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

CONTENTS

MONITORING REPORT
Version 01, 17/03/2011

Samsung Electronics SF_6 abatement project
Reference Number: 3333
The First Monitoring Period (21/10/2010 - 28/02/2011)

SECTION A. General description of the project activity

A.1. Brief description of the project activity:

The purpose of the Samsung Electronics SF_6 abatement project (the Project or the Project activity) is to abate the emissions of sulfur hexafluoride (SF_6) at Samsung Electronics (SEC) Tangjung LCD plant 7-2 line. The Plant has been producing LCD substrate, using SF_6 gas, a type of greenhouse gas, as an etching gas since commencement of 7-2 line, in January 2006. Prior to the Project the SF_6 was simply emitted into the atmosphere. Through implementation of the Project, SEC has reduced the emission of SF_6 successfully.

The Project has installed an abatement system which includes recuperative thermal oxidation reactors, electrical heaters, powder traps, wet scrubbers and fans. Annubar, QMS and FTIR are used to effectively monitor emission reductions. This electric thermal abatement system destroys SF_6 gas at an operating temperature of 1,200 ~ 1,400 °C.

The project activity has operated continuously from 21/10/2010 and this monitoring report was prepared for the period of 21/10/2010 and 28/02/2011 (131 days). The Project has achieved emission reduction of 60,669 tCO_2e in this, its first monitoring period.

The Project originally had a starting date of 15/07/2010, date that the Project got registered at the UNFCCC. However, due to technical difficulties of the abatement system, starting date of the crediting period was delayed by over three months and the starting date was changed to 21/10/2010.

A.2. Project Participants

Name of Party Involved	Private and/or Public Entity(ies) Project Participant
Republic of Korea	Samsung Electronics Co., Ltd.

A.3. Location of the project activity:

Country: Republic of Korea
Prefecture: Chungcheongnam-do
City: Asan-si

The Project site is located at 200 Tangjung-Myeon, Asan-si, Chungcheongnam-do, Korea. Its geographical coordinates are 36°48'53.04''N and 127°03'51.23''E.

Figure 1. Location of the site for the project activity

A.4. Technical description of the project

Key equipment used in the Project is shown in the following table:

Table 1. Summary of Key Equipments

	Number of units	Manufacturer	Q'ty of unit in Operation	Q'ty of Standby	Total Q'ty installed
Abatement System	RTO Reactor electrical heater	Clean Systems Korea	4	1	5
	Powder Trap	Clean Systems Korea	4	6	10
	Wet Scrubber (Pre-treatment)	Clean Systems Korea	1	1	2
	Wet Scrubber (Post-treatment)	Clean Systems Korea	4	1	5
	Fan	Clean Systems Korea	4	2	6
Monitoring device	Annubar	Air monitor Corporation	2	0	2
	QMS	El, Inc.	2	0	2
	FTIR	Otsuka Electronics Korea Co., Ltd.	2	0	2

Abatement System

Regenerative Thermal Oxidation Reactor Electrical heating (RTO Reactor)

To abate SF_6 emissions from LCD etching process, the electric thermal abatement system will be installed at the Project site. The electric thermal abatement system destroys SF_6 gases at an operating temperature of 1,300 °C. Furthermore, steam is supplied to SF_6 abatement system to convert F to HF chemically. Specification of the abatement system is given below.

Table 2. Key Parameters for RTO Reactor Electrical Heater

	ITEM DESIGN SPEC	DESIGN SPEC	Remark
1	DIMENSION, mm	1,498L×1,808H×1,560W (INCLUDING HIGH CASTER)	
2	CAPACITY (without standby)	MAX. 3,400 L/min × 4 unites	13.6 CMM
3	TARGET PROCESS	LCD-DRY ETCH	
4	TARGET GAS	SF_6	
5	DESTRUCTION EFFICIENCY OF GAS	ABOVE 90%	
6	MAIN POWER	440V, 3 PHASE	
7	TEMPERATURE CONTROLLER	P.I.D.	
8	HEAT RECOVERY EFFICIENCY	92.2%	

Powder Trap

A powder trap is installed for pre-treatment of the flue gas. This is to prevent the deposition of the particulate matter on the walls of the RTO reactor system.

Table 3. Key Parameters for Powder Trap

	ITEM	DESIGN SPEC.	REMARK
1	DIMENSION	745D×1,600H	
2	CAPACITY (without standby)	MAX.3.4 CMM × 4 UNITS	13.6 CMM
3	TARGET PROCESS	LCD-DRY ETCH	
4	TARGET GAS	SF_6	
5	REMOVAL EFFICIENCY OF DUST	90%	INLET : 143mg/m3 OUTLET : 14.3mg/m3
6	MAIN POWER	NO USE	
7	TEMPERATURE CONTROL	NO USE	
8	ENERGY CONSUMPTION	N/A	
9	MAINTENANCE	Every 3 Months	On-site

Post Treatment Wet Scrubber

A wet scrubber is installed as a post-treatment system to remove any HF and SOx in the flue gas from the RTO system.

Table 4. Key Parameters for Post Treatment Wet Scrubber

	ITEM	REMARK
1	TYPE	VERTICAL WET SCRUBBER
2	SIZE	650mm X 650mm X 2,500mmH
3	MAT'L	FRP
4	LAYOUT	650mm X 650mm X 2,500mmH
5	TOTAL Q'TY	5 sets (4 sets and 1 standby)

Pre Treatment Wet Scrubber

A wet scrubber is also installed as a pre-treatment system to remove toxic gases such as HF, HCl, and SiF_4 in the flue gas from the Main Duct.

Table 5. Key Parameters for Pre Treatment Wet Scrubber

	ITEM	REMARK
1	TYPE	VERTICAL WET SCRUBBER
2	SIZE	1,300mmW X 2,400mmL X 3,110mmH
3	MAT'L	FRP
4	LAYOUT	1,300mmW x 2,400mmL
5	TOTAL Q'TY	2 units (1 set and 1 standby)

Fans

FRP fans are installed to control the total system flow rate and the static pressure through the main inlet duct.

Table 6. Key Parameters for Fan

	ITEM	REMARK
1	Main Inlet Pressure	-150mmAq
2	Max Flow Rate	4 CMM/Unit
3	TOTAL Q'TY	6 units(4 sets and 2 standby)

Monitoring devices

As required by the methodology, various monitoring equipments were placed for the Project. A brief description of key equipment is given below.

Annubar

This system, consisting of averaging pitot tubes and flow monitor systems, is to measure the inlet and outlet gas flow of the SF_6 abatement system to within a 2% accuracy under the required minimum duct clearance conditions of installation.

The system reports zero and span errors every 24 hours, and is equipped with an AUTO-air purge system to ensure accurate measurement performance.

Quadruple Mass Spectrometer (QMS)

The QMS is a measuring device which works by filtering sample ions based on their mass-to-charge ratio. After separation, the individual ionized species are collected using a Faraday cup or an electron multiplier.

Fourier Transform infrared (FTIR)

An FTIR is a measuring device that employs a source of mid-infrared radiation, an interferometer, an enclosed sample cell of a known absorption path length, an infrared detector, optical elements that transfer the infrared radiation between components, and a computer system. The time-domain detector response (interferogram) is processed by Fourier transform to yield a representation of the detector response vs. infrared frequency.

Furthermore, location of these equipments and accuracy of these devices are give below.

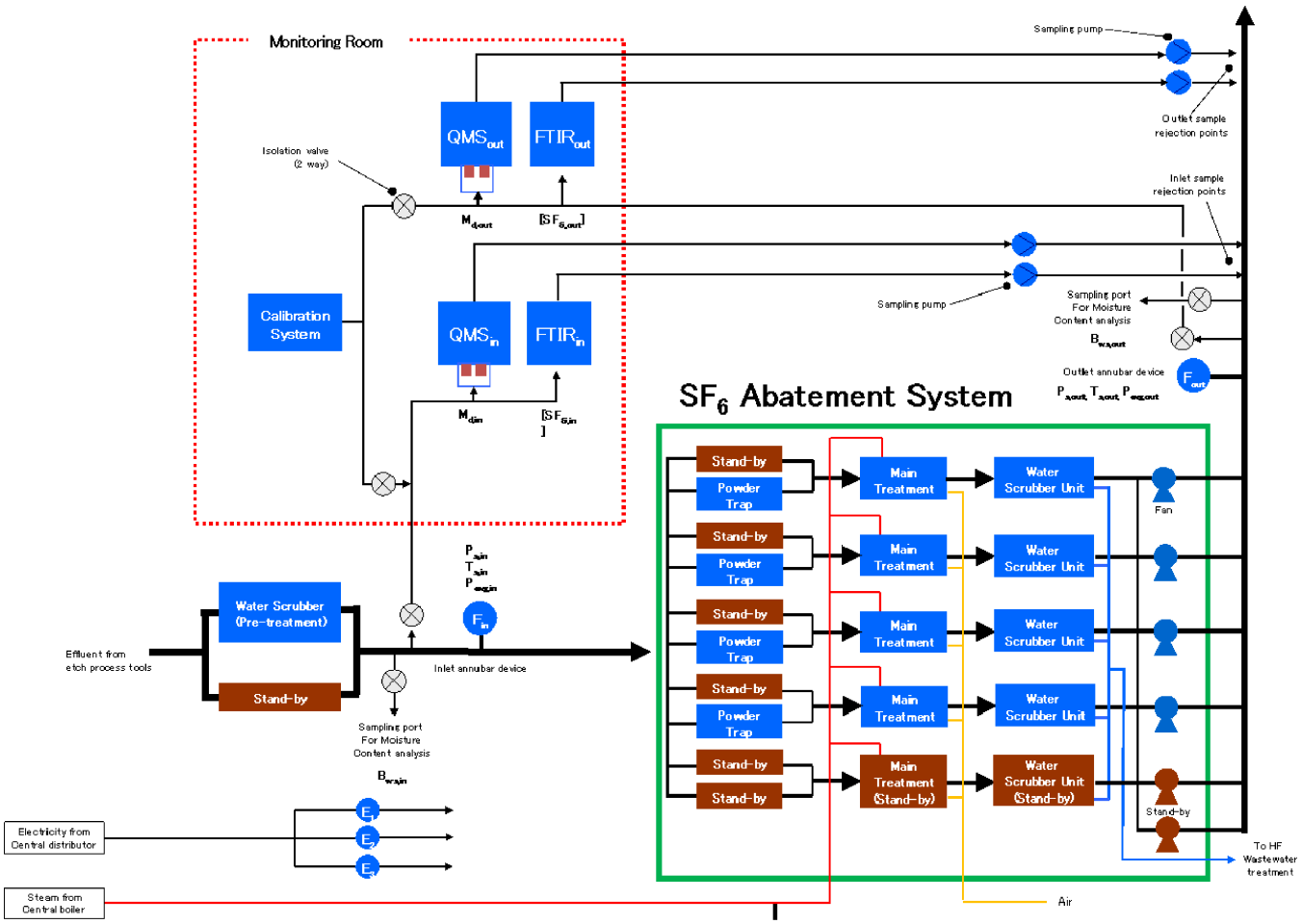

Figure 2. Location of monitoring devices

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

Approved baseline and monitoring methodology applied to the Project activity is:

- "Point of Use Abatement Device to Reduce SF_6 emissions in LCD Manufacturing Operations" (AM0078 Version 01.1)

Also the Project activity refers to the latest version of following tools:

- "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 02.2)
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01);
- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (Version 02)

A.6. Registration date of the project activity:

15/07/2010

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

21/10/2010 – 28/02/2011

The chosen crediting period is 10 years (non-renewable). The post-registration approval was obtained

on 03/12/2010 to change the crediting period from 15/07/2010 – 14/07/2020 to 21/10/2010 – 20/10/2020.

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

This Monitoring Report was prepared by;

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SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

The Project was registered in15/07/2010 and installation of equipment was completed on the 14/10/2010. After few weeks of condition setting and final testing, the Project finally started in 21/10/2010. Monitoring was conducted from 21/10/2010 to 28/02/2011 total of 131 days. During this period, monitoring was interrupted for seven times, as shown below.

Table 7. Key events occurred during the monitoring

Date	Monitoring interrupted time	Events	Comments
15/07/2010	-	Registered at UNFCCC	The Project was successful registered at UNFCCC as a CDM project
14/10/2010	-	Completion of equipment installation	Abatement system, monitoring equipments were installed. Also steam and electricity connection was also completed
17/10/2010	-	Start of test run	To insure performance of the Project, test run was conducted
18/10/2010	-	1st preliminary-sampling	As instructed in the methodology (page 8), preliminary sampling of effluent was conducted to identify the effluent components.
19/10/2010	-	FTIR, QMS Calibration	QMS and FTIR were calibrated for gases which has

			concentration of greater than 100 ppm, based on the 1st preliminary sampling
21/10/2010	-	Start of the Project/ Monitoring period (21/10/2010 00:03)	
22/10/2010	-	M_d measurement	M_d value was measured and calculated
22/10/2010	08:51-16:33	Annubar relocation	Annubar panel was moved from Control Room to beside of the Annubar sensor. During this period, there is no data from Annubar (both inlet and outlet)
25/10/2010	-	2nd preliminary-sampling	As instructed in the methodology (page 8), preliminary sampling of effluent was conducted to identify the effluent
26/10/2010	11:30-11:35	Change of monitoring frequency	Monitoring frequency was changed from every 3 min. to every 5 min.
04/11/2010	-	Measurement of moisture content (B_{ws})	Moisture content (B_{ws})
30/11/2010	15:19 ~ 17:34	FTIR cell cleaning and calibration	Data was not recorded during this time
05/01/2011	14:20 ~ 17:08	FTIR Cell Cleaning and calibration	Data was not recorded during this time
14/02/2011	11:55 ~ 15:10	Replace the Cell window and FTIR calibration	Data was not recorded during this time
01/03/2011	-	End of 1st monitoring period (01/03/2011 0:00)	

B.2. Revision of the monitoring plan

There is no revision of the monitoring plan in this monitoring period.

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

Deviation will be applied for this monitoring plan. Deviation of monitoring plan performed on the basis of applied methodology, AM0078 version 0.1.1 and "Procedures for requests for deviation prior to submitting request for issuance (version 01)" in annex 26 of EB49 meeting report.

There will be deviations of the monitoring plan, concerning following issues.

1. Monitoring frequency of SF_{6in}, SF_{6out} (SF_6 concentration), P_s (stack pressure), T_s (stack temperature), P_{avg} (averaged velocity head measurement), M_d (total dry molecular weight) and B_{ws} (proportion of water in the stack gas)
2. Use of FTIR for M_d values
3. Use of library data, instead of the gas standard for FTIR calibration

"CDM: Form for submission of requests for deviation prior to submitting request for issuance" have been prepared by SEC and will be submitted to DOE. This deviation is expected to proceed.

B.4. Notification or request of approval of changes

Notification or request of approval of changes will be applied for this project. Notification or request of approval of changes will be performed on the basis of registered PDD of the Project and "Procedures for notifying and requesting approval of changes from the project activity as described in the registered project design document" in annex 66 of EB48 meeting report.

There will be two project changes.

1. Change of specification on powder trap
2. Change of specification on QMS
3. Introduction of steam
4. Instalment of pre-wet scrubbers

Documents necessary for Notification or request of approval of changes will be submitted to DOE. This changes is expected to proceed..

SECTION C. Description of the monitoring system

Monitoring and location

The following diagram indicates the location of all relevant monitoring points, used for the Project.

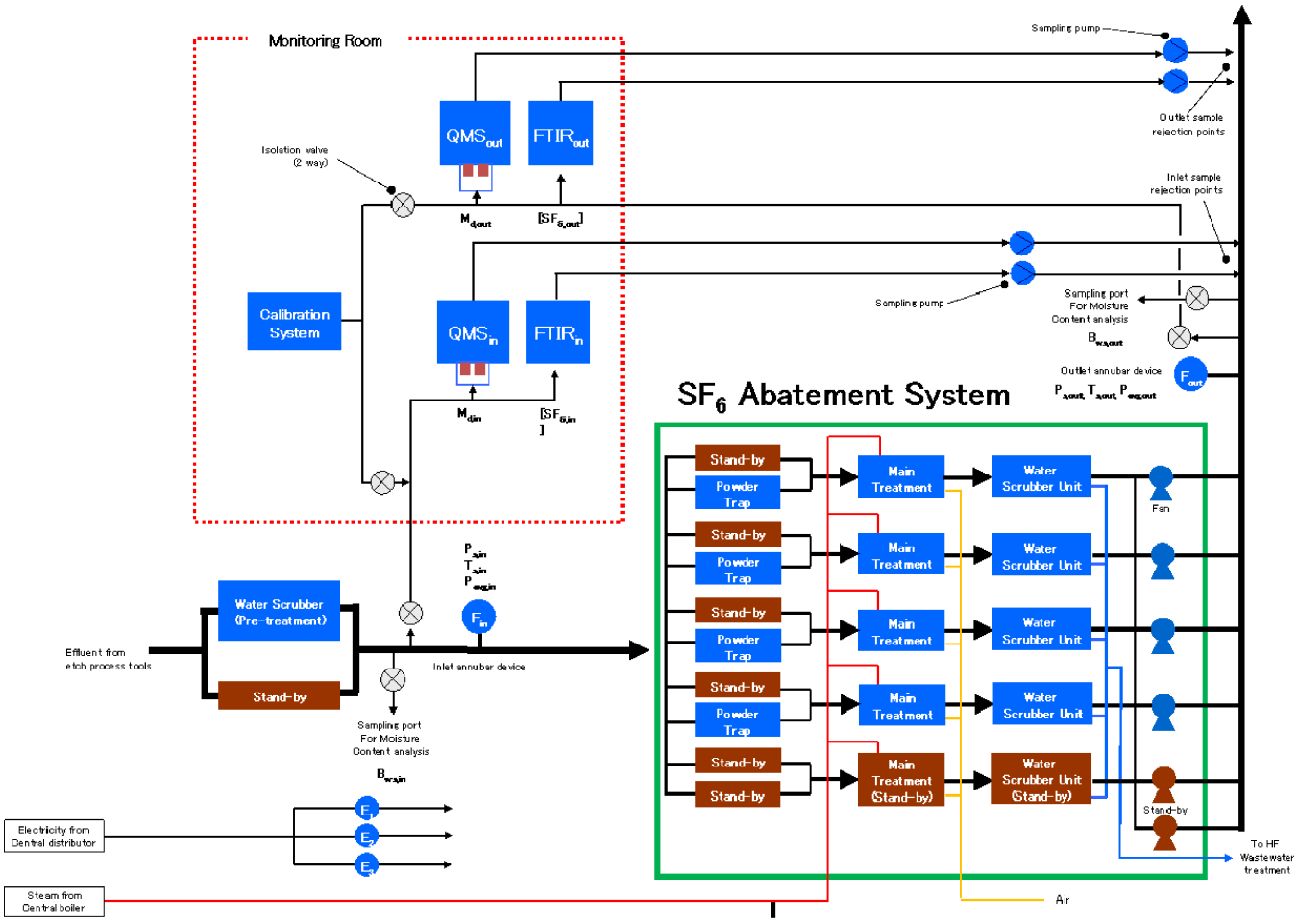

Figure 3. Monitoring points

Monitoring Structure

SEC has outsourced monitoring tasks to a third party, Samsung Engineering Co., Ltd. (SECL). Accordingly, SECL has organized a monitoring structure, which consists of three qualified management teams which are; Management Organization, Monitoring Task team, and Database Task team as shown below.

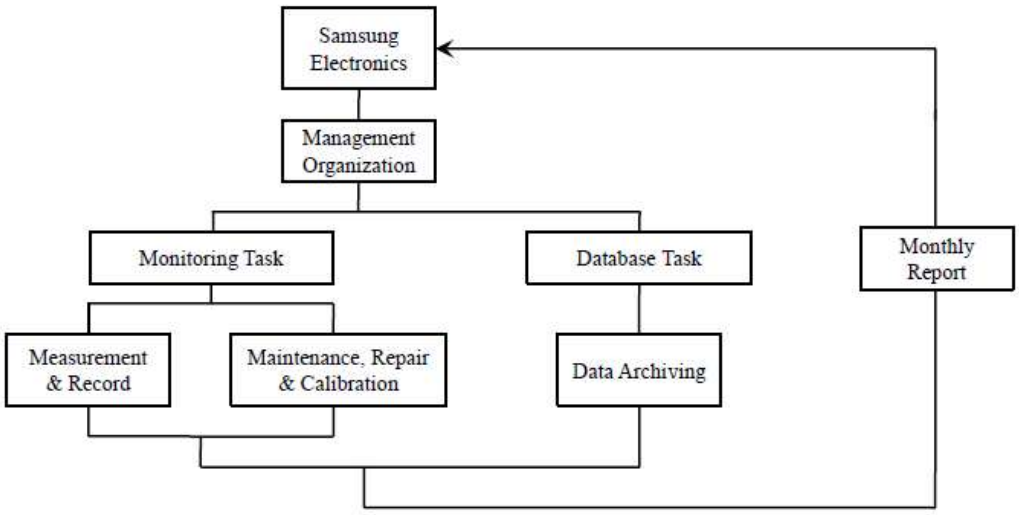

Figure 4. Management and Operational Systems

Management Organization oversees the entire monitoring of the Project. The roles and responsibilities of the Management Organization include;

- Supervising daily operation, monitoring and calibration of the Project, making sure that the monitoring/calibration is conducted in accordance with the CDM methodology
- Scheduling of staff
- Training of staff
- Supervision of suppliers and outsourced workers

The Monitoring Task Team ensures that accurate monitoring is conducted at the Project. Roles of Monitoring task team (Measurement & Record and Maintenance, Repair & Calibration team) include;

- Regular repair and maintenance of the Project
- Conducting the emergency procedure, in case of any emergency
- Designing of the monitoring and recording procedure, to meet requirements of the methodology
- Improvement work for the Project
- Calibration of metering device and reporting of calibration results
- Maintenance/repair and report of metering devices
- Accuracy check and result report for measurements

The Database Task Team makes sure that all the required data is gathered and input to the database. The role of the Database Task Team (Data archiving) includes;

- Data monitoring and recording
- Controlling daily operation
- Regular check on SF6 abatement facilities
- Database management
- Checks and troubleshooting for any alarms from the metering devices

Data Collection Process

To ensure accurate monitoring and data gathering, SEC and SECL have designed the following data processing flow.

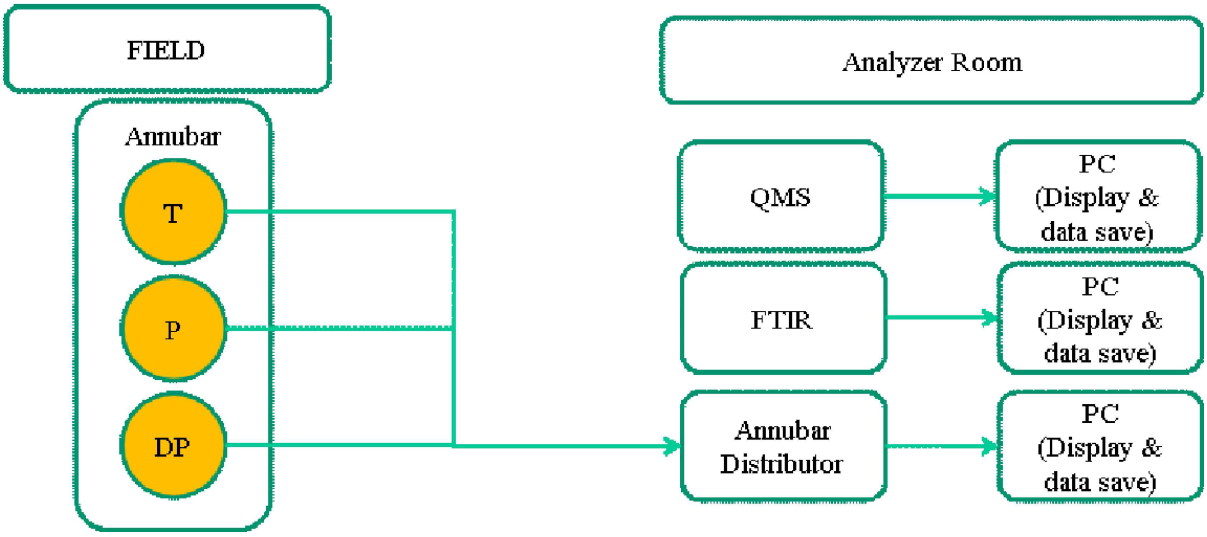

Figure 5. Data Processing Flow

All the data gathered from monitoring device are sent to a central computer of the analyzer room. In here, all the data is saved under supervision of Database Task Team.

Emergency Procedures

In case of emergency, the emergency procedure plan shown below will be followed to minimize errors while restoring the system in the shortest period of time possible.

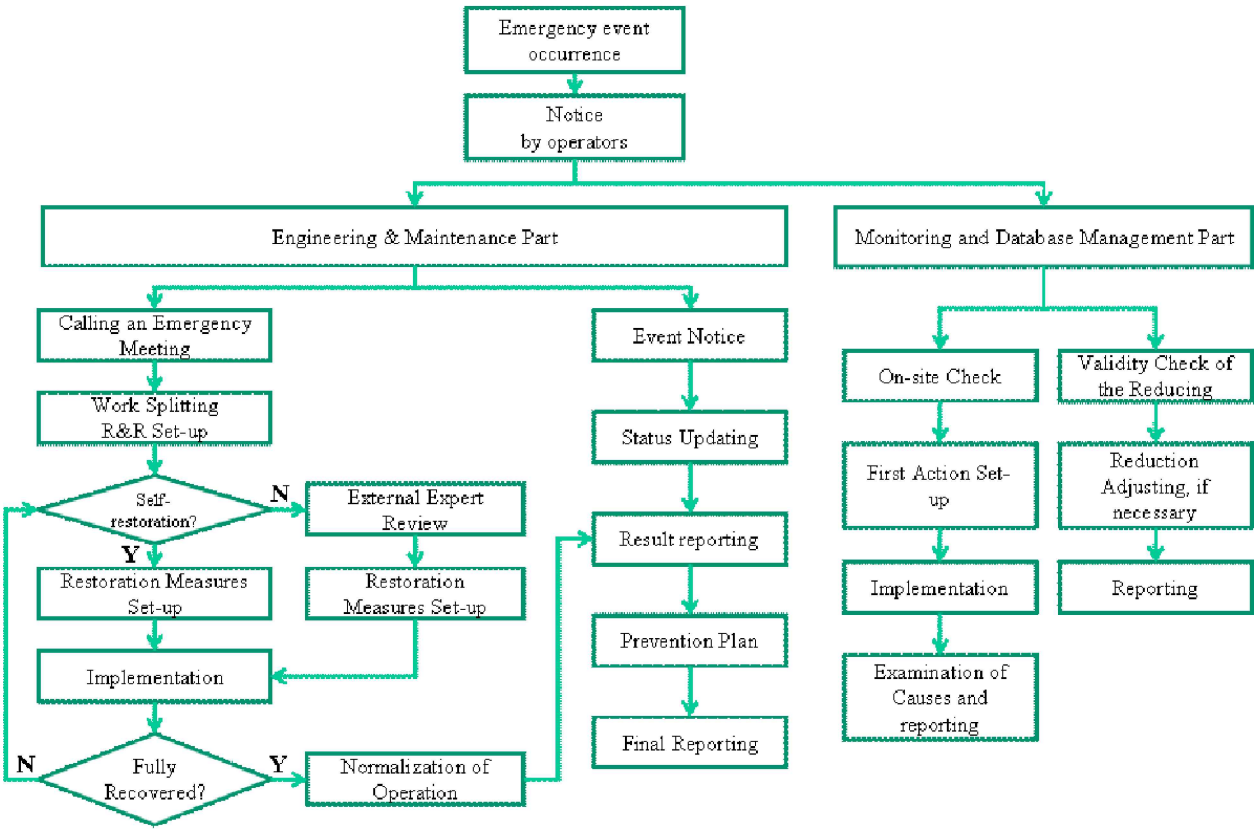

Figure 6. Emergency Procedures

SECTION D. Data and parameters

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

Data / Parameter:	**$EF_{grid,y}$**
Data unit:	tCO_2/MWh
Description:	Emission factor for electricity generation for source j in year y
Source of data used:	Based on data from Statistics of Electric Power in Korea, emission factor was calculated in accordance with Tool to calculate baseline, project and/or leakage emissions from electricity consumption (ver. 1)
Value applied:	0.5914
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This is used for Project Emission
Any comment:	

Data / Parameter:	**$EF_{CO2,NG,y}$**
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of the natural gas combusted in the Project
Source of data used:	IPCC
Value applied:	58.3
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This is used for Project Emission
Any comment:	

Data / Parameter:	**GWP of SF_6**
Data unit:	$kgCO_2eq/Kg\ SF_6$
Description:	Global warming potential of SF_6
Source of data used:	IPCC
Value applied:	23,900
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This is used for the Baseline emission
Any comment:	

Data / Parameter:	**Historical SF_6 consumption ($C_{SF6,hist}$)**
Data unit:	Tonnes
Description:	Historical SF_6 consumption, 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 SF_6 purchased in a year, taking into account the change in inventory in a specific year
Source of data used:	Record of purchase and inventory
Value applied:	74.48 ton /year or 26.73 ton/ 131 days
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This is used for baseline emission
Any comment:	Historical three years consumption data is as follows:

	Year 2006 (01/01/2006 ~ 31/12/2006): 38.00 tonnes Year 2007 (01/01/2007 ~ 31/12/2007): 69.92 tonnes Year 2008 (01/01/2008 ~ 31/12/2008): 74.48 tonnes

Data / Parameter:	**Historical production of LCD substrate (SP_{-i})**
Data unit:	m^2
Description:	Historical production of LCD substrate (m^2) during year i (where i = -1, -2, -3) prior to the implementation of the project activity before January 31, 2009
Source of data used:	Production records
Value applied:	Year 2006 (01/01/2006 ~ 31/12/2006): 2,455,198 m^2 Year 2007 (01/01/2007 ~ 31/12/2007): 5,126,394 m^2 Year 2008 (01/01/2008 ~ 31/12/2008): 6,485,252 m^2
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	This is used for baseline emission
Any comment:	

Data / Parameter:	**Maintenance schedule for abatement device**
Data unit:	Maintenance requirements by the manufacturer
Description:	Maintenance schedule for each item required by the manufacturer's instruction
Source of data used:	Manufacturers specification
Value applied:	N/A
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable
Any comment:	

Data / Parameter:	**Maintenance schedule for FTIR measurement devices**
Data unit:	Maintenance requirements by the manufacturer
Description:	Maintenance schedule for each item required by the manufacturer's instruction
Source of data used:	Manufacturers specification
Value applied:	N/A
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable
Any comment:	

Data / Parameter:	**Maintenance schedule for Annubar device**
Data unit:	Maintenance requirements by the manufacturer
Description:	Maintenance schedule for each item required by the manufacturer's instruction
Source of data used:	Manufacturers specification
Value applied:	N/A
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable
Any comment:	

Data / Parameter:	**$C_{p,in}$**
Data unit:	Coefficient of the inlet Annubar device (dimensionless)
Description:	Inlet annubar device coefficients

Source of data used:	Korea Research Institute of Standards and Science
Value applied:	1.0126
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Any comment:	

Data / Parameter:	**$C_{p,out}$**
Data unit:	Coefficient of the inlet Annubar device (dimensionless)
Description:	Outlet annubar device coefficients
Source of data used:	Korea Research Institute of Standards and Science
Value applied:	1.0126
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Any comment:	

Data / Parameter:	**Cross sectional area of the inlet stack (A_{in})**
Data unit:	m^2
Description:	Cross-sectional areas of the inlet stacks
Source of data used:	Isometric Drawing
Value applied:	0.0755
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Any comment:	

Data / Parameter:	**Cross sectional area of the outlet stack (A_{out})**
Data unit:	m^2
Description:	Cross-sectional areas of the outlet stacks
Source of data used:	Isometric Drawing
Value applied:	0.0755
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Any comment:	

D.2. Data and parameters monitored

Data / Parameter:	**$EC_{PJ,j,y}$**
Data unit:	MWh
Description:	Quantity of electricity consumed by the project electricity consumption source j in year y (21/10/2010 – 28/02/2011, total of 131 days for this monitoring report)
Measured /Calculated /Default:	Measured
Source of data:	Meter
Value(s) of monitored parameter:	2.106
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission

Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Meter #1 Type : Electric meter Serial Number : MCC-4C17-RF1 Meter #2 Type : Electric meter Serial Number : MCU-4CR-RF1 Meter #3 Type : Electric meter Serial Number : MCU-3C9-RF2
Measuring/ Reading/ Recording frequency:	Recorded daily
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	The meters have been periodically calibrated meeting the manufacturer's instruction and/or national standard.

Data / Parameter:	**$TDL_{j,y}$**
Data unit:	%
Description:	Average technical transmission and distribution losses for providing electricity to source j in year y
Measured /Calculated /Default:	Measured and calculated by KOREA ELECTRIC POWER CORPORATION
Source of data:	STATISTICS OF ELECTRIC POWER IN KOREA 2009 (by KOREA ELECTRIC POWER CORPORATION)
Value(s) of monitored parameter:	4.07
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	The value is published annually
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Not applicable

Data / Parameter:	**$E_{SF6,in,y}$**
Data unit:	tonnes
Description:	Mass of SF_6 gas entering the abatement device in year y (21/10/2010 – 28/02/2011, total of 131 days for this monitoring report)
Measured /Calculated /Default:	Calculated
Source of data:	Data calculation output
Value(s) of monitored parameter:	12.948
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type,	Not applicable, this is a calculated data

accuracy class, serial number, calibration frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	Annual or per monitoring, whichever is shorter
Calculation method (if applicable):	Sum of $E_{SF6,in}$
QA/QC procedures applied:	Data is automatically calculated by a data processing program and recorded in a log. The Management Organization make sure that the monitoring is done properly, as described in Section C above.

Data / Parameter:	**$C_{SF6,y}$**
Data unit:	tonnes
Description:	Annual consumption of SF_6 during the year y, defined as the total SF_6 purchase in a specific project year y taking into account the change in inventory in the same year (21/10/2010 – 28/02/2011, total of 131 days for this monitoring report)
Measured /Calculated /Default:	Measured
Source of data:	Record of purchase and inventory
Value(s) of monitored parameter:	27.19
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	Annually or every monitoring period, whichever is shorter
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	The data was cross-checked with the purchase record

Data / Parameter:	**$SP_{project,y}$**
Data unit:	m^2
Description:	Production of LCD substrate during the project year y (21/10/2010 – 21/11/2010 for this monitoring)
Measured /Calculated /Default:	Measured
Source of data:	Production, sales and inventory records
Value(s) of monitored parameter:	2,607,108
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Internal inventory data system and invoice
Measuring/ Reading/	Annually or every monitoring period, whichever is shorter

Recording frequency:	
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	

Data / Parameter:	**$E_{SF6,in}$**
Data unit:	Gram/second
Description:	Amount of SF_6 gas measured at the inlet of the SF_6 abatement system
Measured /Calculated /Default:	Calculated
Source of data:	Data calculation output
Value(s) of monitored parameter:	Average: 1.198
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable, this is a calculated data
Measuring/ Reading/ Recording frequency:	Value is calculated and recorded at least every 5 min.
Calculation method (if applicable):	$E_{SF6,in} = 65.18 Q_{in} [SF_{6,in}]$
QA/QC procedures applied:	Data is automatically calculated by a data processing program and recorded in a log. The Management Organization make sure that the monitoring is done properly, as described in Section C above.

Data / Parameter:	**$E_{SF6,out}$**
Data unit:	Gram/second
Description:	Amount of SF_6 gas measured at the inlet of the SF_6 abatement system
Measured /Calculated /Default:	Calculated
Source of data:	Data calculation output
Value(s) of monitored parameter:	Average: 0.191
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable, this is a calculated data
Measuring/ Reading/ Recording frequency:	Value is calculated and recorded at least every 5 min.
Calculation method (if applicable):	$E_{SF6,out} = 65.18 Q_{out} [SF_{6,out}]$
QA/QC procedures applied:	Data is automatically calculated by a data processing program and recorded in a log. The Management Organization make sure that the monitoring is done properly, as described in Section C above.

Data / Parameter:	**$M_{d,in}$**
Data unit:	Gram/mole
Description:	Total dry molecular weight of inlet stack gas

Measured /Calculated /Default:	Measured and calculated
Source of data:	Inlet QMS and FTIR measurement data
Value(s) of monitored parameter:	28.5529
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	To calculate $M_{d,in}$ data from FTIR and QMS is used. Inlet QMS Type : Quadruple Mass spectrometry Serial Number : 44506282 Inlet FTIR Type : Fourier transform infrared spectroscopy Serial Number : K2000010
Measuring/ Reading/ Recording frequency:	Annually or every monitoring period, whichever is shorter
Calculation method (if applicable):	$M_{d,in} = 1.460[SF_{6in}] + 0.44[CO_{2in}] + 0.399[Ar_{in}] + 0.320[O_{2in}] + 0.280[N_{2in}]$
QA/QC procedures applied:	QMS and FTIR were calibrated with all components that have concentration of greater than 100 ppm

Data / Parameter:	**$M_{d,out}$**
Data unit:	Gram/mole
Description:	Total dry molecular weight of inlet stack gas
Measured /Calculated /Default:	Calculated
Source of data:	QMS and FTIR measurement data
Value(s) of monitored parameter:	28.5445
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	To calculate $M_{d,out}$, data from FTIR and QMS is used. Outlet QMS Type : Quadruple Mass spectrometry Serial Number : 44506283 Outlet FTIR Type : Fourier transform infrared spectroscopy Serial Number : K2000009
Measuring/ Reading/ Recording frequency:	Annually or every monitoring period, whichever is shorter
Calculation method (if applicable):	$M_{d,out} = 1.460[SF_{6,out}] + 0.399[Ar_{out}] + 0.320[O_{2out}] + 0.280[N_{2out}] + 0.28[CO_{out}] + 0.44[CO_{2,out}] + 0.380[F_{2out}] + 0.200[HF_{out}] + 0.641[SO_{2out}] + 0.861[SOF_{2,out}] + 1.021[SO_2F_{2,out}]$
QA/QC procedures applied:	QMS and FTIR were calibrated with all components that have concentration of greater than 100 ppm

Data / Parameter:	**$B_{ws,\ in}$**
Data unit:	Dimensionless (percentage volume fraction)

Description:	The proportion of water in the inlet gas stream measured using EPA Method 4, and used to calculate the inlet gas molecular weight.
Measured /Calculated /Default:	Measured
Source of data:	Stack sampler
Value(s) of monitored parameter:	2.783
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Inlet water proportion analyser Type : Stack sampler Serial Number : 28-071702-1
Measuring/ Reading/ Recording frequency:	Annually or every monitoring period, whichever is shorter
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Guideline in Annex 1.a in the methodology was followed.

Data / Parameter:	**$B_{ws,out}$**
Data unit:	Dimensionless (percentage volume fraction)
Description:	The proportion of water in the inlet gas stream measured using EPA Method 4, and used to calculate the inlet gas molecular weight.
Measured /Calculated /Default:	Measured
Source of data:	Stack sampler
Value(s) of monitored parameter:	3.763
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Outlet water proportion analyser Type : Stack sampler Serial Number : 05W-5255-63M
Measuring/ Reading/ Recording frequency:	Annually or every monitoring period, whichever is shorter
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Guideline in Annex 1.a in the methodology was followed.

Data / Parameter:	**$P_{s,in}$**
Data unit:	mmHg
Description:	The inlet stack pressure measured during manufacturing operations
Measured /Calculated /Default:	Measured
Source of data:	Annubar (Pressure)
Value(s) of monitored parameter:	Average: 752.099
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission

Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Inlet annubar Type : Pressure (PITOT TUBE) Serial Number : 70945A
Measuring/ Reading/ Recording frequency:	Value is measured and recorded at least every 5 min.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	**$P_{s,out}$**
Data unit:	mmHg
Description:	The inlet stack pressure measured during manufacturing operations
Measured /Calculated /Default:	Measured
Source of data:	Annubar (Pressure)
Value(s) of monitored parameter:	Average: 747.092
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Outlet annubar Type : Pressure (PITOT TUBE) Serial Number : 70945B
Measuring/ Reading/ Recording frequency:	Value is measured and recorded at least every 5 min.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	**$T_{s,in}$**
Data unit:	K
Description:	The inlet stack temperature measured during manufacturing operations
Measured /Calculated /Default:	Measured
Source of data:	Annubar (Temperature)
Value(s) of monitored parameter:	Average: 289.455
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Inlet annubar Type : Temperature (PITOT TUBE) Serial Number : 70945A
Measuring/ Reading/ Recording frequency:	Value is measured and recorded at least every 5 min.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	**$T_{s,out}$**

Data unit:	K
Description:	The inlet stack temperature measured during manufacturing operations
Measured /Calculated /Default:	Measured
Source of data:	Annubar (Temperature)
Value(s) of monitored parameter:	Average: 298.561
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Outlet annubar Type : Temperature (PITOT TUBE) Serial Number : 70945B
Measuring/ Reading/ Recording frequency:	Value is measured and recorded at least every 5 min.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	$\mathbf{p_{avg,in}}$
Data unit:	mmH_2O
Description:	The averaged velocity head measurement used to calculate the inlet gas velocity
Measured /Calculated /Default:	Measured
Source of data:	Annubar (Differential pressure gauge)
Value(s) of monitored parameter:	Average: 0.485
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Inlet annubar Type : Velocity Head (PITOT TUBE) Serial Number : 70945A
Measuring/ Reading/ Recording frequency:	Value is measured and recorded at least every 5 min.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	$\mathbf{p_{avg,out}}$
Data unit:	mmH_2O
Description:	The averaged velocity head measurement used to calculate the inlet gas velocity
Measured /Calculated /Default:	Measured
Source of data:	Annubar (Differential pressure gauge)
Value(s) of monitored parameter:	Average: 0.674
Indicate what the data are used for (Baseline/ Project/ Leakage emission	Project emission

calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Outlet annubar Type : Velocity Head (PITOT TUBE) Serial Number : 70945B
Measuring/ Reading/ Recording frequency:	Value is measured and recorded at least every 5 min.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	$v_{s,in}$
Data unit:	m/sec
Description:	Inlet gas velocity
Measured /Calculated /Default:	Calculated
Source of data:	Data calculation output
Value(s) of monitored parameter:	Average : 2.904
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable, this is a calculated data
Measuring/ Reading/ Recording frequency:	Value is calculated and recorded at least every 5 min.
Calculation method (if applicable):	$v_{s,in} = K_P \times C_{p,in} \sqrt{p_{avg,in}} \sqrt{\frac{T_{s,in}}{P_{s,in} \times M_{s,in}}}$
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	$v_{s,out}$
Data unit:	m/sec
Description:	Inlet gas velocity
Measured /Calculated /Default:	Calculated
Source of data:	Data calculation output
Value(s) of monitored parameter:	Average: 3.481
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable, this is a calculated data
Measuring/ Reading/ Recording frequency:	Value is calculated and recorded at least every 5 min.

Calculation method (if applicable):	$v_{s,out} = K_P \times C_{p,out} \sqrt{p_{avg,out}} \sqrt{\frac{T_{s,out}}{P_{s,out} \times M_{s,out}}}$
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	**Q_{in}**
Data unit:	m^3/s
Description:	Inlet volumetric flow rate
Measured /Calculated /Default:	Calculated
Source of data:	Data calculation output
Value(s) of monitored parameter:	Average: 0.218
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable, this is a calculated data
Measuring/ Reading/ Recording frequency:	Value is calculated and recorded at least every 5 min.
Calculation method (if applicable):	$Q_{in} = \{(100 - B_{ws,in}) \div 100\} v_{s,in} A_{in} \left[\frac{T_{std} P_{s,in}}{T_{s,in} P_{std}} \right]$
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	**Q_{out}**
Data unit:	m^3/s
Description:	Outlet volumetric flow rate
Measured /Calculated /Default:	Calculated
Source of data:	Data calculation output
Value(s) of monitored parameter:	Average: 0.250
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable, this is a calculated data
Measuring/ Reading/ Recording frequency:	Value is calculated and recorded at least every 5 min.
Calculation method (if applicable):	$Q_{out} = \{(100 - B_{ws,out}) \div 100\} v_{s,out} A_{out} \left[\frac{T_{std} P_{s,out}}{T_{s,out} P_{std}} \right]$
QA/QC procedures applied:	Followed by US EPA Method.

Data / Parameter:	**$SF_{6\ in}$**
Data unit:	ppm
Description:	Inlet SF_6 concentration measured by FTIR

Measured /Calculated /Default:	Measured
Source of data:	FTIR
Value(s) of monitored parameter:	Average : 830.085
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Inlet FTIR Type : Fourier transform infrared spectroscopy Serial Number : K2000010
Measuring/ Reading/ Recording frequency:	Value is measured and recorded at least every 5 min.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	FTIR was calibrated in accordance with the methodology

Data / Parameter:	**$SF_{6\ out}$**
Data unit:	ppm
Description:	Outlet SF_6 concentration measured by FTIR
Measured /Calculated /Default:	Measured
Source of data:	FTIR
Value(s) of monitored parameter:	Average: 116.388
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Outlet FTIR Type : Fourier transform infrared spectroscopy Serial Number : K2000009
Measuring/ Reading/ Recording frequency:	Value is measured and recorded at least every 5 min.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	FTIR was calibrated in accordance with the methodology

Data / Parameter:	**$C_{NG,plant}$**
Data unit:	Nm^3
Description:	Quantity of natural gas consumed by the central boiler in year y (21/10/2010 – 28/02/2011, total of 131 days for this monitoring report)
Measured /Calculated /Default:	Measured
Source of data:	Meter
Value(s) of monitored parameter:	18,877,964
Indicate what the data are used for (Baseline/ Project/	Project Emission

Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	LNG flow meter LNG meter #1 Type : Turbine Serial Number : 71379 LNG meter #2 Type : Turbine Serial Number : 10400413 LNG meter #3 Type : Turbine Serial Number : 10400414 LNG meter #4 Type : Turbine Serial Number : 10400416 LNG meter #5 Type : Turbine Serial Number : 10400415 LNG meter #6 Type : Turbine Serial Number : 520065 LNG meter #7 Type : Turbine Serial Number : 410163
Measuring/ Reading/ Recording frequency:	Recorded daily
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	The meters have been periodically calibrated meeting the manufacturer's instruction and/or national standard.

Data / Parameter:	$C_{Steam,plant,y}$
Data unit:	ton
Description:	Quantity of steam generated by the central boiler in year y (21/10/2010 – 28/02/2011, total of 131 days for this monitoring report)
Measured /Calculated /Default:	Measured
Source of data:	Meter
Value(s) of monitored parameter:	284,051
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Steam flow meter for central boiler Steam meter #1 Type : Vortex Serial Number : C15-S0990HN

	Steam meter #2 Type : Vortex Serial Number : DE24053G Steam meter #3 Type : Vortex Serial Number : DE24056G Steam meter #4 Type : Vortex Serial Number : DE24054G Steam meter #5 Type : Vortex Serial Number : DE24055G Steam meter #6 Type : Vortex Serial Number : DE25016G Steam meter #7 Type : Vortex Serial Number : C20-1766SN
Measuring/ Reading/ Recording frequency:	Recorded daily
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	The meters has been periodically calibrated meeting the manufacturer's instruction and/or national standard.

Data / Parameter:	**$C_{Steam,y}$**
Data unit:	ton
Description:	Quantity of steam consumed by the Project year y (21/10/2010 – 28/02/2011, total of 131 days for this monitoring report)
Measured /Calculated /Default:	Measured
Source of data:	Meter
Value(s) of monitored parameter:	16.25
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Steam flow meter for abatement system Type : Vortex Serial Number : 1008702
Measuring/ Reading/ Recording frequency:	Recorded daily
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	The meters has been periodically calibrated meeting the manufacturer's instruction and/or national standard.

Data / Parameter:	**$NCV_{NG,y}$**

Data unit:	TJ/Nm^3
Description:	Net calorific value of natural gas
Measured /Calculated /Default:	Not applicable
Source of data:	Korea Gas Cooperation data
Value(s) of monitored parameter:	43.54×10^{-6}
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	Value is published annually
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

Mass of SF_6 gas entering the abatement system

$$E_{SF6,y} = \min\left\{E_{SF6,in,y}; 0.48 \times C_{SF6,y}; 0.48 \times C_{SF6,hist}\right\}$$

Whereas, value (including expected) for each parameters are,

$E_{SF6,in,y}$	=	12.95 ton
$C_{SF6,y}$	=	27.19 ton
$C_{SF6,hist}$	=	26.73 ton (74.48t/year was converted for 131 days)

$$E_{SF6,y} = \min\left\{12.95; 0.48 \times 27.19; 0.48 \times 26.73\right\}$$
$$= 12.83033$$

SF_6 consumption ratio

$$SF_{6,ratio} = \min\left(C_{SF6,-1} \div SP_{-1}; C_{SF6,-2} \div SP_{-2}; C_{SF6,-3} \div SP_{-3}\right)$$

Whereas, value for each parameters are,

Table 8. Historical data for SF_6 consumption

	$C_{SF6,hist}$	SP_{-i}	$SF6_{ratio}$
2006 (-3)	38	2,455,198	0.0000155
2007 (-2)	69.92	5,126,394	0.0000136
2008 (-1)	74.48	6,485,252	0.0000115

$$SF_{6,ratio} = 0.0000115$$

SF_6 consumption factor

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

Whereas, value for each parameters are,

$C_{SF6,y}$	=	27.192 ton
$SP_{project,y}$	=	2,607,108 m^2

$$C_{SF6,y} / SP_{project,y} = 0.0000104 < 0.0000115$$

Therefore, k = 1

Baseline emissions

$$BE_{in,y} = k \cdot E_{SF6,in,y} \cdot GWP_{SF6}$$

Whereas, value for each parameters are,

K	=	1
$E_{SF6,in,y}$	=	12.83033 ton
GWP_{SF6}	=	23,900 tCO_2/ton SF_6

$BE_{in,y}$ = 306,645

E.2. Project emissions calculation

CO_2 emissions from electricity consumption

$$C_{CO2,y} = \sum_j EC_{PJ,j,y} \times EF_{grid,y} \times (1 + TDL_{j,y})$$

Whereas, value for each parameters are,

$EC_{PJ,j,y}$	=	2.106 MWh
$EF_{grid,j,y}$	=	0.5914 tCO2/MWh
$TDL_{j,y}$	=	0.0407

$C_{CO2,y}$ = 1.3 tCO_2e

CO_2 emissions from steam consumption

Fuel Consumption

$$FC_{NG,y} = C_{NG,plant,y} \times w_{Steeam}$$

$$w_{Steam} = C_{Steam,y} / C_{Steam,plant,y}$$

Whereas, vale for each parameters are,

$C_{NG,plant}$	=	18,877,964 Nm^3
$C_{Steam,plant,y}$	=	284,051 ton
$C_{Steam,y}$	=	16.25 ton

$FC_{NG,y}$ = 1,080 Nm^3

Emission from steam

$$COEF_{NG,y} = NCV_{NG,y} \times EF_{CO2,NG,y}$$

$$PE_{NG,y} = FC_{NG,y} \times COEF_{NG,y}$$

Whereas, vale for each parameters are,

$NCV_{NG,y}$	=	43.54 x 10^{-6} TJ/Nm^3
$EF_{CO2,NG,y}$	=	58.3 tCO_2/TJ
$FC_{NG,y}$	=	1,080 Nm^3

$PE_{NG,y}$ = 2.7 tCO_2e

Determination of the SF_6 destruction removal efficiency (DRE) of the abatement device

$$DRE_y = 1 - \frac{E_{SF6,out,y}}{E_{SF6,in,y}}$$

Whereas, value for each parameters are,

$E_{SF6,out,y}$ = 2.07 ton
$E_{SF6,in,y}$ = 12.95 ton

$DRE_y = 0.840$

Project emissions

$$PE_y = BE_y (1 - DRE_y) + C_{CO2,y} + PE_{NG,y}$$

Whereas, value for each parameters are,

BE_y = 306,645 ton
DRE_y = 0.840
$C_{CO2,y}$ = 1.3 tCO_2
$PE_{NG,y}$ = 2.7 tCO_2

$PE_{,y}$ = 49,067 tCO_2e

E.3. Leakage calculation

There is no leakage emission in this project

E.4. Emission reductions calculation / table

$$ER_y = BE_y - PE_y$$

Whereas, value for each parameters are,

BE_y = 306,645 t CO_2
PE_y = 49,067 t CO_2

ER_y = 257,578 t CO_2

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

This section shall include a comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the registered CDM-PDD.

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO_2e)	275,726 t CO_2*	257,578 t CO_2

* 768,245 tCO_2/year was converted for 131 days

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

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The actual emission reduction resulting from the Project during this monitoring period was lower than the estimation in the PDD. Furthermore, the difference (18,148 t CO_2) is 6.5% of the PDD estimation, which is considered marginal.

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History of the document

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