0), which was definitely invalid, due to mal-functioning of the transmission process for the data. We checked and fixed electric lines for the transmission, and finally this event hasn't occurred any more. However, for the whole period when the data was abnormal, we deleted all not to count emission reduction.
Re-booting Trend PC	09/09/2012	09:16:30-09:17:05	Trend PC was in error temporarily (specifically, Cimon X program didn't work properly) due to heavy loading of the data transmitted from MMI. To response this issue, the Trend PC was re-booted, and it got back to normal. While re-booting Trend PC, temporary loss of data occurred. Those data was eliminated from the daily emission reductions calculation.
	26/10/2012	18:22:23-18:26:55	
	12/11/2012	12:36:09-13:09:14	
	18/11/2012	00:25:56-06:17:45	
	19/11/2012	17:06:35-17:10:01	
	10/12/2012	08:15:08-08:15:48 08:16:22-08:18:25 08:33:06-08:35:10 08:39:48-08:42:41	
Re-booting outlet FTIR analysis PC	16/12/2012	14:54:15-15:10:20	Outlet FTIR analysis PC was in error unexpectedly due to heavily loaded data accumulated in it. To tackle this issue, outlet FTIR analysis PC was re-booted. While re-booting the analysis PC, temporary data loss was unavoidable. Those data was all eliminated from the emission reductions calculation.
	24/12/2012	17:40:46-17:53:24	

Fixing rubber-packing of the sight glasses on Scrubber	04/12/2012	11:03:51-11:04:21 14:08:46-14:09:32	As winter came along, its temperature notably dropped compared to mild weather in summer and fall. In general, the lowered temperature causes contraction of materials. In this event, the contraction led to little crack in the spot where two different materials, a glass and metallic surface of Scrubber, were attached to each other. Through this crack, water leaking was founded, so we repaired rubber packing in between a glass and metallic surface of Scrubber. After that, water leaking was no longer founded. However, during the repairing task, volumetric flow rate was affected by deviating from its standard value. Thus, we deleted the whole period in which abnormal values were represented.
	26/12/2012	13:28:05-13:29:15	
Deviated inlet and outlet volumetric flow rate	07/12/2012	10:28:11-14:14:59	Due to LGD's PM(preventive measure) on one of the dry etching device, inlet and outlet volumetric flow rates were affected temporarily. When these were off the permitted range, we deliberately eliminated emission reductions for the whole period in ER 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.

[Plant 7 in Paju]

Events	Date	Duration	Effects on emission reduction
Re-booting Trend PC	04/09/2012	02:09:16-02:14:52	Trend PC was in error temporarily (specifically, Cimon X program didn't work properly) due to heavy loading of the data transmitted from MMI. To response this issue, the Trend PC was re-booted, and it got back to normal. While re-booting Trend PC, temporary loss of data occurred. Those data was eliminated from the daily emission reductions calculation.
		18:28:23-18:53:52	
	09/09/2012	05:16:14-05:17:44	
		05:41:07-05:41:27	
	12/09/2012	02:59:01-03:00:59	
	14/09/2012	00:00:07-00:00:30	
	26/09/2012	00:14:54-00:16:27	
	09/10/2012	21:58:10-22:00:51	
	25/10/2012	02:06:16-02:09:04	
	08/11/2012	23:09:35-23:10:47	
	14/11/2012	06:03:36-06:09:03	
	26/11/2012	02:05:05-02:11:41	
	03/12/2012	15:56:24-16:25:28	
	17/12/2012	23:56:25-23:56:59	

	28/12/2012	00:45:56-00:50:31	
		00:58:10-00:58:55	
Re-install Cimon X program	05/09/2012	02:44:08-03:00:05	To prevent the Trend PC's error which was happen quite frequently caused by mal-functioning of the Cimon X program, we re-installed it after completely deleting it.
		15:15:33-15:16:42	In order to take stability test of the Cimon X program after re-installing it, the Trend PC was re-rooted. While re-booting the Trend PC, temporary loss of data occurred.
Re-booting outlet FTIR analysis PC	26/09/2012	08:45:50-08:48-59	Outlet FTIR analysis PC was in error unexpectedly due to heavily loaded data accumulated in it. To tackle this issue, outlet FTIR analysis PC was re-booted. While re-booting the analysis PC, temporary data loss was unavoidable. Those data was all eliminated from the emission reductions calculation.
Measured excessive outlet SF6 concentration	14/12/2012	16:23:48-16:24:26	Since moisture abruptly flew into the outlet FTIR cell, outlet SF6 concentration was measured to exceed the 2ppm level in a moment. The moisture was believed to be created in the FTIR route by drastic temperature difference between in and out of the FTIR analyzing room. As a follow-up measure, we removed moisture in the FTIR outlet chamber filter.
	22/12/2012	02:26:48-02:27:27	
	23/12/2012	19:09:54-19:10:31	
		19:40:30-19:41:06	
		20:39:49-20:40:25	
	29/12/2012	11:32:57-11:33:35	
	22/10/2012	18:45:25-18:46:03	After removing moisture in outlet FTIR chamber filter, we re-opened the valve for volumetric flowing, and then the outlet SF6 concentration was measured to be higher than normal one since the flow contained much more SF6 concentration. Removing moisture in outlet FTIR chamber filter was conducted frequently, but especially at this time, this event occurred. It was solved without any particular measure.
	28/12/2012	21:00:00-21:00:35	
	06/09/2012	11:03:30-11:04:29	To remove moisture in FTIR route, sample line purging was conducted on purpose. During the purging period, we did not count any emission reduction.
Transmission error of LNG signals	13/09/2012	18:09:46-18:11:05	LNG signals were abnormally represented, while being deviated from the permitted minus 5% range from the standard setting value. (The signal suddenly dipped down to the bottom without any fluctuation, or any sign of dropping.) It is believed to be caused by the error in its digital transmission system, in which its temperature and pressure values were collided with each other, so overall the LNG signals were off the track. All emission reductions during this event were not automatically counted at all. (For your information, there is no definite rule in our methodology applying the certain permitted range like plus & minus 5% of the standard value into the LNG input. By the way, we are applying it here in LNG since we believe it is more conservative approach)
	11/10/2012	04:38:42-04:40:31	
	08/11/2012	12:34:19-12:35:38	
	07/12/2012	23:43:05-23:44:54	

Deviated inlet volumetric flow rate and its stack gas velocities	08/11/2012	13:55:20-14:07:10	Normally, working condition for dry etching process in LGD changes from time to time. When this change occurred in the LGD manufacturing line was severe, in later process, inlet volumetric flow rate and its velocity were also hugely affected. To maintain stable static pressure level in LGD's operation, our SF6 abatement system's operating condition was automatically adjusted to it. As a result, many operating factors such as inlet volumetric flow rate, stack gas velocities and LNG consumption could not help but be influenced. When these were off the permitted range, emission reductions for the whole period were eliminated in ER calculation.
	09/12/2012	07:09:10-07:42:50	Inlet volumetric flow rate and stack gas velocities were fluctuated, and even deviated from its permitted ranges of plus & minus 5% from standard setting value. A purge fan located in inlet SF6 abatement facility was operated in order to stabilize inlet volumetric flow rate and stack gas velocities. When volumetric flow rate and stack gas velocities were off the permitted range, emission reductions for the whole period were eliminated in ER calculation.
Deviated outlet volumetric flow rate and its stack gas velocities	24/12/2012	00:28:30-00:49:30	Since some particles stuck into outlet pitot-tube in Annubar interfering its proper sensing, volumetric flow rate and stack gas velocities were fluctuated. To tackle this issue, we deliberately carried out purging. After this, a relatively stable trend of outlet volumetric flow rate and its stack gas velocities were achieved. However, when these were off the permitted range, emission reductions for the whole period were eliminated from ER calculation.
	25/12/2012	22:28:00-22:48:00	

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. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

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No deviation has been made.

B.2.2. Corrections

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None

B.2.3. Permanent changes from registered monitoring plan or applied methodology

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None

B.2.4. Changes to project design of registered project activity

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None

B.2.5. Changes to start date of crediting period

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None

B.2.6. Types of changes specific to afforestation or reforestation project activity

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None

SECTION C. Description of monitoring system

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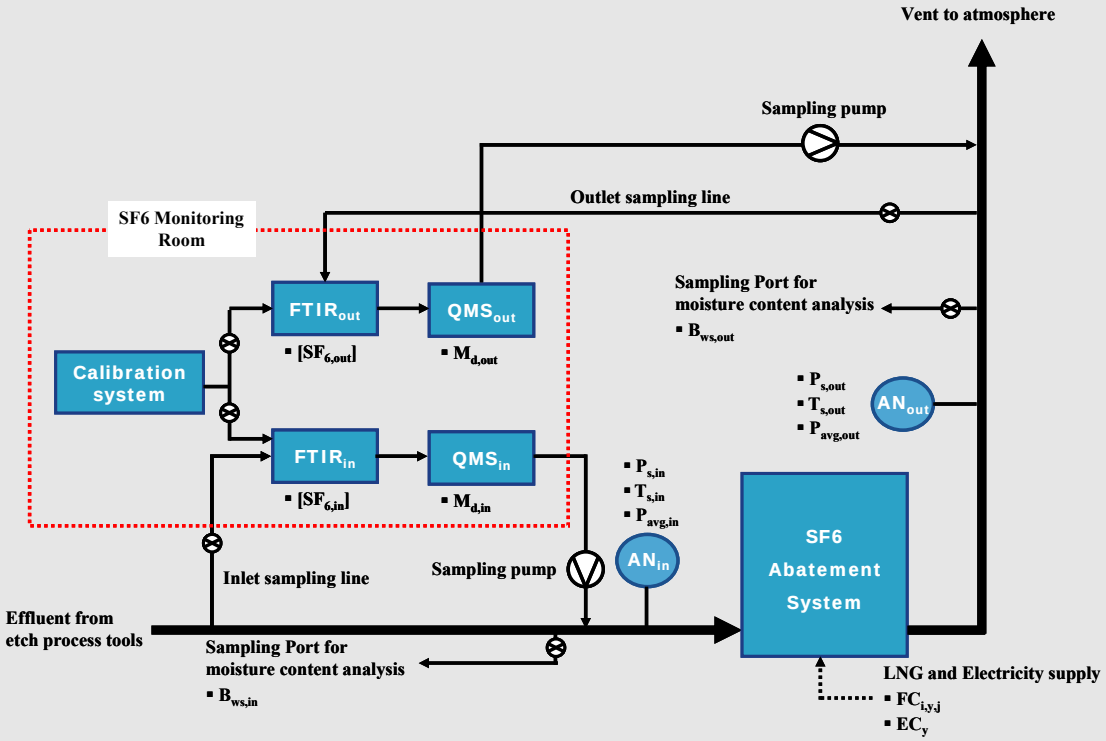
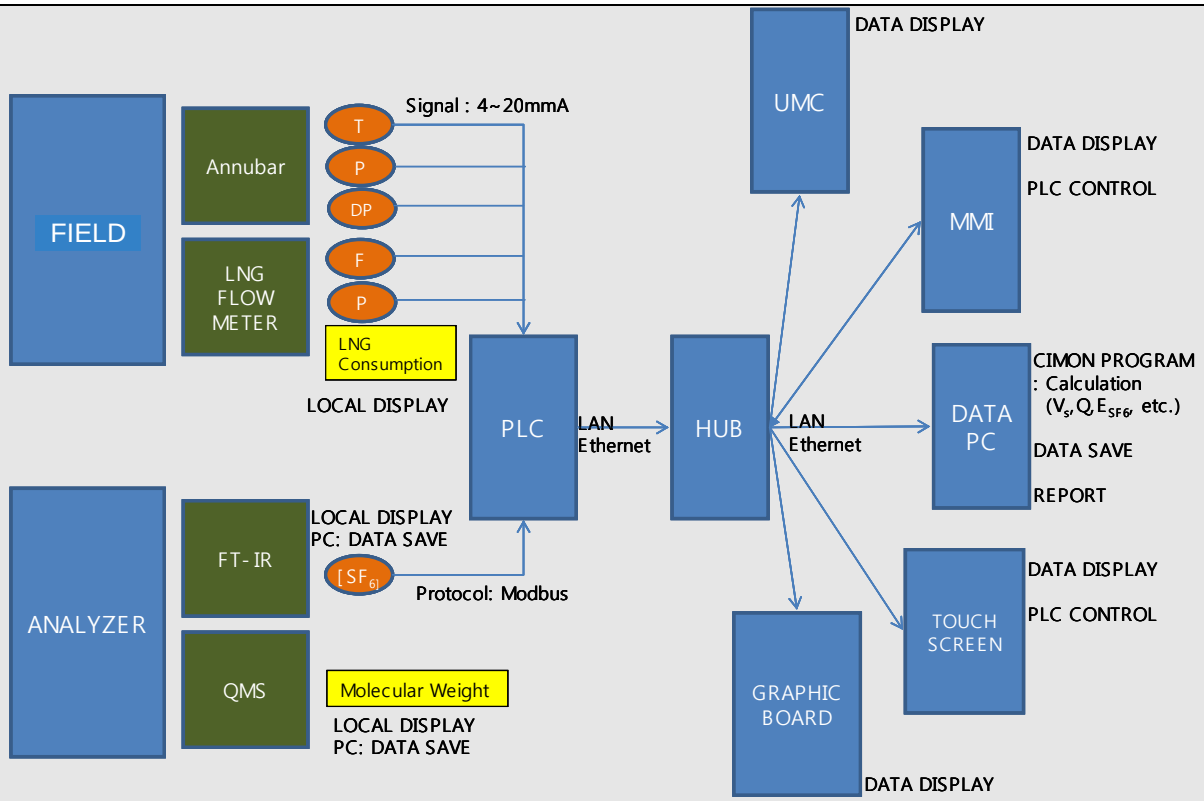
Parameters used in the emission reductions calculation can be classified into 4 groups – continuously monitored group, frequently monitored group, calculated group and externally provided group. The following diagrams show all relevant monitoring points and how the continuously monitored factors and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



<Monitoring points>

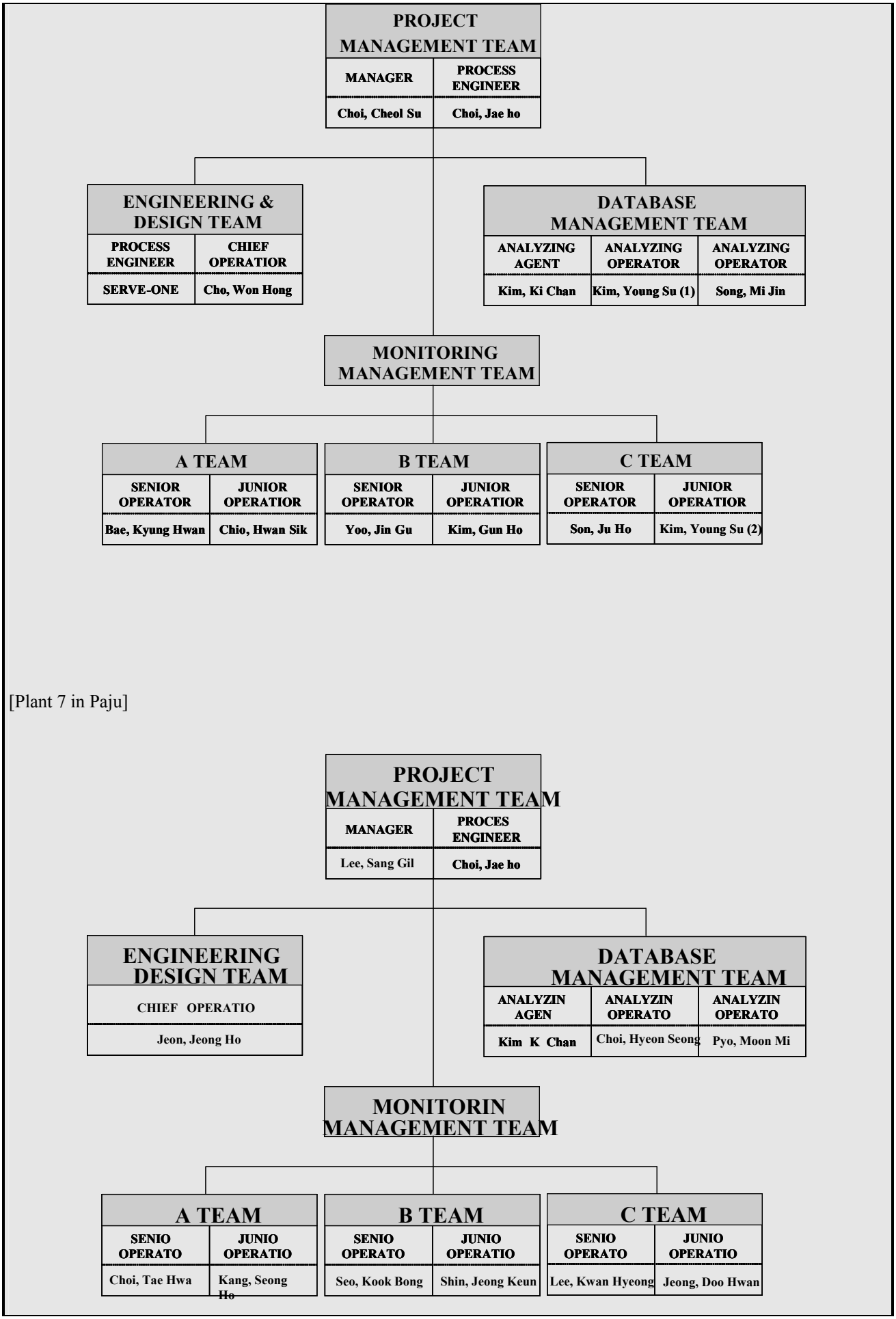


<Data Processing Flow>

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.

[Plant 6 in Gumi]



[Plant 7 in Paju]

Each sub team has following roles and responsibilities;

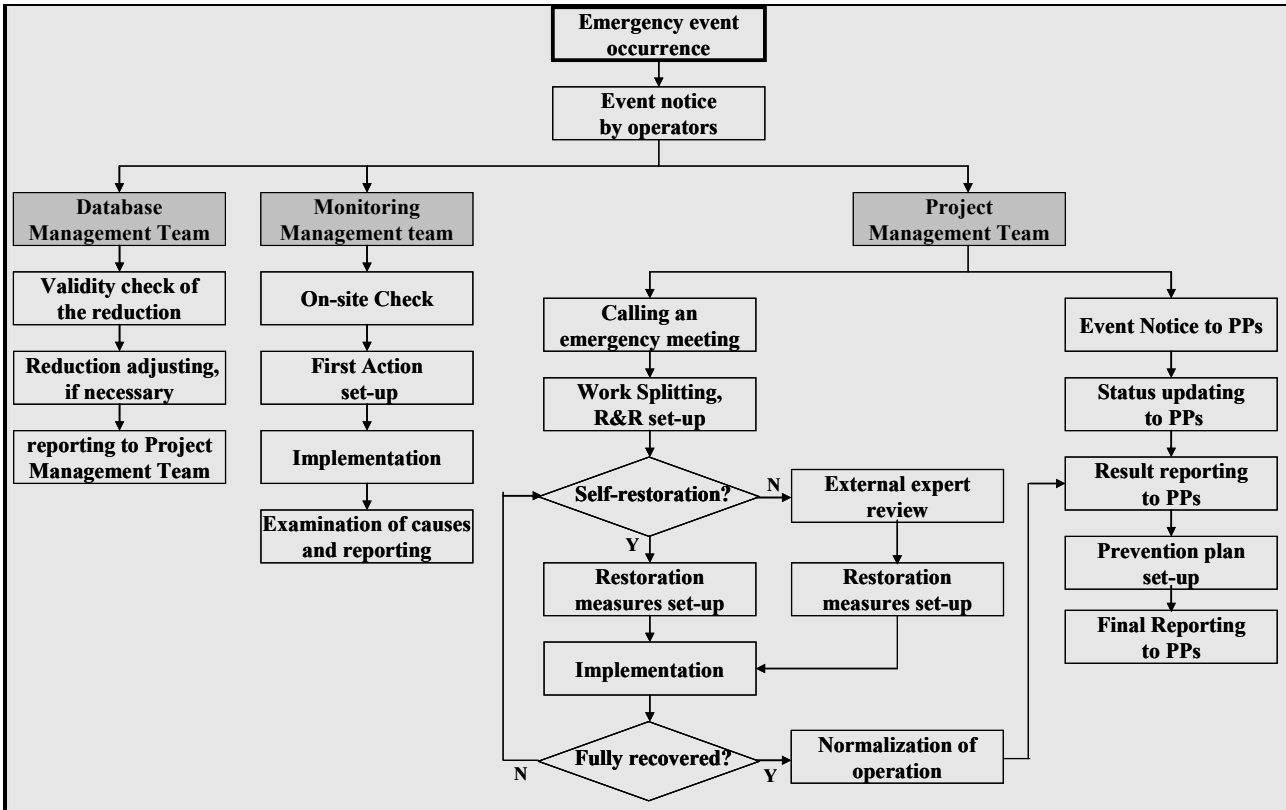
1) Project Management team's roles and responsibilities
- Responsible for the overall legal affairs for SF6 decomposition facilities
- Secure operations of the SF6 decomposition facilities in accordance with the CDM methodology
- Secure and manage human resources necessary for operations of SF6 decomposition 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 fixed ex ante or at renewal of crediting period

Data/Parameter	**GWP of SF_6**
Unit	$tCO2eq/tSF_6$
Description	Global Warming Potential of SF_6
Source of data	IPCC default value
Value(s) applied	23,900
Purpose of data	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 SF* 6, *ex*)**
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	Historic operation design of existing plants
Value(s) applied	None- Not applicable
Purpose of data	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 ($CSF6,hist$)**
Unit	Tonnes
Description	Historical SF6 consumption of Plant 6 & 7, calculated as the three years maximum consumption prior to the implementation of the project activity before 31 January 2009. Consumption is defined as the total SF6 purchased in a year, taking into account the change in inventory in a specific year.
Source of data	Record of purchase and inventory
Value(s) applied	P6: 25,409 tonnes, P7: 32,818 tonnes This value is the maximum consumption of SF6 in Plant 6 & 7 over the three year historic period.

Fab	Yearly SF6 consumption (kg)		
	'06	'07	'08
P6 (in the PDD)	55,024	73,990	76,226
P7 (in the PDD)	24,371	70,092	98,453
P6 (adjusted)	18,392	24,731	25,409
P7 (adjusted)	8,146	23,428	32,818

For this monitoring purpose, P6: 122days / P7: 122days of $C_{SF6.hist}$ are necessary. Therefore, the values presented in the PDD are re-calculated on a pro-rata basis.

Purpose of data	This data is used for the baseline calculation.
Additional comment	-

Data/Parameter	Historical production of LCD substrate **(SP-i)**
Unit	m2
Description	Historical production of LCD substrate (m2) of Plant 6 & 7 during year i (where i =-1, -2, -3) prior to the implementation of the project activity before January, 31, 2009 (values of P6: 122days / P7: 122days, for this monitoring purpose)
Source of data	Production record
Value(s) applied	

Fab	Glass input(m2)		
	'06	'07	'08
P6 (in the PDD)	4,078,800	5,252,354	5,680,338
P7 (in the PDD)	2,438,002	6,020,234	7,559,469
P6 (adjusted)	1,363,325	1,755,581	1,893,446
P7 (adjusted)	814,894	2,012,243	2,519,823

For this monitoring purpose, P6: 122days / P7: 122days of SP-i are necessary. Therefore, the values presented in the PDD are re-calculated on a pro-rata basis.

Purpose of data	This data is used for the baseline calculation.
Additional comment	-

Data/Parameter	**Maintenance schedule for abatement device**
Unit	List of maintenance requirements and checking frequency
Description	Complete maintenance schedule for the device
Source of data	Yearly plan of Operation & Maintenance team
Value(s) applied	A summary of this information has been submitted to the DOE for verification purpose.
Purpose of data	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
Unit	List of maintenance requirements and checking frequency
Description	Complete maintenance schedule for the device
Source of data	Yearly plan of Operation & Maintenance team
Value(s) applied	A summary of this information has been submitted to the DOE for verification purpose.
Purpose of data	Not applicable
Additional comment	This data is not used for calculating emission reduction. However, reporting this data is required by the applied methodology. * Maintenance on the FTIR is regularly conducted in June every year on the occasion of AST (Annual Surveillance Test), even if there is no signal to malfunctioning. At his time, recalibration is carried out. The official supplier, Joowon Industrial Co., of the FTIR, does not request, or recommend cleaning and replacement of FTIR window at regular frequency.

Data/Parameter	Maintenance schedule for QMS measurement devices
Unit	List of maintenance requirements and checking frequency
Description	Complete maintenance schedule for the device
Source of data	Yearly plan of Operation & Maintenance team
Value(s) applied	A summary of this information has been submitted to the DOE for verification purpose.
Purpose of data	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 Annubar devices
Unit	List of maintenance requirements and checking frequency
Description	Complete maintenance schedule for the device
Source of data	Yearly plan of Operation & Maintenance team
Value(s) applied	A summary of this information has been submitted to the DOE for verification purpose.
Purpose of data	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	$EF_{grid,CM,y}$
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	Values have been calculated using the "Tool to calculate the emission factor for an electricity system v.2"
Value(s) applied	0.5708 TCO2/MWh
Purpose of data	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	$C_{p.in}$
Unit	dimensionless
Description	Pitot tubes or Averaging Pitot Tube coefficient of the inlet Annubar device
Source of data	Annubar device manufacturer specification
Value(s) applied	1
Purpose of data	This data is used for the project calculation.
Additional comment	

Data/Parameter	$C_{p.out}$
Unit	dimensionless
Description	Pitot tubes or Averaging Pitot Tube coefficient of the outlet annubar device
Source of data	Annubar device manufacturer specification
Value(s) applied	1
Purpose of data	This data is used for the project calculation.
Additional comment	

Data/Parameter	Cross sectional area of the inlet stack (A_{in})
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	Supplier's specification
Value(s) applied	0.0961625
Purpose of data	This data is used for the project calculation.
Additional comment	0.175m * 0.175m*3.14 (Diameter of the inlet stack is 0.35m)

Data/Parameter	Cross sectional area of the outlet stack (A_{out})
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	Supplier's specification
Value(s) applied	0.2826
Purpose of data	This data is used for the project calculation.
Additional comment	0.3m * 0.3m*3.14 (Diameter of the outlet stack is 0.6m)

D.2. Data and parameters monitored
[Plant 6 in Gumi]

Data/Parameter	ESF6,in,y
Unit	tonnes
Description	Mass of SF6 gas entering the abatement device in year *y* (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Calculated
Source of data	Data processing program and Daily/weekly/monthly logs
Value(s) of monitored parameter	9.4302 tonnes
Monitoring equipment	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	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.
Purpose of data	This data is used for the Baseline emission calculation
Additional comment	

Data/Parameter	**C**SF6,y
Unit	Tonnes
Description	Annual consumption of SF6 during the project year *y*, defined as the total SF6 purchased in a specific project year *y* taking into account the change in inventory in the same year. (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Calculated
Source of data	Purchase records, monthly records on SF6 inventory change and cylinder replacement records.
Value(s) of monitored parameter	21.600 tonnes
Monitoring equipment	Not applicable
Measuring/Reading/ Recording frequency	Once per year or a monitoring period, whichever is shorter.
Calculation method (if applicable)	(Total SF6 purchase Amount – Inventory change) * 10% of heel value
QA/QC procedures	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 6.0%. However, for more conservative calculation, 10% of heel value is applied in the emission reduction calculation.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	SPproject,y
Unit	m^2
Description	Production of LCD substrate during the project year *y* (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Measured
Source of data	Manufacturing Execution system of LG Display
Value(s) of monitored parameter	2,417,903 m^2
Monitoring equipment	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	Cross check with LGD's monthly & annual production summary reports
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	ESF6,in
Unit	Gram / second
Description	Emissions of SF6 gas measured at the inlet of the SF6 abatement system
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	0.91 gram / second This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	Inlet QMS, FTIR and inlet Annubar devices
Measuring/Reading/ Recording frequency	Once per second
Calculation method (if applicable)	Equation 14 in the applied methodology $E_{SF6in} = 65.18 Q_{in} [SF_{6in}]$
QA/QC procedures	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	ESF6,out
Unit	Gram / second
Description	Emissions of SF6 gas measured at the outlet of the SF6 abatement system
Measured/Calculated /Default	Calculated

Source of data	Data processing program
Value(s) of monitored parameter	0.01 gram / second This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	Outlet QMS, FTIR and outlet Annubar devices
Measuring/Reading/ Recording frequency	Once per second
Calculation method (if applicable)	Equation 15 in the applied methodology $E_{SF6out} = 65.18 Q_{out} [SF_{6out}]$
QA/QC procedures	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	**$M_{s,in}$**
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	28.341 g/mole (determined on Jun. 9, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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 $M_{s,in} = M_{d,in} \cdot (100 - B_{ws,in}) \div 100 + 0.18 B_{ws,in}$
QA/QC procedures	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 $B_{ws,in}$.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	**$M_{s,out}$**
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	27.407 g/mole (determined on Jun. 9, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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 $M_{s,out} = M_{d,out} \cdot (100 - B_{ws,out}) \div 100 + 0.18 B_{ws,out}$
QA/QC procedures	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 $B_{ws,out}$.
Purpose of data	This data is used for the Project emission calculation.
Additional comment	

Data/Parameter	$M_{d,in}$
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	28.840 g/mole (determined on Jun. 9, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	inlet QMS

Type	Quadruple Mass spectrometry
Accuracy class	±3%
Serial number	2X31131
Calibration frequency	Once per year
Date of last Calibration	19/08/2010 (previous) 22/06/2011 09/06/2012
Validity	08/06/2013

Measuring/Reading/ Recording frequency	Once per year, at least
Calculation method (if applicable)	Equation 6 in the applied methodology and relevant clauses thereof. $M_{d,in} = 1.460[SF_{6in}] + 0.440[CO_{2in}] + 0.320[O_{2in}] + 0.280[N_{2in}] + 0.399[Ar_{in}] + 1.021[SO_2F_{2in}] + 0.040[He_{in}]$
QA/QC procedures	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_2F_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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	$M_{d,out}$
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	29.080 g/mole (determined on Jun. 9, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	outlet QMS Type: Quadruple Mass spectrometry Accuracy class: ±3% Serial number: 2X31132 Calibration frequency: Once per year Date of last Calibration: 19/08/2010 (previous), 22/06/2011, 09/06/2012 Validity: 08/06/2013
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	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	**$B_{ws,in}$**
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	4.6% (determined on Jun. 9, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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 (previous), 13/12/2010 Validity: 12/12/2012
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	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	$B_{ws,out}$
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	15.1% (determined on Jun. 9, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Absolute inlet stack pressure ($P_{s,in}$)
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	828 mmHg This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(inlet annubar device) Type: Differential Pressure-Pitot tube Accuracy class: ±3% Serial number: 72742A Calibration frequency: Once per year Date of last Calibration: 23/06/2010 (previous), 21/06/2011, 09/06/2012 Validity: 08/06/2013
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Absolute outlet stack pressure ($P_{s,out}$)
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	757 mmHg This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(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 (previous), 21/06/2011, 09/06/2012 Validity: 08/06/2013
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Absolute inlet stack temperature ($T_{s,in}$)
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	310 K This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(inlet annubar device) Type: Standard Platinum Resistance Thermometer Accuracy class: ±3% Serial number: 72742A Calibration frequency: Once per year Date of last Calibration: 23/06/2010 (previous), 21/06/2011, 09/06/2012 Validity: 08/06/2013
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Absolute outlet stack temperature ($T_{s,out}$)
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	330 K This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.

Monitoring equipment	(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 (previous), 21/06/2011, 09/06/2012 Validity: 08/06/2013
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Velocity head measurement by inlet Annubar device ($p_{avg,in}$)
Unit	mmH_2O
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	1.33 mmH_2O This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(inlet annubar device) Type: Differential Pressure-Pitot tube Accuracy class: ±3% Serial number: 72742A Calibration frequency: Once per year Date of last Calibration: 23/06/2010 (previous), 21/06/2011, 09/06/2012 Validity: 08/06/2013
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Velocity head measurement by outlet Annubar device ($p_{avg,out}$)
Unit	mmH_2O
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	0.86 mmH_2O This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(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 (previous), 21/06/2011, 09/06/2012 Validity: 08/06/2013
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Inlet gas velocity ($v_{s,in}$)
Unit	m/sec
Description	Inlet gas velocity
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	4.63 m/sec This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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 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	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Outlet gas velocity ($v_{s,out}$)
Unit	m/sec
Description	Outlet gas velocity
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	4.08 m/sec This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Inlet stack volumetric flow rate (Q_{in})
Unit	m^3/sec
Description	Inlet volumetric flow rate
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	0.44 m^3/sec This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6.in}$ and $E_{SF6.out}$ using each real-time value of $P_{s.in}$, $P_{s.out}$, $T_{s.in}$, $T_{s.out}$, $P_{avg.in}$, $P_{avg.out}$ and SF_6 concentration and fixed values of $M_{d.in}$, $M_{d.out}$, $B_{ws.in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.

Monitoring equipment	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	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Outlet stack volumetric flow rate (Q_{out})
Unit	m^3/sec
Description	Outlet volumetric flow rate
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	0.86 m^3/sec This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6.in}$ and $E_{SF6.out}$ using each real-time value of $P_{s.in}$, $P_{s.out}$, $T_{s.in}$, $T_{s.out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Inlet SF_6 concentration
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	318.9 ppm This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	Inlet FTIR

Type	FT-IR spectrometry
Accuracy class	±2%
Serial number	580
Calibration frequency	Once per year
Date of last Calibration	07/12/2010 (previous) 22/06/2011 09/06/2012
Validity	08/06/2013

Measuring/Reading/ Recording frequency	Once per 40 seconds
Calculation method (if applicable)	Not applicable
QA/QC procedures	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Outlet SF_6 concentration
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	2.0 ppm This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	outlet FTIR

Type	FT-IR spectrometry
Accuracy class	±2%
Serial number	581
Calibration frequency	Once per year
Date of last Calibration	08/11/2010 (previous) 22/06/2011 09/06/2012
Validity	08/06/2013

Measuring/Reading/ Recording frequency	Once per 40 seconds

Calculation method (if applicable)	Not applicable
QA/QC procedures	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 SF_6. However, considering that the SF_6 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. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	**FCi,j,y** volume unit per year of natural gas consumed by the abatement device.
Unit	Nm^3
Description	Quantity of natural gas combusted in the abatement process during the year *y* (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Measured
Source of data	**LNG flow-meter**
Value(s) of monitored parameter	393,428 Nm^3
Monitoring equipment	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	The flow meter will be maintained by Korea Gas Corporation (a public enterprise). The value recorded in the system is 388,232 Nm^3 and the applied value comes from daily log book manually recorded by operators. The latter data recorded by operators 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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	WC,i,y
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	0.751 tC/tLNG (measured on Aug. 20, 2012)
Monitoring equipment	Not applicable This is an externally provided data.

Measuring/Reading/ Recording frequency	Once per year (Last measurement conducted on Aug. 20, 2012)
Calculation method (if applicable)	Not applicable
QA/QC procedures	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	ρi,y
Unit	t natural gas/ m3 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	0.7934* 10^-3 t natural gas/ m3 natural gas (measured on Aug. 20. 2012)
Monitoring equipment	Not applicable This is an externally provided data.
Measuring/Reading/ Recording frequency	Once per year (Last measurement conducted on Aug. 20, 2012)
Calculation method (if applicable)	Not applicable
QA/QC procedures	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	$EC_{,y}$
Unit	kWh
Description	Electricity Consumption in year y (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Measured
Source of data	**Logbooks and 6 electricity meters**
Value(s) of monitored parameter	374,751 kWh

Monitoring equipment

Meter #1

Type	Electric meter
Accuracy class	±2% (Grade 2, Certified by KEPCO)
Serial number	97001891
Calibration frequency	Once per 7 years
Date of last Calibration	20/12/2009
Validity	19/12/2016

Meter #2

Type	Electric meter
Accuracy class	±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	±2% (Grade 2, Certified by KEPCO)
Serial number	98001026
Calibration frequency	Once per 7 years
Date of last Calibration	30/09/2009
Validity	29/09/2016

Meter #4

Type	Electric meter
Accuracy class	±2% (Grade 2, Certified by KEPCO)
Serial number	9084449
Calibration frequency	Once per 7 years
Date of last Calibration	13/01/2009
Validity	12/01/2016

Meter #5

Type	Electric meter
Accuracy class	±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	±2% (Grade 2, Certified by KEPCO)
Serial number	90064868
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	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 374,751 kWh is greater than daily log book data (374,512 kWh) manually recorded by operators. The greater value is applied for conservativeness.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

[Plant 7 in Paju]

Data/Parameter	ESF6,in,y
Unit	tonnes
Description	Mass of SF6 gas entering the abatement device in year *y* (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Calculated
Source of data	Data processing program and Daily/weekly/monthly logs
Value(s) of monitored parameter	19.8270 tonnes
Monitoring equipment	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	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.
Purpose of data	This data is used for the Baseline emission calculation
Additional comment	

Data/Parameter	**C**SF6,y
Unit	Tonnes
Description	Annual consumption of SF6 during the project year *y*, defined as the total SF6 purchased in a specific project year *y* taking into account the change in inventory in the same year. (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Calculated
Source of data	Purchase records, monthly records on SF6 inventory change and cylinder replacement records.
Value(s) of monitored parameter	45.043 tonnes
Monitoring equipment	Not applicable
Measuring/Reading/ Recording frequency	Once per year or a monitoring period, whichever is shorter.

Calculation method (if applicable)	(Total SF6 purchase Amount – Inventory change) * 10% of heel value
QA/QC procedures	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 6.0%. However, for more conservative calculation, 10% of heel value is applied in the emission reduction calculation.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	SPproject,y
Unit	m^2
Description	Production of LCD substrate during the project year *y* (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Measured
Source of data	Manufacturing Execution system of LG Display
Value(s) of monitored parameter	4,124,991 m^2
Monitoring equipment	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	Cross check with LGD's monthly & annual production summary reports
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	ESF6,in
Unit	Gram / second
Description	Emissions of SF6 gas measured at the inlet of the SF6 abatement system
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	1.90 gram / second This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet..
Monitoring equipment	inlet QMS, FTIR and inlet Annubar devices
Measuring/Reading/ Recording frequency	Once per second
Calculation method (if applicable)	Equation 14 in the applied methodology $E_{SF6in} = 65.18 Q_{in} [SF_{6in}]$

QA/QC procedures	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	ESF6,out
Unit	Gram / second
Description	Emissions of SF6 gas measured at the outlet of the SF6 abatement system
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	0.01 gram / second This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet..
Monitoring equipment	Outlet QMS, FTIR and outlet Annubar devices
Measuring/Reading/ Recording frequency	Once per second
Calculation method (if applicable)	Equation 15 in the applied methodology $E_{SF6out} = 65.18 Q_{out} [SF_{6out}]$
QA/QC procedures	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	**$M_{s,in}$**
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	29.205 g/mole (determined on Jun. 30, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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 $M_{s,in} = M_{d,in} \cdot (100 - B_{ws,in}) \div 100 + 0.18 B_{ws,in}$
QA/QC procedures	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 $B_{ws,in}$.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	**$M_{s.out}$**
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	27.697 g/mole (determined on Jun. 30, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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 $M_{s,out} = M_{d,out} \cdot (100 - B_{ws,out}) \div 100 + 0.18 B_{ws,out}$
QA/QC procedures	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 $B_{ws,out}$.
Purpose of data	This data is used for the Project emission calculation.
Additional comment	

Data/Parameter	$M_{d,in}$
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	29.820 g/mole (determined on Jun. 30, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	inlet QMS

Type	Quadruple Mass spectrometry
Accuracy class	±3%
Serial number	60321
Calibration frequency	Once per year
Date of last Calibration	25/01/2012 (previous) 18/03/2012 30/06/2012
Validity	29/06/2013

Measuring/Reading/ Recording frequency	Once per year, at least
Calculation method (if applicable)	Equation 6 in the applied methodology and relevant clauses thereof. $M_{d,in} = 1.460[SF_{6in}] + 0.440[CO_{2in}] + 0.320[O_{2in}] + 0.280[N_{2in}] + 0.399[Ar_{in}] + 1.021[SO_2F_{2in}] + 0.040[He_{in}]$

QA/QC procedures	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_2F_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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	$M_{d,out}$
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	28.970 g/mole (determined on Jun. 30, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	outlet QMS Type: Quadruple Mass spectrometry Accuracy class: ±3% Serial number: 60320 Calibration frequency: Once per year Date of last Calibration: 25/01/2012 (previous), 18/03/2012, 30/06/2012 Validity: 29/06/2013
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	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	**$B_{ws,in}$**
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	5.2% (determined on Jun. 30, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.

Monitoring equipment	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: 601023 Calibration frequency: Once per 2 years Date of last Calibration: 25/01/2012 (previous) 18/03/2012 Validity: 17/03/2014
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	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	$B_{ws,out}$
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	11.6% (determined on Jun. 30, 2012) $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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: 80-091100-1 Calibration frequency: Once per 2 years Date of last Calibration: 25/01/2012 (previous) 18/03/2012 Validity: 17/03/2014
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	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Absolute inlet stack pressure ($P_{s,in}$)
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	851 mmHg This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(inlet annubar device) Type: Differential Pressure-Pitot tube Accuracy class: ±3% Serial number: 069453A Calibration frequency: Once per year Date of last Calibration: 22/09/2011 Validity: 21/09/2012
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Absolute outlet stack pressure ($P_{s,out}$)
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	755 mmHg This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(outlet annubar device) Type: Differential Pressure-Pitot tube Accuracy class: ±3% Serial number: 076132A Calibration frequency: Once per year Date of last Calibration: 04/10/2011 Validity: 03/10/2012

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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Absolute inlet stack temperature ($T_{s,in}$)
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	322 K This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(inlet annubar device) Type: Standard Platinum Resistance Thermometer Accuracy class: ±3% Serial number: 069453A Calibration frequency: Once per year Date of last Calibration: 22/09/2011 Validity: 21/09/2012
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Absolute outlet stack temperature ($T_{s,out}$)
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	309 K This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(outlet annubar device) Type: Standard Platinum Resistance Thermometer Accuracy class: ±3% Serial number: 076132A Calibration frequency: Once per year Date of last Calibration: 04/10/2011 Validity: 03/10/2012
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Velocity head measurement by inlet Annubar device ($p_{avg,in}$)
Unit	mmH_2O
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	1.49 mmH_2O This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(inlet annubar device) Type: Differential Pressure-Pitot tube Accuracy class: ±3% Serial number: 069453A Calibration frequency: Once per year Date of last Calibration: 22/09/2011 Validity: 21/09/2012
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Velocity head measurement by outlet Annubar device ($p_{avg,out}$)
Unit	mmH_2O
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	1.17 mmH_2O This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	(outlet annubar device) Type: Differential Pressure-Pitot tube Accuracy class: ±3% Serial number: 076132A Calibration frequency: Once per year Date of last Calibration: 04/10/2011 Validity: 03/10/2012
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	This value is measured in accordance with the EPA guideline.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Inlet gas velocity ($v_{s,in}$)
Unit	m/sec
Description	Inlet gas velocity
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	4.86 m/sec This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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 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	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Outlet gas velocity ($v_{s,out}$)
Unit	m/sec
Description	Outlet gas velocity
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	4.59 m/sec This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Inlet stack volumetric flow rate (Q_{in})
Unit	m^3/sec
Description	Inlet volumetric flow rate
Measured/Calculated /Default	Calculated
Source of data	Data processing program

Value(s) of monitored parameter	0.45 m^3/sec This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Outlet stack volumetric flow rate (Q_{out})
Unit	m^3/sec
Description	Outlet volumetric flow rate
Measured/Calculated /Default	Calculated
Source of data	Data processing program
Value(s) of monitored parameter	1.08 m^3/sec This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	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	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	Inlet SF_6 concentration
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	647.0 ppm This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	Inlet FTIR Type: FT-IR spectrometry Accuracy class: ±2% Serial number: M620 Calibration frequency: Once per year Date of last Calibration: 18/01/2012 Validity: 17/01/2013
Measuring/Reading/ Recording frequency	Once per 40 seconds
Calculation method (if applicable)	Not applicable
QA/QC procedures	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.
Purpose of data	This data is used for the baseline emission calculation.
Additional comment	

Data/Parameter	Outlet SF_6 concentration
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	2.0 ppm This is the average value during the monitoring period. To comply precisely with US EPA Methods required in both AM0078 and registered PDD and also to monitor "continuously", actual monitoring was done every second and monitored values were immediately converted by the algorithm in the program of the monitoring system for real-time determination of $V_{s,in}$, $V_{s,out}$, Q_{in}, Q_{out}, $E_{SF6,in}$ and $E_{SF6,out}$ using each real-time value of $P_{s,in}$, $P_{s,out}$, $T_{s,in}$, $T_{s,out}$, $P_{avg,in}$, $P_{avg,out}$ and SF_6 concentration and fixed values of $M_{d,in}$, $M_{d,out}$, $B_{ws,in}$, $B_{ws,out}$, $M_{s,in}$ and $M_{s,out}$ which were determined with separated investigation called "experimental setup" in AM0078. Please see more details in the spreadsheet.
Monitoring equipment	outlet FTIR Type: FT-IR spectrometry Accuracy class: ±2% Serial number: M619 Calibration frequency: Once per year Date of last Calibration: 18/01/2012 Validity: 17/01/2013
Measuring/Reading/ Recording frequency	Once per 40 seconds
Calculation method (if applicable)	Not applicable
QA/QC procedures	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 SF_6. However, considering that the SF_6 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. More detailed information on QA/QC procedure is included in the Data Management Manual which has been provided to DOE for verification purpose.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	**FCi,j,y** volume unit per year of natural gas consumed by the abatement device.
Unit	Nm^3
Description	Quantity of natural gas combusted in the abatement process during the year *y* (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)
Measured/Calculated /Default	Measured
Source of data	**LNG flow-meter**
Value(s) of monitored parameter	461,577 Nm^3
Monitoring equipment	LNG flow meter Type: LNG flow meter Accuracy class: ±2% (Grade 2, certified by Youngnam Energy Service) Serial number: A037-1206083-021 Calibration frequency: Once per 8 years Date of last Calibration: 22/11/2011 Validity: 21/11/2019
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	The flow meter will be maintained by Korea Gas Corporation (a public enterprise). The value recorded in the system is 461,285 Nm^3 and the applied value comes from daily log book manually recorded by operators. The latter data recorded by operators 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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	$W_{C,i,y}$
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	0.751 tC/tLNG (measured on Aug. 20, 2012)
Monitoring equipment	Not applicable This is an externally provided data.
Measuring/Reading/ Recording frequency	Once per year (Last measurement conducted on Aug. 20, 2012)
Calculation method (if applicable)	Not applicable
QA/QC procedures	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	$\rho_{i,y}$
Unit	t natural gas/ m3 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	0.7931* 10^-3 t natural gas/ m3 natural gas (measured on Aug. 20. 2012)
Monitoring equipment	Not applicable This is an externally provided data.
Measuring/Reading/ Recording frequency	Once per year (Last measurement conducted on Aug. 20, 2012)
Calculation method (if applicable)	Not applicable
QA/QC procedures	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.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

Data/Parameter	$EC_{,y}$
Unit	kWh
Description	Electricity Consumption in year y (From 01/09/2012 to 31/12/2012, for this monitoring purpose.)

<table>
<tr><td>Measured/Calculated /Default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Logbooks and 6 electricity meters</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>986,417 kWh</td></tr>
<tr><td>Monitoring equipment</td><td>Meter #1
<table>
<tr><td>Type</td><td>Main Electric meter</td></tr>
<tr><td>Accuracy class</td><td>±2%
(Grade 2, Certified by KEPCO)</td></tr>
<tr><td>Serial number</td><td>10960476</td></tr>
<tr><td>Calibration frequency</td><td>Once per 7 years</td></tr>
<tr><td>Date of last Calibration</td><td>14/04/2010</td></tr>
<tr><td>Validity</td><td>13/04/2017</td></tr>
</table>
Meter #2
<table>
<tr><td>Type</td><td>380V UPS Electric meter</td></tr>
<tr><td>Accuracy class</td><td>±2%
(Grade 1, Certified by KEPCO)</td></tr>
<tr><td>Serial number</td><td>10809210</td></tr>
<tr><td>Calibration frequency</td><td>Once per 8 years</td></tr>
<tr><td>Date of last Calibration</td><td>04/10/2010</td></tr>
<tr><td>Validity</td><td>03/10/2017</td></tr>
</table>
Meter #3
<table>
<tr><td>Type</td><td>Air Heater Electric meter</td></tr>
<tr><td>Accuracy class</td><td>±2%
(Grade 1, Certified by KEPCO)</td></tr>
<tr><td>Serial number</td><td>18601432</td></tr>
<tr><td>Calibration frequency</td><td>Once per 7 years</td></tr>
<tr><td>Date of last Calibration</td><td>20/07/2011</td></tr>
<tr><td>Validity</td><td>19/07/2018</td></tr>
</table>
Meter #4
<table>
<tr><td>Type</td><td>Heat Tracing Electric meter</td></tr>
<tr><td>Accuracy class</td><td>±2%
(Grade 1, Certified by KEPCO)</td></tr>
<tr><td>Serial number</td><td>18002831</td></tr>
<tr><td>Calibration frequency</td><td>Once per 7 years</td></tr>
<tr><td>Date of last Calibration</td><td>04/11/2011</td></tr>
<tr><td>Validity</td><td>03/11/2018</td></tr>
</table>
Meter #5
<table>
<tr><td>Type</td><td>Office Electric meter</td></tr>
<tr><td>Accuracy class</td><td>±2%
(Grade 1, Certified by KEPCO)</td></tr>
<tr><td>Serial number</td><td>18002824</td></tr>
<tr><td>Calibration frequency</td><td>Once per 7 years</td></tr>
<tr><td>Date of last Calibration</td><td>04/11/2011</td></tr>
<tr><td>Validity</td><td>03/11/2018</td></tr>
</table></td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Recording Frequency: Once per second
Calculating Frequency: Once per the given monitoring period</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not applicable</td></tr>
</table>

QA/QC procedures	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. Daily log book data (986,416.9 kWh) manually recorded by operators is greater than the value recorded in the system 986,414.7 kWh. The greater value is applied for conservativeness.
Purpose of data	This data is used for the project emission calculation.
Additional comment	

D.3. Implementation of sampling plan

>>
Sampling plan has been implemented as it should be.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

>>
The Baseline emissions calculation is as follows ;

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

Facility	$E_{SF6,y}$ (01/09/2012~31/12/2012)	k	GWP_{SF6}	$BE_{in,y}$ (01/09/2012~31/12/2012)
P6	9.4302	1.0000	23,900	225,380
P7	15.7525	0.9155	23,900	344,655

where ;Equation (4) in the methodology

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

Facility	$SF_{6,ratio}$	$C_{SF6,y}$	$SP_{project,y}$	k
P6	0.0000134193	26.100	2,417,903	1.0000
P7	0.0000099963	45.043	4,124,991	0.9155

where

$$SF_{6,ratio} = \min(C_{SF6,-1} \div SP_{-1}; C_{SF6,-2} \div SP_{-2}; C_{SF6,-3} \div SP_{-3})$$;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	18.392	24.731	25.409	1,363,325	1,755,581	1,893,446	0.0000134193
P7	8.146	23.428	32.818	814,894	2,012,243	2,519,823	0.0000099963

And

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

Facility	$E_{SF6,in,y}$ (01/09/2012~ 31/12/2012)	0.48 x $C_{SF6,y}$	$C_{SF6,y}$ (01/09/2012~ 31/12/2012)	0.48 x $C_{SF6,hist}$	$C_{SF6.hist}$	$E_{SF6,y}$ (01/09/2012~ 31/12/2012)
P6	9.4302	10.3680	21.6000	12.1961	25.4087	9.4302
P7	19.8270	21.6204	45.0426	15.7525	32.8177	15.7525

where

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

$E_{SF6,in}$ 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

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

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

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

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

E.2. Calculation of project emissions or actual net GHG removals by sinks

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The Project emissions calculation is as follows ;

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

Facility	BE_v (01/09/2012~31/12/2012)	DRE_v (01/09/2012~31/12/2012)	$C_{CO2,v}$ (01/09/2012~31/12/2012)	PE_v (01/09/2012~31/12/2012)
P6	225,380	0.9876	448	3,240
P7	344,655	0.9925	838	3,409

Where

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

Facility	$E_{SF6,in,y}$ (01/09/2012~31/12/2012)	$E_{SF6,out,y}$ (01/09/2012~31/12/2012)	DRE_y (01/09/2012~31/12/2012)
P6	9.4302	0.1168	0.9876
P7	19.8270	0.1479	0.9925

where

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

As well as $E_{SF6,in}$, $E_{SF6,out}$ 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 electronic 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

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

$E_{SF6out} = 65.18 Q_{out}[SF_{6out}]$;Equation (15) in the methodology

And $C_{CO2,y}$ (for the period beginning from September 1,2011 and ending at January 31,2012) 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	$tCO2_{electricity,y}$ (01/09/2012~31/12/2012)	$tCO2_{LNG,y}$ (01/09/2012~31/12/2012)	$C_{CO2,y}$ (01/09/2012~31/12/2012)
P6	214	234	448
P7	563	275	838

where

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

Facility	EC_y (01/09/2012~31/12/2012)	$EF_{grid,CM,y}$	$tCO2_{electricity,y}$ (01/09/2012~31/12/2012)
P6	374.751	0.5708	214
P7	986.417	0.5708	563

And where

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

Facility	$FC_{i,i,y}$ (01/09/2012~31/12/2012)	$wc_{i,y}$	$\rho_{i,y}$	$tCO2_{LNG,y}$ (01/09/2012~31/12/2012)
P6	393,428	0.751	0.0007934	234
P7	461,577	0.751	0.0007931	275

E.3. Calculation of leakage

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

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	570,035	6,649	0	563,386
(P6)	225,380	3,240	0	222,140
(P7)	344,655	3,409	0	341,246

The Emission reductions calculation is as follows ;

$$ER_y = BE_y - PE_y$$;Equation (18) in the methodology

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (tCO_2e)	330,914	563,386
(P6)	165,147 (Equivalent to 122/365 of 494,087 tCO2e which is the reduction estimated for the Year 1.)	222,140
(P7)	165,767 (Equivalent to 122/365 of 495,943 tCO2e which is the reduction estimated for the Year 1.)	341,246

E.6. Remarks on difference from estimated value in registered 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)	28,850 kg (122/365 of the annual value, 86,313 kg derived from the biz plan)	21,600 kg	The actual value is lower than the business plan set up in 2009. This decrease led to small decrease of the baseline emission.
$C_{SF6,y}$ (P7)	29,150 kg (122/365 of the annual value, 87,212 kg derived from the biz plan)	45,043 kg	The actual value is higher than the business plan set up in 2009. This increase led to small increase of the baseline emission.
SF6 etch utilization efficiency (P6)	70.0%	56.3%	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. In case of P7, while $E_{SF6,in,y}$ is higher than $0.48*C_{SF6,hist}$ in the PDD due to the decreased SF6 etch utilization efficiency and $0.48*C_{SF6,hist}$ becomes $E_{SF6,in}$ of this monitoring period. This is a major reason of the increase.
SF6 etch utilization efficiency (P7)	70.0%	56.0%	
heel value (P6 & P7)	10%	6%	In this monitoring report, 10% heel value is used although the actual heel value recorded (6.0%) is much lower than 10%. It was done for a conservative approach to the emission reductions.
DRE (P6)	90.00%	98.76%	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.
DRE (P7)	90.00%	99.25%	

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
P6	$E_{SF6,in,y}$	7,789.6 kg (122/365 of the estimated value on annual basis, 23,305 kg)	9,430.2 kg
	$E_{SF6,out,y}$	778.8 kg (122/365 of the estimated value on annual basis, 2,330 kg)	116.8 kg
P7	$E_{SF6,in,y}$	7,871.5 kg (122/365 of the estimated value on annual basis, 23,550 kg)	19,827.0 kg
	$E_{SF6,out,y}$	787.2 kg (122/365 of the estimated value on annual basis, 2,355 kg)	147.9 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.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	728,653	264,637

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Document information

Version	*Date*	*Description*
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
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