CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

LG Chem Naju plant fuel switching project (the Project or Project activity)
(Version 10.3, 13/03/2009)

A.2. Description of the small-scale project activity:

LG Chem currently produces octanol, plasticizers and acrylic acid at Naju plant. Originally, Naju plant was founded as a fertilizer plant, in 1962 and was modified in 1982 to allow production of octanol. Through subsequent modification and expansion of the plant, current production has reached 190,000 MT/year for octanol, 166,000 MT/year for plasticizers and 26,000 MT/year for acrylic acid.

Steam, which is used in the production process of petrochemical products, is mainly produced in a boiler using bunker fuel oil C (Sulphur 0.5%). On average over the past 3 years, LG Chem has used approximately 23,500 kilolitres of bunker fuel oil C annually for steam generation at Naju plant. The Project activity involves retrofitting the boilers to allow fuel switching from bunker fuel oil C to natural gas.

The Project will contribute to the sustainable development of Korea in the following ways:

- Mitigation of GHGs
  Natural gas is less carbon intensive than bunker fuel oil C. Therefore switching fuel from bunker fuel oil C to natural gas will reduce GHGs emissions.

- Transfer of new technology
  The equipments used for the boiler retrofit will be imported from United Kingdom. The natural gas burner in industrial facility is not common practice in Korea. Therefore, it is expected that there exists technology transfer effects through the Project activity including the operation and maintenance of the newly installed equipments. For the proper operation of the boiler, the operators have received educations from the domestic agent of the burner manufacturer.

- Improvement of environmental condition
  In addition to GHGs emission reduction, the Project activity will reduce emissions of SO_x and NO_x. Under current regulations, bunker fuel oil C (Sulphur 0.5%) can be used as an industrial fuel in the Naju area. Therefore, by switching fuel from bunker fuel oil C to natural gas, which does not contain sulphur, it is expected that emissions of SO_x will be reduced by more than 90%. It is also expected that emissions of NO_x will be reduced.

- Promotion of clean energy usage in the local area
  At present, while natural gas is used as a household fuel in some large cities in Korea, it is not being supplied to many smaller cities such as Naju area due to the lack of infrastructure. However, once the natural gas station is established for the Project, natural gas can also be supplied to Naju area for household fuel, resulting in improvement of the quality of life for locals.

A.3. Project participants:

Name of Party involved(*) ((host) indicates a host Party)	Private and/ or Public entity(ies) Project participants(*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participants (Yes/ No)
Korea (host)	LG Chem, Ltd.	No
Japan	Mitsubishi UFJ Securities Co., Ltd	No

In addition to being a project participant, Mitsubishi UFJ Securities is the CDM Advisor to the Project and the contact for the CDM Project activity.

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

Republic of Korea

A.4.1.2. Region/State/Province etc.:

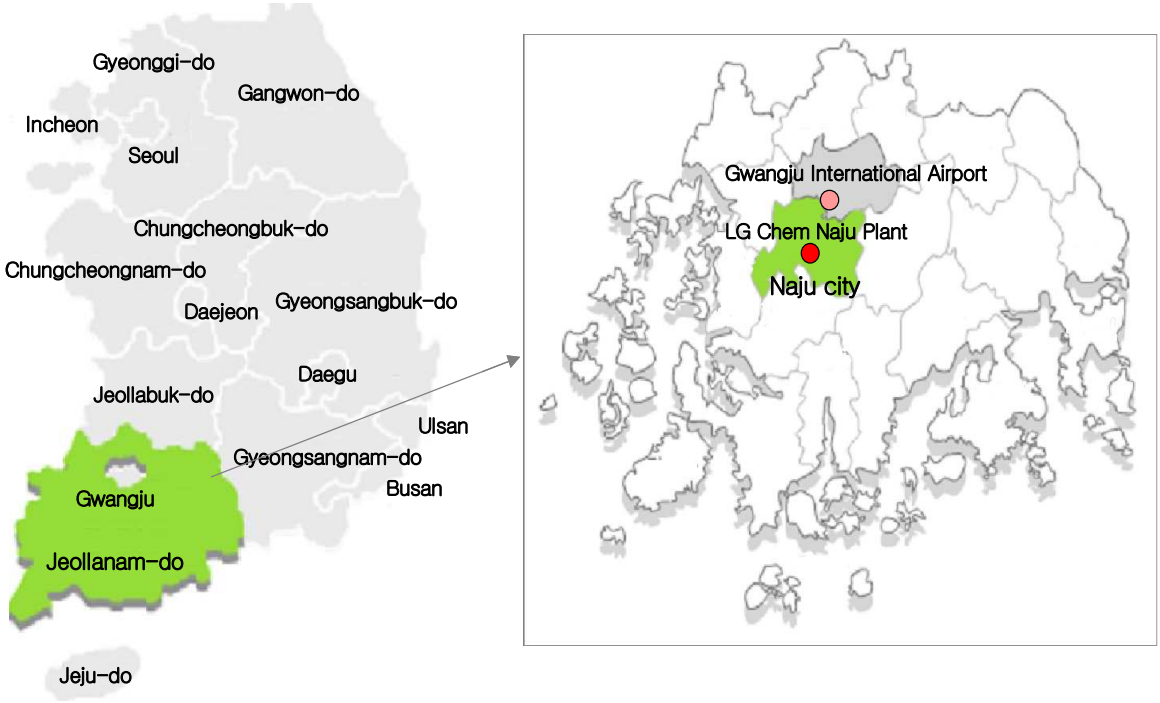
Jeollanam-do

A.4.1.3. City/Town/Community etc:

Naju

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

The Project site is located at 1, Songwal-dong, Naju, Jeollanam-do, 520-130, Korea. It is located in the Naju city and about 20 km southwest from Gwangju International Airport.



< Figure 1 – Map of Republic of Korea, Project activity Location >

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

In accordance with Appendix B of the simplified modalities and procedures for small-scale clean development mechanism project activities ("SSC M&P"), the Project activity falls under the following type and category:

Type III: Other project activities
Category B: Switching fossil fuels (Version 12)
Sectoral Scope 1 – Energy industries (renewable - / non-renewable sources)

The existing boiler has been retrofitted by installing special purpose burners for natural gas combustion as well as other necessary minor modifications. There are three boilers in Naju plant. Among the three boilers, one boiler, which is the main boiler in Naju plant and of which specification is described in the following table, is retrofitted. As a result of the Project activity, the capacity of the boiler and the remaining lifetime of the boiler are not changed.

The existing boilers have also combusted purge gas and by-product liquid fuel generated from the processes. However, the combustion of such by-products is not be affected by the Project activity, since only bunker fuel oil C is switched to natural gas. By-product liquid fuel is generated from EPA Vaporiser, Refine Column, n-Slop Column, Batch Still, VPH Vaporiser and Refine Column. Purge gas is non-reaction gas from OXO reactor, OXO recycle loop and VPH loop. Since these processes are not be affected by the fuel type used for the steam generation, the amount of purge gas and by-product liquid fuel is independent from the fuel switching project activity. Moreover, there is no change in the process/equipment for the deliver/combustion of purge gas and by-product liquid fuel before and after

the project implementation. Therefore, purge gas and by-product liquid fuel will continue to be combusted in the existing boiler without any change, i.e. the amount of purge gas and by-product liquid fuel to be combusted under the baseline scenario and project scenario would be same and only bunker fuel oil C is switched to natural gas.

For fuel switching from bunker fuel oil C to natural gas, four natural gas burners have been installed for the main boiler. Total capacity of four natural gas burners installed is 5,353 Nm^3/hr, which is of sufficient capacity for the expected amount of natural gas consumption at Naju plant. The natural gas burners are provided by HAMWORTHY COMBUSTION, which is one of the world's largest combustion equipment manufacturers, with the experiences of equipment installation in over 100 countries. The specifications of the current boiler, the Project boiler (after modification) and natural gas burner are as follows:

< Table 1 - Boiler specification >

	Baseline scenario	**Project scenario**
Capacity	70 T/H	70 T/H
Operating pressure	35 kg/cm^2G	35 kg/cm^2G
Steam Temperature	400 ℃	400 ℃
Main fuel used	Bunker fuel oil C	Natural gas
Efficiency	91 %	91 %

Source: LG Chem, Ltd & Manufacturer

< Table 2 - Burner specification >

Description	**Specification**
Maker	HAMWORTHY
Model	DF 505
Type	Manifold & Spud
Burning Capacity	
Max	1,405 (Nm^3/hr)
MCR	1,338 (Nm^3/hr)
Min	267 (Nm^3/hr)

Source: HAMWORTHY COMBUSTION

The natural gas is supplied by Hae Yang City Gas in Gwangju Metropolitan City. The composition of the natural gas sample is described in the following table.

< Table 3 - Composition of natural gas (Sample) >

Component	**Value**
Methane (CH_4)	89.78 %

Ethane (C_2H_6)		7.48 %
Propane (C_3H_3)		2.02 %
Propylene (C_3H_6)		-
Butane	**i–C_4H_{10}**	0.36 %
	n-C_4H_{10}	0.34 %
Nitrogen (N_2)		0.02 %
Oxygen (O_2)		-

Source: Hae Yang City Gas

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

< Table 4 - Estimated amount of emission reductions >

Years	Annual estimation of emission reductions in tonnes of CO_2e
Year 1	19,635
Year 2	19,635
Year 3	19,635
Year 4	19,635
Year 5	19,635
Year 6	19,635
Year 7	19,635
Year 8	19,635
Year 9	19,635
Year 10	19,635
Total estimated reductions (tonnes of CO_2e)	196,350
Total number of crediting years	10 years
Annual average over the crediting periods of estimated reductions (tonnes of CO_2e)	19,635

A.4.4. Public funding of the small-scale project activity:

Project financing will not involve ODA or public funding from Annex I countries.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

According to "Compendium of guidance on the debundling for SSC project activities (Annex 27, EB36)", a proposed small-scale project activity shall be deemed to be a debundled component of a large project

activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

(a) With the same project participants;
(b) In the same project category and technology/measure; and
(c) Registered within the previous 2 years; and
(d) Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

There is no registered small-scale CDM project activity or an application to register another small-scale CDM project activity in the same project category and technology/measure within 1 km of the project boundary. Therefore, the Project is not a debundled component of any other large project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

AMS Type III. – "Other Project Activity"
Category B. Switching fossil fuels (version 12)

B.2 Justification of the choice of the project category:

Category B. Switching fossil fuels (version 12)

- This category comprises fossil fuel switching in existing industrial, residential, commercial, institutional or electricity generation applications. Fuel switching may change efficiency as well. If the project activity primarily aims at reducing emissions through fuel switching, it falls into this category. If fuel switching is part of a project activity focussed primarily on energy efficiency, the project activity falls in category II.D or II.E.

- This category is not applicable to project activities that propose switch from fossil fuel use in the baseline to renewable biomass, biofuel or renewable energy in the project scenario. A relevant type I methodology shall be used for such project activities that generate renewable energy displacing fossil fuel use.

- Measures are limited to those that result in emission reductions of less than or equal to 60 $ktCO_2$ equivalent annually.

The Project activity aims at reducing GHG emissions through fuel switching, from bunker fuel oil C to natural gas, in existing LG Chem's Naju plant. Fuel switching may change efficiency as well. However, the main purpose of the Project activity is fuel switching, not energy efficiency. The Project activity does not involve any renewable biomass, biofuel or renewable energy use in the project scenario. Also, in any year of the crediting period, emissions reductions resulting from the Project activity will not exceed 60 $ktCO_2$ equivalent annually. Therefore the Project activity falls into the category B. Switching fossil fuels.

B.3. Description of the project boundary:

As per the baseline methodology, the project boundary is the physical, geographical site where the fuel combustion affected by the fuel switching measure occurs. Therefore the project boundary encompasses the boiler in the Naju plant that the fuel switching occurs.

B.4. Description of baseline and its development:

As described in the methodology, the emission baseline is the current emissions of the facility. In the absence of the Project activity, LG Chem would be utilizing bunker fuel oil C for steam generation, which is the current situation. Under the current regulations, it is allowed to use bunker fuel oil C at Naju area and there are no regulations that requires the use of natural gas or any other fuel. Also, as shown in the Section B.5 below, it is not economically attractive to switch fuel from bunker fuel oil C to natural gas. Therefore, the current situation of using bunker fuel oil C for steam generation is considered as baseline scenario for the Project activity.

Emission reductions will be determined using actual data which are to be monitored. The key variables and parameters used to calculate the emission reductions are as follows:

< Table 5 – Key variables and parameters >

Variables & Parameters	Data source
Quantity of natural gas combusted in the boiler (after the project implementation)	LG Chem
Quantity of by-product liquid fuel combusted in the boiler (before and after the project implementation)	LG Chem
Quantity of purge gas combusted in the boiler (before and after the project implementation)	LG Chem
Quantity of steam generated (before and after the project implementation)	LG Chem
Net calorific value of the natural gas	Standard Manual for Calorific Value[1)]
Net calorific value of the bunker fuel oil C	Standard Manual for Calorific Value[1)]
Net calorific value of by-product liquid fuel	LG Chem
Net calorific value of purge gas	LG Chem
CO_2 emission factor of the natural gas	IPCC default value
CO_2 emission factor of the bunker fuel oil C	IPCC default value

1) The Standard Manual for Calorific Value is approved by Ministry of Knowledge Economy / Korea Energy Management Corporation, revised on 4th, September 2006.
2) Details of each parameter are described in section B.6.2 and B.7.1.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

As described in the Section B.4, it is allowed to use bunker fuel oil C at Naju area and there are no regulations that requires the use of natural gas or any other fuel. Therefore the fuel used for steam generation is decided based on the economics. However, in the absence of the CDM, the Project activity could not be implemented due to the following insurmountable barrier:

Investment barrier

Since the price of natural gas is higher than that of bunker fuel oil C in Korea, fuel switching from bunker fuel oil C to natural gas requires significant amount of additional fuel costs. As described in the table below, NPV of the total cost for project scenario is higher than that of baseline scenario, which means that the Project activity is not economically attractive. Therefore, in the absence of the CDM, the Project activity could not be implemented.

< Table 6 - NPV analysis >

	Baseline scenario (Bunker fuel oil C)	Project scenario (Natural gas)
Initial Equipment cost	0 KRW	800,000,000 KRW
O&M costs	655,000,000 KRW/yr	329,000,000 KRW/yr
Fuel consumption	23,576,764 liter/yr	23,046,286 Nm^3/yr
Fuel costs	330.81 KRW/liter	399.80 KRW/Nm^3
Fuel efficiency	91%	91%
Net calorific value of fuel	39.1MJ/liter	40.0 MJ/Nm^3
NPV of the total cost	72,471,318,544 KRW	82,601,764,151 KRW

Note

1. A discount rate of 9.9% is applied to net present value analysis. This discount rate has been substantiated by an independent financial expert[1].
2. Lifetime of the Project activity is 20 years.
3. Historical 3 year average fuel price (January 2003 ~ December 2005) which is available at the time of decision making (December 2005) is applied in the investment analysis. This is to reflect the frequent change of the fuel prices. The price of Bunker fuel oil C that LG Chem is purchasing is adjusted every month while that of natural gas is adjusted 3 to 5 times per year.
4. Fuel efficiency of the boiler in each scenario is from the nameplate of the boiler. Fuel efficiency is used to estimate the expected amount of natural gas consumption in the project scenario.
5. The difference in O&M costs reflects the parasitic fuel consumption for bunker fuel oil C heating, electricity consumption for pumps, maintenance costs and after-treatment costs. The difference is estimated based on the available information about O&M costs at the time of the project start.

[1] Asia Pacific Equity Research (29 March 2005) – LG Chem, JPMorgan

6. The residual value of the new equipment at the end of the lifetime of the Project activity is 1,000 KRW.
7. Net calorific values of bunker fuel oil C and natural gas are adopted from "The Standard Manual for Calorific Value" approved by Ministry of Knowledge Economy / Korea Energy Management Corporation.

To confirm whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions, sensitivity analysis is conducted for the following situation which is favourable for the project scenario. For the purpose of sensitivity analysis, variation of 10%, which is LG Chem's practice, is applied for each parameter except for the discount rate. For the discount rate, to minimize the uncertainty, wider variation is applied.

1) Sensitivity analysis 1: Initial equipment cost for the project scenario is 10% lower than expected.
2) Sensitivity analysis 2: O&M cost for the project scenario is 10% lower than expected.
3) Sensitivity analysis 3: Natural gas price is 10% lower than expected.
4) Sensitivity analysis 4: Discount rate varies 7 ~ 13 %.

< Table 7 - Sensitivity analysis >

Item	NPV of total cost for baseline scenario	NPV of total cost for project scenario
Sensitivity analysis 1	72,471,318,544 KRW	82,521,764,151 KRW
Sensitivity analysis 2	72,471,318,544 KRW	82,319,745,421 KRW
Sensitivity analysis 3	72,471,318,544 KRW	74,703,606,451 KRW
Sensitivity analysis 4-1 (Discount rate: 7%)	89,566,305,533 KRW	101,897,674,819 KRW
Sensitivity analysis 4-2 (Discount rate: 13%)	59,390,239,767 KRW	67,836,539,234 KRW

As shown in the table above, NPV of total cost for project scenario is always higher than that of baseline scenario, confirming the robustness of economical attractiveness of baseline scenario.

Even with the expected amount additional income from CERs sales, the Project activity is still economically unattractive. However, LG Chem put significant non-monetary values on the Project activity as a CDM activity. With the confidence that the Project activity is eligible for a CDM activity, LG Chem decided to implement the Project activity.

Additionally, following tables show the timeline of the actions taken for the project implementation as well as the CDM registration.

< Table 8 - Timeline for the project implementation >

Date	Action taken	Remark
During the year of 2005	Feasibility study	Feasibility study was conducted by LG Chem. In the feasibility study, technical feasibility of fuel

		switching as well as CDM potential has been assessed.
14/12/2005	Decision making	Final decision to proceed into the fuel switching project activity as a CDM project activity was made by CEO.
21/06/2006	Purchase order for natural gas burners	Purchase order for natural gas burners is finalized between LG Chem and Huengkuk Industries.
30/09/2006	Start of boiler retrofit	
11/2006	Test run of Project activity	

< Table 9 - Timeline for CDM registration >

Date	Action taken	Remark
11/2005	Bidding for CDM consulting	LG Chem opened a bid for CDM consulting and several proposals were submitted by CDM consulting companies.
01/2006	Selection of a CDM consultant	Mitsubishi UFJ Securities was selected as a CDM consultant.
05/2006	Finalization of CDM consulting agreement	A CDM consulting agreement was finalized between LG Chem and Mitsubishi UFJ Securities.
07/2006	Finalization of validation contract	Validation contract was finalized with KEMCO. The Project activity is selected as a witnessing activity for KEMCO (Sectoral scope 4).
11/08/2006 ~ 09/09/2006	Publication of PDD on UNFCCC website	PDD prepared using ACM0009 was published on UNFCCC website for global stakeholder consultation.[1)]
03/2007	Draft witness report form – validation by CDM-AT team	CDM-AT team gave its opinions that the Project activity is not suitable for witnessing activity.
15/05/2007 ~ 13/07/2007	Re-publication of PDD on UNFCCC website	According to CDM-AT team's opinions, PDD is revised using small scale methodology AMS-III.B and republished on UNFCC website for global stakeholder consultation.[2)]
06/2007	Submission of request for registration	Request for registration was submitted
11/2007	Suspension of validation	CDM EB instructed the DOE to suspend the validation procedure of the Project activity due to the possible conflict of interest of the DOE with the Project activity.
03/2008	Withdrawal of request for registration	Request for registration was withdrawn due to the DOE's incapability of validation for the Project activity[3)]
05/2008	Termination of validation contract	Validation contract with the DOE was terminated.
07/2008	Finalization of a validation contract with other DOE (KFQ)	Validation contract was finalized with other DOE (KFQ).
29/07/2008 ~	Re-publication of PDD on	As new validation procedure started and the PDD

27/08/2008	UNFCCC website	was revised using a new version of the methodology, PDD was republished on UNFCCC website for global stakeholder consultation.

1) http://cdm.unfccc.int/Projects/Validation/DB/P04VV01VK5SCSLK5QPUZWMT1FKRMDU/view.html
2) http://cdm.unfccc.int/Projects/Validation/DB/E0RTEXUFQ4A17BHE71BWFZ2HHDI92N/view.html
3) http://cdm.unfccc.int/Projects/DB/KEMCO1182237520.89/view
4) http://cdm.unfccc.int/Projects/Validation/DB/A5BO99BK9DTNHIBP7WJ9OHJAF32NQQ/view.html

As shown in the tables above, LG Chem has been considered the incentive from the CDM before the start of project activity and has taken continuing and real actions to secure CDM status.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Project emissions

Project emissions consist of those emissions related with the use of fossil fuel after the fuel switch. Project emissions are calculated as follows:

$$PE_y = FF_{project,y} \cdot NCV_{NG} \cdot EF_{NG,CO2}$$

where,

PE_y	Project emissions during the year y (tCO_2e)
$FF_{project,y}$	Quantity of natural gas combusted in the project boiler during the year y (Nm^3)
NCV_{NG}	Net calorific value of the natural gas combusted (TJ/Nm^3)
$EF_{NG,CO2}$	CO_2 emission factor of the natural gas combusted in the project boiler (tCO_2/TJ)

Baseline emissions

Baseline emissions are the emissions that would otherwise be emitted in the absence of the Project activity by using bunker fuel oil C in the project boiler. Baseline emissions are calculated as follows:

$$BE_y = EF_{baseline} \times Q_y$$

Where:

BE_y	Baseline emission during the year y (tCO_2e)
$EF_{baseline}$	Baseline emission factor for the baseline situation (tCO_2/TJ)
Q_y	Quantity of steam generated by natural gas (TJ)

Baseline emission factor for the baseline situation is calculated as follows:

$$EF_{baseline} = FF_{baseline} \times EF_{baseline,CO2} \times NCV_{baseline} / Q_{baseline}$$

Where:

$FF_{baseline}$	Quantity of bunker fuel oil C combusted in the baseline situation (liter)
$EF_{baseline,CO2}$	CO_2 emission factor of bunker fuel oil C (tCO_2/TJ)
$NCV_{baseline}$	Net calorific value of bunker fuel oil C (TJ/liter)
$Q_{baseline}$	Quantity of steam generated by bunker fuel oil C in the baseline situation (TJ)

For quantity of bunker fuel oil C combusted and quantity of steam generated by bunker fuel oil C, 3 years data prior to project implementation (from 1st, November, 2003 to 31st, October 2006) is used. Since purge gas and by-product liquid fuel are also combusted in the boiler, quantity of steam generated by natural gas and quantity of steam generated by bunker fuel oil C is calculated based on the proportion of fuel used as follows:

$$Q_y = Q_{total,y} \times \frac{FF_{project,y} \times NCV_{NG}}{(FF_{project,y} \times NCV_{NG} + PG_y \times NCV_{PG,y} + LF_y \times NCV_{LF,y})}$$

Where:

$Q_{total,y}$	Total quantity of steam generated by natural gas, waste gas and by-product liquid fuel during year y (TJ)
PG_y	Quantity of purge gas combusted in the boiler during year y (Nm^3)
$NCV_{PG,y}$	Net calorific value of purge gas (TJ/Nm^3)
LF_y	Quantity of by-product liquid fuel combusted in the boiler during year y (liter)
$NCV_{LF,y}$	Net calorific value of by-product liquid fuel (TJ/liter)

$$Q_{baseline} = Q_{total,baseline} \times \frac{FF_{baseline} \times NCV_{baseline}}{(FF_{baseline} \times NCV_{baseline} + PG_{baseline} \times NCV_{PG,baseline} + LF_{baseline} \times NCV_{LF,baseline})}$$

Where:

$Q_{total,baseline}$	Total quantity of steam generated by bunker fuel oil C, waste gas and by-product liquid fuel in the baseline situation (TJ)
$PG_{baseline}$	Quantity of purge gas combusted in the boiler in the baseline situation (Nm^3)
$NCV_{PG,baseline}$	Net calorific value of purge gas (TJ/Nm^3)
$LF_{baseline}$	Quantity of by-product liquid fuel combusted in the boiler in the baseline situation (liter)
$NCV_{LF,baseline}$	Net calorific value of by-product liquid fuel (TJ/liter)

Leakage

As described in AMS III.B, no leakage calculation is required.

Emission reductions

$$ER_y = BE_y - PE_y$$

where,

ER_y	Emissions reductions of the project activity during the year y (tCO_2e)
BE_y	Baseline emissions during the year y (tCO_2e)
PE_y	Project emissions during the year y (tCO_2e)

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**$FF_{baseline}$**
Data unit:	Liter
Description:	Quantity of bunker fuel oil C combusted in the baseline situation
Source of data used:	LG Chem
Value applied:	70,730,291
Justification of the choice of data or description of measurement methods and procedures actually applied :	3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used. The detailed data is presented in annex 3.
Any comment:	

Data / Parameter:	**NCV_{NG}**
Data unit:	TJ/Nm^3
Description:	Net calorific value of natural gas
Source of data used:	Standard Manual for Calorific Value
Value applied:	40.0×10^{-6}
Justification of the choice of data or description of measurement methods and procedures actually applied :	The accurate and reliable national data is used. The value is from the "Standard Manual for Calorific Value" (revised on 4th, September 2006) approved by Ministry of Knowledge Economy / Korea Energy Management Corporation.
Any comment:	

Data / Parameter:	**$EF_{NG,CO2}$**
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of the natural gas combusted
Source of data used:	IPCC default value

Value applied:	56.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Since the accurate and reliable national data is not available, default value from 2006 IPCC Guidelines for National Greenhouse Gas Inventories is used. (Table 1.4)
Any comment:	

Data / Parameter:	**$NCV_{baseline}$**
Data unit:	TJ/liter
Description:	Net calorific value of bunker fuel oil C
Source of data used:	Standard Manual for Calorific Value
Value applied:	39.1×10^{-6}
Justification of the choice of data or description of measurement methods and procedures actually applied :	The accurate and reliable national data is used. The value is from the "Standard Manual for Calorific Value" (revised on 4th, September 2006) approved by Ministry of Knowledge Economy / Korea Energy Management Corporation.
Any comment:	

Data / Parameter:	**$EF_{baseline,CO2}$**
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of bunker fuel oil C
Source of data used:	IPCC default value
Value applied:	77.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	Since the accurate and reliable national data is not available, default value from 2006 IPCC Guidelines for National Greenhouse Gas Inventories is used. (Table 1.4)
Any comment:	

Data / Parameter:	**$Q_{total,baseline}$**
Data unit:	TJ
Description:	Total quantity of steam generated by bunker fuel oil C, purge gas and by-product liquid fuel in the baseline situation
Source of data used:	LG Chem
Value applied:	3,701.09
Justification of the choice of data or description of measurement methods and procedures actually applied :	3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used. LG Chem produces superheated steam at 27 atm, 390℃. The enthalpy of the superheated steam is 767.7kcal/kg of steam according to the steam table (Spirax Sarco: http://www.spiraxsarco.com/resources/steam-tables.asp). The temperature of

	the feed water is 104℃. The detailed data is presented in annex 3.
Any comment:	This parameter is used to calculate $Q_{baseline}$ (Quantity of steam generated by bunker fuel oil C in the baseline situation).

Data / Parameter:	**$PG_{baseline}$**
Data unit:	Nm^3
Description:	Quantity of purge gas combusted in the boiler in the baseline situation
Source of data used:	LG Chem
Value applied:	13,203,959
Justification of the choice of data or description of measurement methods and procedures actually applied :	3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used. The detailed data is presented in annex 3.
Any comment:	

Data / Parameter:	**$LF_{baseline}$**
Data unit:	liter
Description:	Quantity of by-product liquid fuel combusted in the boiler in the baseline situation
Source of data used:	LG Chem
Value applied:	26,297,017
Justification of the choice of data or description of measurement methods and procedures actually applied :	3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used. The detailed data is presented in annex 3.
Any comment:	

Data / Parameter:	**$NCV_{PG,baseline}$**
Data unit:	TJ/Nm^3
Description:	Net calorific value of purge gas
Source of data used:	52.15×10^{-6}
Value applied:	LG Chem
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measured value by LG Chem is used. The average value measured during 3 year prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used.
Any comment:	

Data / Parameter:	**$NCV_{LF,baseline}$**
Data unit:	TJ/liter

Description:	Net calorific value of by-product liquid fuel
Source of data used:	30.576 x 10^{-6}
Value applied:	LG Chem
Justification of the choice of data or description of measurement methods and procedures actually applied :	Due to the absence of the reliable data for the period of 3 year prior to the project implementation (from 1st, November 2003 to 31st, October 2006) does not exist, the data recently measured by the independent laboratory is used.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Project emissions

$$PE_y = FF_{project,y} \cdot NCV_{NG} \cdot EF_{NG,CO2}$$
$$= 23{,}046{,}286\,(Nm^3) \times 40.0 \times 10^{-6}\,(TJ/Nm^3) \times 56.1\,(tCO_2/TJ)$$
$$= 51{,}716\,tCO_2$$

Quantity of natural gas combusted in the project scenario ($FF_{project,y}$) is estimated for ex-ante purpose based on the historical bunker fuel consumption, net calorific value of bunker fuel oil C and natural gas.

Baseline emissions

$$BE_y = EF_{baseline} \times Q_y$$
$$= 89.05\,(tCO_2/TJ) \times 801.24\,(TJ)$$
$$= 71{,}351\,(tCO_2)$$

Quantity of steam is estimated for ex-ante purpose based on the historical steam generation.

$$EF_{baseline} = FF_{baseline} \times EF_{baseline,CO2} \times NCV_{baseline} / Q_{baseline}$$
$$= 70{,}730{,}291\,(liter) \times 77.4\,(tCO_2/TJ) \times 39.1 \times 10^{-6}\,(TJ/liter) / 2{,}403.73\,(TJ)$$
$$= 89.05\,(tCO_2/TJ)$$

$$Q_{baseline} = Q_{total,baseline} \times \frac{FF_{baseline} \times NCV_{baseline}}{(FF_{baseline} \times NCV_{baseline} + PG_{baseline} \times NCV_{PG,baseline} + LF_{baseline} \times NCV_{LF,baseline})}$$
$$= 3{,}701.09 \times \frac{70{,}730{,}291 \times 39.1 \times 10^{-6}}{(70{,}730{,}291 \times 39.1 \times 10^{-6} + 13{,}203{,}959 \times 52.15 \times 10^{-6} + 26{,}297{,}017 \times 30.576 \times 10^{-6})}$$
$$= 2{,}403.73\,(TJ)$$

Emission reductions

$$ER_y = BE_y - PE_y$$
$$= 71{,}351 - 51{,}716$$
$$= 19{,}635\, tCO_2e / yr$$

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2e)
Year 1	51,716	71,351	0	19,635
Year 2	51,716	71,351	0	19,635
Year 3	51,716	71,351	0	19,635
Year 4	51,716	71,351	0	19,635
Year 5	51,716	71,351	0	19,635
Year 6	51,716	71,351	0	19,635
Year 7	51,716	71,351	0	19,635
Year 8	51,716	71,351	0	19,635
Year 9	51,716	71,351	0	19,635
Year 10	51,716	71,351	0	19,635
Total	**517,160**	713,510	0	196,350

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**$FF_{project,y}$**
Data unit:	Nm^3
Description:	Quantity of natural gas combusted in the project boiler during the year y
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	23,046,286
Description of measurement methods and procedures to be applied:	Monitored continuously using meters.
QA/QC procedures to be applied:	The meters (Tag No. FQ_7000) will be calibrated periodically by the natural gas provider, Hae Yang City Gas, according to the internal regulation of the provider. Certificates will be issued after the periodic calibrations are conducted. Once the erroneous measurement or malfunction is detected, corrective actions

	will be taken by the natural gas provider. The amount of natural gas combusted will be double checked with the receipt of purchase.
Any comment:	

Data / Parameter:	$Q_{total,y}$
Data unit:	TJ
Description:	Total quantity of steam generated by natural gas, purge gas and by-product liquid fuel in the project boiler during the year y
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,233.70
Description of measurement methods and procedures to be applied:	Monitored continuously using meters
QA/QC procedures to be applied:	The meters (Tag No. FQ_7102)will be calibrated periodically. Once the erroneous measurement or malfunction is detected, corrective actions will be taken by LG Chem.
Any comment:	

Data / Parameter:	PG_y
Data unit:	Nm^3
Description:	Quantity of purge gas combusted in the project boiler during the year y
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	4,401,320
Description of measurement methods and procedures to be applied:	Monitored continuously using meters
QA/QC procedures to be applied:	The meters (Tag No. FQ_7106) will be calibrated periodically. Once the erroneous measurement or malfunction is detected, corrective actions will be taken by LG Chem.
Any comment:	

Data / Parameter:	LF_y
Data unit:	Liter
Description:	Quantity of by-product liquid fuel combusted in the project boiler during the year y

Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8,765,672
Description of measurement methods and procedures to be applied:	Monitored continuously using meters
QA/QC procedures to be applied:	The meters (Tag No. FQ_7104) will be calibrated periodically. Once the erroneous measurement or malfunction is detected, corrective actions will be taken by LG Chem.
Any comment:	

Data / Parameter:	**$NCV_{WG,y}$**
Data unit:	TJ/Nm^3
Description:	Net calorific value of purge gas
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	52.15×10^{-6}
Description of measurement methods and procedures to be applied:	Monitored at least quarterly and yearly average value will be used.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**$NCV_{LF,y}$**
Data unit:	TJ/liter
Description:	Net calorific value of by-product liquid fuel
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	30.576×10^{-6}
Description of measurement methods and procedures to be	Monitored at least quarterly and yearly average value will be used.

applied:	
QA/QC procedures to be applied:	
Any comment:	

B.7.2 Description of the monitoring plan:

LG Chem organizes an Operating and Monitoring Team, which composes of a manager and operators. The manager is responsible for monitoring and archiving all data associated with items depicted in the monitoring plan. Operators working under the manager are assigned to the task of monitoring different parameters on a timely basis as well as recording and archiving data in an orderly manner. All data collected as part of monitoring plan will be archived electronically and be kept at least 2 years after the end of the crediting period. Monitoring reports will be reviewed by the manager on a monthly basis in order to ensure that the Project activity meets all requirements as outlines above.

1. Introduction

The purpose of this Monitoring Plan (MP) is to provide a standard by which LG Chem. LG Chem will conduct monitoring and verification. The MP shall be in accordance with all relevant rules and regulations of the CDM. The MP is an integral part of this PDD and can be utilized to facilitate accurate and consistent monitoring of the Project's Certified Emission Reductions (CERs).

LG Chem will use the MP for the duration of the Project activity. The company will strictly follow the MP in order to measure and track the project impacts and prepare for the periodic verification process required to confirm the amount of CERs achieved.

Specifically, the MP facilitates the following;

- Establishing and maintaining a suitable monitoring system
- Guide for the implementation of necessary measurement and management operations
- Guide for meeting CDM requirements for verification and certification

2. Operational and Monitoring Obligations

In order to facilitate accurate CER determination, the project participant must fulfil a number of operational and data collection obligations. This will ensure that CERs are calculated in a transparent manner and monitoring is carried out as stipulated in the MP.

All data required for emission reduction determination shall be monitored as directed in Section B of this PDD.

3. Management and Operational Systems

In order to ensure a successful operation of the Project and the credibility and verifiability of the CERs achieved, the Project will have a well-defined management and operational system. A system will be put

in place for the Project and include the operation and management of the monitoring and record keeping system that is described in this MP.

3.1 Allocation of Project management responsibilities

The management and operation of the Project is the responsibility of LG Chem, the Project operator. Ensuring the environmental credibility of the Project through accurate and systematic monitoring of the Project's implementation and operation for the purpose of achieving trustworthy CERs is the key responsibility and accountability of the operator.

3.2 Management and operational systems

The project developers implements a management and operational system that meets the requirements of the Project. This includes:

3.2.1 Data handling

– The establishment of a transparent system for the collection, computation and storage of data, including adequate record keeping and data monitoring systems. The project participants develop and implement a protocol that provides for these critical functions and processes, which will be fit for independent auditing.

3.2.2 Quality assurance

– LG Chem designates a competent manager who is in charge of and accountable for the generation of CERs including monitoring, record keeping, computation of CERs, audits and verification. The person officially sign-offs on all GHG Emission worksheets.
– Well-defined protocols and routine procedures, with good, professional data entry, extraction and reporting are encouraged to maximise transparency of data archiving.
– Proper management processes and recording of official data

3.2.3 Training

- Internal training is made available to operational staff to enable them to undertake the tasks required by this MP. Initial staff trainingis provided before the Project starts operating and generating CERs.

B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

The first baseline study was completed in 26/06/2006 and the revised baseline study was completed in 01/09/2008 by the Clean Energy Finance Committee. The contact details of Mitsubishi UFJ Securities Co., Ltd. appear below:

Clean Energy Finance Committee
Mitsubishi UFJ Securities Co., Ltd.
Tokyo, Japan
Tel: (81-3) 6213-6860

CDM – Executive Board

E-mail: watanabe-hajime@sc.mufg.jp

The Clean Energy Finance Committee, Mitsubishi UFJ Securities Co., Ltd. is the CDM Adviser to the Project and will be the contact for the CDM activity described in this PDD.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

21/06/2006 (Date of purchase order for natural gas burners)

C.1.2. Expected operational lifetime of the project activity:

20 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

Not applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

10/05/2009 or the date of registration, whichever is later

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

"Enforcement Decree of the Act on Assessment of Impacts of Works on Environment, Traffic, Disasters, etc." describes projects for which an Environment Impact Assessment (EIA) is required. Under the Act, the proposed Project activity does not require the completion of an EIA.

In actual fact, the Project activity will help to improve local air quality as well as mitigate climate change. Since the natural gas will not contain sulphur, it is expected that emissions of SO_x will be reduced by more than 90% comparing to the baseline situation (bunker fuel oil C consumption). It is also expected that emissions of NO_x will be reduced by the Project activity.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

It is expected that there will be no negative environmental impacts associated with the Project activity.

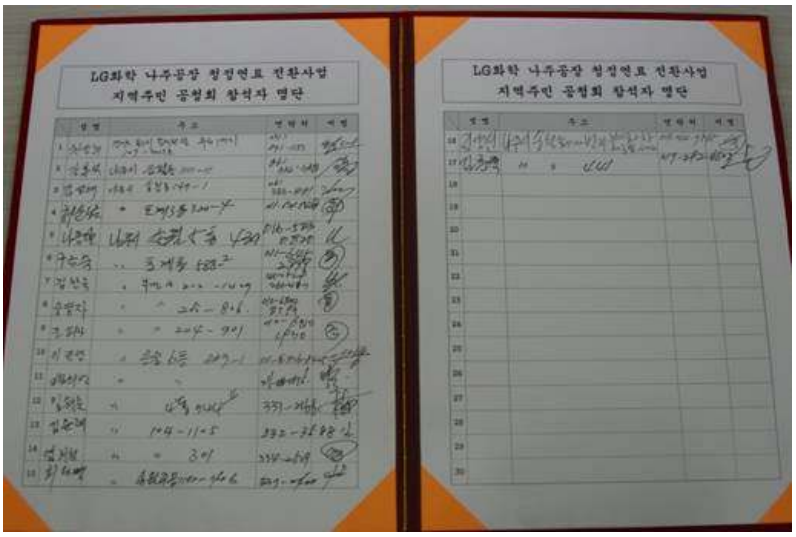
SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

A stakeholders' meeting was conducted by LG Chem on July 28, 2006. The meeting took place at the Project plant in Naju. Local network and newspaper announcements were used to advertise the stakeholders' meeting and invite local stakeholders. A total of 17 local inhabitants attended the meeting and showed strong interest in the Project as it will help to improve local air quality.

The below is a brief summary of points elaborated on by LG Chem staff during a presentation held at the meeting.

- Description of the Project and explanation of its main objectives.
- Explanation of how the Project helps to reduce local air pollution
- Explanation of how the Project contributes to reducing GHG emissions.



< Figure 2 - Pictures of the stakeholders' meeting and list of the participants >

E.2. Summary of the comments received:

All of the participants are in favour of the Project activity considering its environmental and the socio-economic effects. However, following concerns were expressed by local stakeholders:

1. What is the reason for the 3 ~ 4 ℃ higher temperature in the area near where the Project plant is located as compared to other areas in Naju?

   LG Chem's response: This is just because of regional climate characteristics, and not caused by industrial activities at the LG Chem plant. Therefore, the Project will also not affect the local climate other than helping to mitigate the adverse effects of climate change by reducing GHG gas emissions

2. Will the pilot flame on the flare stack disappear after the implementation of the Project?

   LG Chem's response: The spark on the flare stack should always remain lit, even after project implementation. Actually, this pilot flame is installed for environmental reasons.

The stakeholders were satisfied with the answers by LG Chem.

There were no adverse comments in regards to the Project activity.

E.3. Report on how due account was taken of any comments received:

As stated above, there were no negative comments from local stakeholders in regards to the Project activity.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Represented by:	
Title:	Manager
Salutation:	Mr.
Last Name:	Won
Middle Name:	
First Name:	Sung Hee
Department:	Environmental & Safety Team
Mobile:	
Direct FAX:	
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State/Region:	-
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URL:	http://www.sc.mufg.jp/english/e_cefc/
Represented by:	
Title:	Chairman
Salutation:	Mr.
Last Name:	Watanabe
Middle Name:	
First Name:	Hajime
Department:	Clean Energy Finance Committee
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Project financing will not involve ODA or public funding from any Annex I countries

Annex 3

BASELINE INFORMATION
Fuel consumption and steam generation

	Amount of steam (Metric ton)	B-C consumption (liter)	LF consumption (liter)	PG consumption (Nm3)
2003-11	48,591	2,727,626	781,193	329,269
2003-12	45,898	2,699,486	664,834	281,108
2004-01	43,516	2,463,055	588,098	327,304
2004-02	44,732	2,527,304	668,523	360,836
2004-03	47,596	2,687,456	673,716	434,471
2004-04	40,472	2,281,918	617,441	316,194
2004-05	32,010	1,842,996	424,258	253,790
2004-06	38,657	1,798,714	900,059	449,576
2004-07	39,600	1,873,448	895,769	461,897
2004-08	40,337	1,910,208	915,300	443,849
2004-09	40,676	2,100,399	819,444	404,357
2004-10	29,311	1,473,748	650,575	301,607
2004-11	4,553	288,160	49,518	41,976
2004-12	44,009	2,501,062	821,264	362,185
2005-01	46,992	2,882,148	701,482	386,870
2005-02	41,415	2,388,403	757,612	386,037
2005-03	42,845	2,422,578	808,343	403,800
2005-04	29,825	1,668,543	590,789	301,747
2005-05	38,049	2,095,002	819,125	466,474
2005-06	38,084	2,074,811	798,898	432,593
2005-07	39,485	2,169,574	784,271	439,189
2005-08	37,425	1,947,220	823,599	407,295
2005-09	28,728	1,747,713	452,246	233,115
2005-10	36,368	1,897,125	878,432	422,262
2005-11	35,248	1,637,636	833,183	399,832
2005-12	42,079	2,356,681	828,153	295,964
2006-01	42,065	2,391,589	839,656	321,770
2006-02	36,557	1,979,898	777,728	301,947
2006-03	35,617	1,888,952	806,564	369,781
2006-04	19,767	1,074,795	336,374	199,217
2006-05	34,504	1,717,599	670,756	422,715
2006-06	34,959	1,573,358	814,126	470,621
2006-07	35,308	1,545,783	883,592	472,734
2006-08	32,790	1,420,456	856,279	462,388
2006-09	32,228	1,298,195	893,999	450,657
2006-10	31,615	1,376,652	871,818	388,532
Total	1,331,911	70,730,291	26,297,017	13,203,959

Annex 4

MONITORING INFORMATION

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