Hanwha Corporation
1 CHANGGYO-DONG, CHUNG-KU, SEOUL, 100-797, KOREA
Mitsubishi Corporation
3-1, MARUNOUCHI 2-CHOME, CHIYODA-KU, TOKYO 100-8086, JAPAN

CDM Monitoring Report No.3 :

(3rd verification)

“ Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea ”

UNFCCC 0922

Monitoring Period : from January 1, 2009 to December 31, 2009

Version 1
January 18, 2010

Mitsubishi Corporation

2-3-1, Marunouchi, Chiyoda-ku, Tokyo, Japan
Tel : +81 3 3210 7574
Fax: +81 3 3210 7708

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1 Introduction

The purpose of this monitoring report is to calculate and clarify GHG emission reduction quantity achieved by this project activity for periodic verification.

This monitoring report covers the activity from January 1, 2009 to December 31, 2009 as the period of second monitoring report. Duration of the project activity period is as below :
The project was registered at UNFCCC on : 03/05/2007 with number 0922
The starting date of the crediting period is : 27/06/2007 (*refer to Item 3 Definition)

* In the PDD, it is mentioned that project period is 7 years starting from July 1, 2007 (until June 30, 2014). However, the project has been frontloaded and started from June 27, 2007. So overall project period has also become frontloaded, 7 years starting from June 27, 2007 (until June 26, 2014).

Mitsubishi Corporation, together with Hanwha Corporation and Mitsubishi Corporation (Korea) Limited, has implemented the project of GHG emission reduction by abating N_2O gas by catalytic decomposition (destruction) in Hanwha Corporation, South Korea. The project is categorized as large scale project under sectoral scope 5; "Chemical Industry". The Host Party of the project activity is the Republic of Korea.

2 Reference

Approved Baseline Methodology :
AM0028 Version 3 : "Catalytic N_2O Destruction in tail gas of Nitric Acid or Caprolactam Production Plants".

Approved Monitoring Methodology :
AM0028 Version 3 : "Catalytic N_2O Destruction in tail gas of Nitric Acid or Caprolactam Production Plants".

Project Design Document :
"Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea"
Version : 08
Date : November 17, 2006

Validation Report :
Validation of the CDM Project : "Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea", made and submitted by TÜV SÜD Industries Service GmbH, Germany.
Report No. : 910471
Date : November 21, 2006

CDM Registration :
"Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea"
UNFCCC reference number : 0922
Date of Registration : May 03, 2007

3 Definition

Monitoring Period "in this report, January 1, 2009 to December 31, 2009.", which is exactly 365 days.

PDD : Project Design Document of this project "Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea.", Version 08 on November 17, 2006

4 General Description of Project

4.1 Project Activity

The Project Activity includes development, design, engineering, procurement, finance, construction, operation and maintenance of the system for catalytic of N_2O. In the production process of nitric acid (HNO_3), NO is produced as an intermediate material from ammonia (NH_3). The associated chemical reactions of oxidizing ammonia and simultaneous unwanted reactions are as described in 4.2.

4.2 General Introduction :

Nitrous oxide (N_2O) is an undesired (unwanted), invisible and previously neglected by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide (NO) during the catalytic oxidation of ammonia in air over noble metal gauzes. The production of nitric acid takes place in three main process of ammonia steps as indicated by the following reactions :

Overall desired reaction ;

$NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$ Reaction 1

Ammonia (NH3) combustion to form nitric oxide (NO) ;

$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ (main reaction 1) Reaction 2

NO is oxidized to nitrogen dioxide (NO_2) ;

$2NO + O_2 \rightarrow 2NO_2$ (main reaction 2) Reaction 3

Absorption of NO_2 in water to form nitric acid HNO_3 ;

$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$ (main reaction 3) Reaction 4

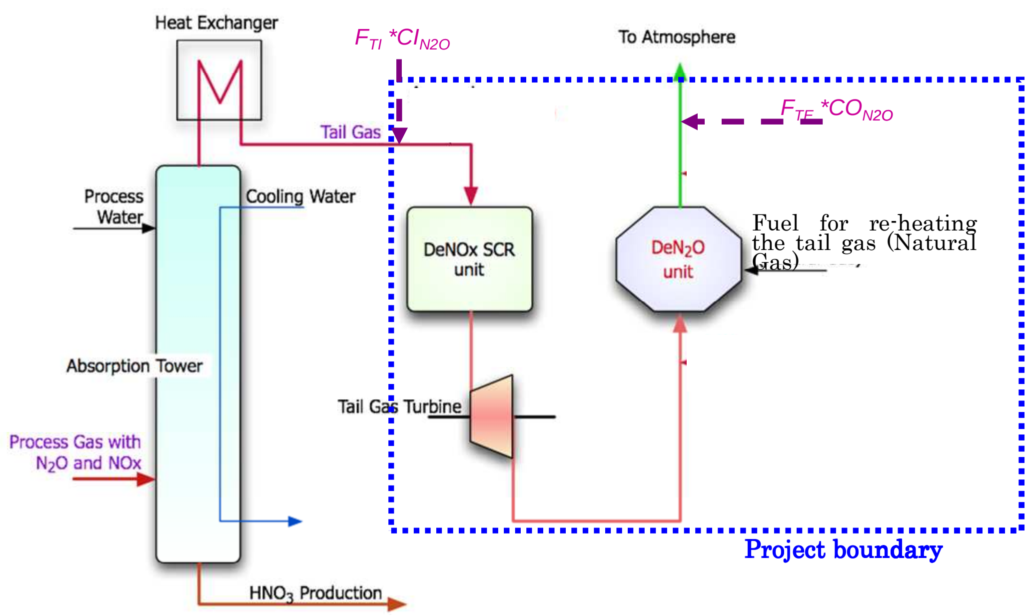
Simultaneously nitrous oxide (N_2O), nitrogen (N) and water (H_2O) are formed as well, in accordance with the following equations :

$4NH_3 + 3O_2$	→	$2N_2 + 6H_2O$	(side reaction 1, undesired)	Reaction 5
$4NH_3 + 4O_2$	→	$2N_2O + 6H_2O$	(side reaction 2, undesired)	Reaction 6
$2NH_3 + 8NO$	→	$5N_2O + 3H_2O$	(side reaction 3, undesired)	Reaction 7

Through Reaction 6 and 7, some amount of N_2O is generated in the process and it is released to the atmosphere as a part of exhausted gas. The N_2O abatement technology of catalytic decomposition at the tail gas, tertiary method, after the Absorption Tower and NH3 SCR before the Stack, has been introduced and N_2O is decomposed as below :   (side reaction 2, undesired)

$$N_2O \rightarrow N_2 + (1/2)\,O_2$$

4.3 Process Chart



DeNOx unit based on NH3 SCR process has been installed in July, 2005, about 2 years before the installation of DeN_2O unit. As specified in item 5.1, N_2O emission from DeNOx unit is excluded from the baseline emissions, as per the applied methodology, AM0028, version-3.

4.4 Project Participants

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)
Republic of Korea (host)	**Hanwha Corporation (HWC)** [owner and operator of the nitric acid plant]
	Mitsubishi Corporation (Korea) Ltd. (MCK) [developer and co-financer of this CDM project]
Japan	**Mitsubishi Corporation (MC)** [developer and co-financer of this CDM project]

4.5 Focal Point

The Project participants agreed that Mitsubishi Corporation serves as focal point of the communication with the Executive Board and the UNFCCC Secretariat.

5 Baseline Methodology

5.1 Justification of the Baseline Methodology

Approved baseline methodology AM0028 version 3, “Catalytic N_2O destruction in the tail gas of Nitric Acid or Caprolactam Production Plants”, submitted by Mitsubishi Corporation as well as Climate Experts Ltd. was applied to this project activity.

The applicability conditions specified in the methodology and the applicability to this project activity are as follows:

1) The methodology is applied to the existing design production capacity of Nitric Acid Plant which was installed before December 31, 2005.
2) HWC has not installed any N_2O destruction or abatement technologies prior to the start of the project.
3) The project activity does not affect the nitric acid production level.
4) The applied technology is the tail gas system. Therefore, the project activity does not cause the increase of NOx emissions.
5) Selective Catalytic Reduction (SCR) DeNOx unit was installed prior to the project activity.
6) N_2O concentration in the flow at the inlet and the outlet of catalytic N_2O destruction facility are measurable in the real time.
7) Relevant historical data and manufacturer information are available.

5.2 Project Boundary

As specified in the methodology, the project boundary covers

1) the catalytic N_2O destruction facility including hydrocarbon input, and
2) for monitoring purposes only, the nitric acid plant, to measure the nitric acid output and operating parameters of the ammonia oxidation reactor.

Baseline Emissions :

Source	Gas		Explanations
Emissions of N_2O as a result of side reaction to the nitric acid production process	N_2O	Included	Main emission source, taking national N_2O emission regulations into account.
Emissions related to the production of ammonia used for NO_X reduction	CO_2 CH_4 N_2O	Included	Since SCR DeNOx unit is already installed prior to the project start, ammonia input for SCR is considered to be of the same magnitude to project related ammonia input for NOx reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation.
N_2O emissions from SCR DeNOx-unit	N_2O	Excluded	The presence of a SCR DeNOx unit tends to increase the N_2O emissions. Therefore the ex post measurement of the baseline emissions at the inlet of the N_2O destruction facility represents a conservative determination of the baseline N_2O emissions.

Project Emissions and Leakage:

Source	Gas		Explanations
Emissions of N_2O as a result of side reaction to the nitric acid production process (project emissions)	N_2O	Included	Main emission source that remains in the tail gas after the N_2O destruction facility
Emissions related to the production of ammonia used for NO_X reduction (project emissions)	CO_2 CH_4 N_2O	Included	Since SCR DeNOx unit is already installed prior to the project start, ammonia input for SCR is considered to be of the same magnitude to project related ammonia input for NOx reduction. Baseline emissions and project emissions are similar and therefore

			not considered for calculation.
Emissions at the project site resulting from hydrocarbons used as reducing agent and/or re-heating the tail gas (project emissions)	CO_2 CH_4 N_2O	Included	The technology applied to this project activity does not use hydrocarbon as reducing agent. Natural gas is used as fuel to increase the temperature of tail gas. In this case natural gas is mainly converted to CO_2 while some natural gas may remain intact. Fraction of unreacted methane is counted.
Emissions at the project site resulting from hydrocarbons used as reducing agent (project emissions)	CH_4 CO_2	n/a	The technology applied to this project activity does not use hydrocarbon as reducing agent.
Emissions from electricity demand (leakage)	CO_2 CH_4 N_2O	Included	GHG emissions related to the electricity consumption are insignificant, but monitored and counted for conservativeness.
Emissions related to the production of the hydrocarbons (leakage)	CO_2 CH_4 N_2O	Excluded	GHG emissions related to the production of hydrocarbons used as reducing agent represent less than 0.001% of expected emission reductions and will not be taken into account due to unreasonable costs for monitoring. The technology applied to this project activity does not use hydrocarbon as reducing agent.

Project Boundary is specified in the process chart, which is in the item 4.3. (page 5)

6 Monitoring Methodology and Plan

The approved Monitoring Methodology AM0028 version 3 "Catalytic N_2O destruction in the tail gas of Nitric Acid or Caprolactam Production Plants", submitted by Mitsubishi Corporation as well as Climate Experts Ltd. was applied to this project activity.

This approved Monitoring Methodology is applicable to the project activities that abates N_2O emissions either by catalytic decomposition or catalytic reduction of N_2O in the tail gas of nitric acid plants (i.e. tertiary destruction). The present project activity, which has been registered on May 3, 2007, satisfied applicability conditions.

The data being collected in order to monitor GHG emissions from the project activity are described below.

7 Quality Control (QC) and Quality Assurance (QA)

7.1 Quality Management System

Project Operator is Hanwha Corporation, one of the biggest Nitric Acid Plant in Republic of South Korea who is ISO 9001 / 2000 certified.

The operating personnel of Nitric Acid Plant have been trained by the technology provider, Uhde, Germany. Hanwha Corporation is also responsible for monitoring and reporting data under the CDM Project.

Hanwha has been operating Nitric Acid Plant since the commissioning of the Plant and has sufficient and well-experienced staffs. Hanwha has been in production of nitric acid for number of years and measurement of various production parameters including operation of analyzers which are managed by Production Team. The monitoring of the N_2O for the project will be responsible by Production Team and the operation and maintenance of N_2O Monitoring system will incorporate the ISO9001 / 2000 standard procedures. The Monitoring of the relevant data will be done by the N_2O Monitoring System and recorded onto the electric media.

Production Team will be appointed to be responsible for the operation of the N_2O Monitoring System. Production Team will follow the Monitoring Plan and report the data on regular intervals to Management Team and Plant Manager in ascending order.

7.2. Quality Control and Quality Assurance Procedures undertaken data monitored

The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been defined based on applicable international standards, as well as standards provided by technology supplier. Hanwha Corporation is certified under the ISO9001 and applies appropriate QA & QC procedures. The QC and QA procedures are set and implemented in order to ;

--secure a good consistency through planning to implementation of the CDM project and,

--stipulate the responsibilities for operation and monitoring and,

--avoid any misunderstanding between people and organization involved.

7.3. Calibration and maintenance

All measuring and analytical instruments are being calibrated as defined in the Approved Methdology AM0028 version3. Calibration procedures have been incorporated in Hanwha Corporation's Quality Management System and Procedures.

The measurement equipments will be calibrated on regular intervals as recommended by the manufacturers. Additionally, selected staffs from Hanwha Corporation will participate in initial training and be trained to operate measurement system.

For other concerning good monitoring practice and performance characteristics including such as EN14181 or equivalent standards available in Republic of Korea specified in AM0028 version 3, which is mentioned in Annex 4 of concerned PDD.

7.4. Environmental Impacts

According to the national Environmental Law in Korea, Environmental Impacts are :
Gaseous matter : There is no additional pollution. The N_2O destructed into harmless N_2 and O_2.
Particular matter : There is no additional pollution.
Water matter : Not applicable. The destruction reaction occurs in gaseous phase.
Spent catalyst : The catalyst over its lifetime is recycled to get precious components and then reproduced to new catalyst. The catalyst has a long lifetime.
No transboundry impacts are expected.

8 GHG Calculation

In terms of the Approved Methdology (AM0028 version 3), the emission reduction (ER_y) by the project activity during a given period "y" is the difference between the baseline emission (BE_y) and project emission (PE_y), as follows ;

ER_y = BE_y - PE_y - LE_y

where;

ER_y	emission 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)
LE_y	leakage emissions in the year y (tCO_2e)

8.1. Baseline Emissions :

It has been checked that there are no Korean regulation in place that would limit the quality of N_2O that can be taken into account for the calculation of baseline emissions.
Baseline emissions of the project activity are determined based on the quantity of N_2O emitted in the baseline scenario, taking national regulations, production levels and operating conditions into consideration. The quantity of N_2O is determined based on the measurement of the N_2O at the inlet of DeNOx unit, which results in a conservative estimation of baseline emissions.
Baseline emissions are limited to the design capacity of the nitric acid plant, According to AM0028 version 3, the design capacity is measured in tons of nitric acid per year. The actual nitric acid production in the covered monitoring period does not exceed the design capacity.

$$BE\_y = \text{Minimum}(P_{product,max} \quad P_{product,y}) / P_{product,y} * \sum_{i=1}^{n} [F_{TI,i} * CI_{N2O,i} * M_i * GWP_{N2O}]$$

i :	Interval,
n :	Number of intervals during the year (1/yr),
$F_{TI,i}$:	Volume flow rate at the inlet of the destruction facility during interval i (Nm^3/h),

$CI_{N2O,i}$: N_2O concentration a destruction facility inlet during interval i(tN_2O/Nm^3),
GWP_{N2O} : Global warming potential of N_2O,
$P_{product,max}$: Design capacity ($tHNO_3$/yr), and
$P_{product,y}$: Production of nitric acid in a year y ($tHNO_3$/yr).

If the actual average daily operating temperature and/or pressure in the ammonia oxidation reactor (T_g and P_g) are outside a "permitted range" of operating temperatures and/or pressures ($T_{g,hist}$ and $P_{g,hist}$), or the daily ammonia input to the oxidation reactor($A_{OR,d}$) exceeds maximum historical ammonia input to oxidation reactor ($A_{OR,hist}$), the baseline N_2O emissions for that period are capped at 4.5kgN_2O/tonne of nitric acid conservatively applying the IPCC default value.

Furthermore, as for composition of ammonia oxidation catalyst, the plant operator is allowed to use compositions of ammonia oxidation catalysts that are common practice in the region or have been used in the nitric acid production plant during the last three years without limitation of N_2O baseline emissions.

In case the nitric acid production plant operator wishes to change to a composition not used during the last three years, but is common practice in the region and supplied by a reputable manufacturer, or if it corresponds to a composition that is reported as being in use in the relevant literature, the plant operator is allowed to use these ammonia oxidation catalysts without limitation of N_2O baseline emissions.

In case the nitric acid production plant operator changes the composition of ammonia oxidation catalysts and the composition is not common practice in the region and not reported as being in use in the relevant literature, the project applicant has to demonstrate (either by economic or other arguments) that the choice of the new composition was based on considerations other than an attempt to increase the rate of N_2O production. If the project applicant can demonstrate appropriate and verifiable reasons, the plant operator is allowed to use new ammonia oxidation catalysts without limitation of N_2O baseline emissions.

The first composition of ammonia oxidation catalyst used during the crediting period shall be of the same kind of catalyst composition already in operation in the specific nitric acid production plant. This is to avoid gaming at the beginning of the project activity.

In case the nitric acid production plant operator changes the composition of ammonia oxidation catalysts and the composition is not common practice in the region and not reported as being in use in the relevant literature, and the project applicant cannot demonstrate appropriate and verifiable reasons for this baseline emissions are limited to the maximum specific N_2O emissions of previous periods ($tN_2O/tHNO_3$), documented in the verified monitoring reports.

Required monitoring parameters:

- G_{sup} : Supplier of the ammonia oxidation catalyst
- $G_{sup,hist}$: Historical supplier of the ammonia oxidation catalyst
- G_{com} : Composition of the ammonia oxidation catalyst
- $G_{com,hist}$: Historical composition of the ammonia oxidation catalyst
- $SE_{N2O,y}$: Specific N_2O emissions per ton HNO_3 of product of nitric acid in year y ($tN_2O/tHNO_3$)

In the event that N_2O concentrate of outlet of DeN_2O facility is not within the monitoring range, we apply

the IPCC default value for that period.
In the event that the monitoring system is down, the lowest between the conservative default value established in the methodology or the last measured byproduct rate (whichever the lower) will be valid and applied for the downtime period for the baseline emission factor, and the highest measured byproduct rate during the project activity will be applied for the downtime period for the campaign emission factor.

$$BE\_y = \text{Minimum}(P_{product,max} \quad P_{product,y}) / P_{product,max} * \sum_{i=1}^{n} [F_{TI,i} * CI_{N2O,i} * M_i * GWP_{N2O}]$$

$$= \underline{\mathbf{264,913\ tCO_2e}}$$

* Calculation based on actual data is given in the Annex-2 and 3.

8.2. Project Emissions :

The emissions due to the project activity are composed of (a) the emission of not destroyed N_2O and (b) emissions from auxiliary hydrocarbons input resulting from the operation of the nitric acid plant. N_2O emissions not destroyed by the project activity are calculated based on the continuous measurement of the N_2O concentration in the tail gas of the nitric acid plant and the volume flow rate of the tail gas stream. The emissions related to the operation of the N_2O destruction facility are given by on-site emissions due to the hydrocarbons used as input to the nitric acid plant.
Project emissions are limited to the design capacity of the nitric acid plant. According to AM0028 version 3, the design capacity is measured in tons of nitric acid per year. The actual nitric acid production in the covered monitoring period does not exceed the design capacity.

$$PE\_y = PE_{ND,y} + PE_{DF,y}$$
$$= PE_{ND,y} + HCE_{C,y} + HCE_{NC,y}$$

$PE_{ND,y}$: Project emissions from N_2O not destroyed in year y (tCO_2e/yr),
$PE_{DF,y}$: Project emissions related to the operation of the destruction facility in year y (tCO_2e/yr)
$HCE_{C,y}$: Converted hydrocarbon emissions in year y (tCO_2/yr),
$HCE_{NC,y}$: Methane emissions in year y (tCO_2e/yr)

$$PE_{ND,y} = \sum_{i=1}^{n} [F_{TE,i} * CO_{N2O,i} * M_i * GWP_{N2O}]$$

i : Interval,
n : Number of intervals during the year (1/yr)
$F_{TE,i}$: Volume flow rate at the exit of the destruction facility during interval i(Nm^3/h),
$CO_{N2O,i}$: N_2O concentration in the tail gas of the N_2O destruction facility during interval i (tN_2O/Nm^3),
M_i : Length of measuring interval i (h),
GWP_{N2O} : Global warming potential of N_2O.

$PE_{ND,y} = \sum_{i=1}^{n} [F_{TE,i} * CO_{N2O,i} * M_i * GWP_{N2O}]$

= **39,415 tCO_2e**

* Calculation based on actual data is given in the Annex-2 and 3.

In the event that the monitoring system is down, the highest measured byproduct rate during the project activity will be applied for the downtime period for the campaign emission factor.

$$HCE_{C,y} = \rho_{NMHC} * Q_{NMHC,y} * OXID_{NMHC}/100 * EF_{NMHC} + \rho_{HNC} * Q_{HNC,y} * OXID_{CH4}/100 * EF_{HNC}$$
$$= \rho_{NMHC} * Q_{NMHC,y} * EF_{NMHC}$$

$$HCE_{NC,y} = \rho_{HNC} * Q_{HNC,y} * (1 - OXID_{CH4}/100) * GWP_{CH4}$$
$$= \rho_{HNC} * Q_{HNC,y} * GWP_{CH4}$$

ρ_{NMHC} : Hydrocarbon (Non-methane part of the natural gas) density ($tNMHC/Nm^3$),
$Q_{NMHC,y}$: Hydrocarbon (Non-methane part of the natural gas) input in year y (Nm^3),
$OXID_{NMHC}$:Oxidation factor of hydrocarbon (Non-methane part of the natural gas) (%),
EF_{NMHC} : Carbon emissions factor of hydrocarbon (Non-methane part of the natural gas) ($tCO_2/tNMHC$),
ρ_{HNC} : Methane (Methane part of the natural gas) density (tCH_4/Nm^3),
$Q_{HNC,y}$: Methane(Methane part of the natural gas) used in year y (Nm^3)
EF_{HNC} : Carbon emissions factor of methane (Methane part of the natural gas) (tCO_2/tCH_4),
$OXID_{CH4}$: Oxidation factor of methane(Methane part of the natural gas) (%), and
GWP_{CH4} : Global warming potential of methane.

For this project, fraction of Methane not converted is not be measured due to unreasonable costs. So, 0% is applied to $OXID_{CH4}$ and 100% is applied to $OXID_{NMHC}$.

$$HCE_{C,y} = \rho_{NMHC} * Q_{NMHC,y} * OXID_{NMHC}/100 * EF_{NMHC} + \rho_{HNC} * Q_{HNC,y} * OXID_{CH4}/100 * EF_{HNC}$$
$$= \rho_{NMHC} * Q_{NMHC,y} * EF_{NMHC}$$

= 150 tCO_2e (non-methane)

* Calculation based on actual data is given in the Annex-2 and 3.

$$HCE_{NC,y} = \rho_{HNC} * Q_{HNC,y} * (1 - OXID_{CH4}/100) * GWP_{CH4}$$
$$= \rho_{HNC} * Q_{HNC,y} * GWP_{CH}$$

= 3,152 tCO_2e (methane)

* Calculation based on actual data is given in the Annex-2 and 3.

Therefore, total value of Project Emission is calculated as below :

$PE\_y = PE_{ND,y} + PE_{DF,y}$

$= PE_{ND,y} + HCE_{C,y} + HCE_{NC,y}$
= 39,415 + 150 + 3,152
= 42,717 tCO_2e
* Calculation based on actual data is given in the Annex-2 and 3.

8.3. Leakage Emissions :

Additional power such as DeN_2O unit running will be needed by the project implementation. The CO_2 emission related to the electricity consumption is insignificant, but monitored and counted as leakage in conservative manner.

$LE\_y = EI_{RCS,y} * EF_{RCS}$

$EI_{RCS,y}$: Additional electricity input for running the DeN_2O unit (MWh/yr), and
EF_{RCS} : Emissions factor for running the DeN_2O unit.

$LE\_y = EI_{RCS,y} * EF_{RCS}$
= **201 tCO_2e**
* Calculation based on the actual data is given in the Annex-2 and 3

8.4. Emission Reductions :

The total emission reduction achieved by this project activity during the first monitoring period is therefore;

ER_y = BE_y - PE_y - LE_y
= 264,913 - 42,717 - 201
= 221,995tCO_2e

The total amount of emission reductions is calculated as **221,995tons CO_2e.**

9 Check against baseline requirement

In order to avoid that the operation of the nitric acid production plant is manipulated in a way to increase N_2O generation, thereby increasing the CERs, actual operating conditions have been checked against the baseline requirements.

9.1 Operating Temperature

The actual average daily operating temperature in the ammonia oxidation reactor was within the permitted range for all days covered by this monitoring report.

Parameters are Annex-1

9.2. Operating Pressure

The actual average daily operating pressure in the ammonia oxidation reactor was within the permitted range for all days covered by this monitoring report.
Parameters are Annex-1

9.3. Composition of the Ammonia Oxidation Catalyst

The composition of the ammonia oxidation catalyst is the same kind of catalyst composition already in operation prior to the start of the project activity.

9.4. Ammonia Flow Rate to the Ammonia Oxidation Reactor

The daily ammonia input to the ammonia oxidation reactor does not exceed the maximum permitted daily ammonia input.
Parameters are Annex-1

9.5. Production of Nitric Acid

Production volume of Nitric Acid during the project period is 85,587tons, which is calculated as
--- 131,672.9066tons x 65% = 85,587.3893tons
--- 131,672.9066tons is the production volume of HNO_3 which includes H_2O as 35%. Therefore we shall exclude H_2O and come to the pure $HNO_{3\ \text{production volume.}}$ 85,587.3893tons
whereas, $P_{product,max}$ specified in the PDD, based on the manufacturer's specification is 107,100tons, which is 306 [HNO_3/day]*350[day/yr]. Therefore, during the period, maximum production is calculated as
306 x 350 = 107,100tons.
Thus actual production of 85,587.3893tons is less than 107,100tons.
Daily basis production during the period was also within the permitted range, mentioned in the PDD.

Meantime, the operation of Nitric Acid Plant was stopped 33 days during the following period as below :
March 17–30 (primary catalyst replacement)
July 19-27 (primary catalyst replacement)
November 16-25 (primary catalyst replacement)

9.6. Shutdown of De N_2O unit

The De N_2O unit was operated to reduce the N_2O gas from nitric acid plant, except following 16days i.e.. the operation of De N_2O unit was stopped during the following period :
May 25-28 (catalyst cleaning)
June 5-6 (installation of De-Sulfur Unit)
July 28- Aug 6 (installation of cleaned catalyst and RCS repairing)

9.7. N_2O Regulation

No national regulation for N_2O emission. We periodically visit the web-site of the concerned ministry in Korea and check the regulation. In case the regulation is updated, we will follow it accordingly.

9.8. NOx Regulation

National regulation for NOx emission is Clean Conservation Act (CCA) of the Republic of Korea. According to CCA, currently, NOx regulation requires to limit the emission below 200ppmv. We are periodically visit the web-site of CCA and check the regulation. In case the regulation is updated, we will follow it accordingly. During the period of 01/January/2009 to 31/December/2009, the average value of NOx is 64 ppm, the maximum value 172.54 ppm (on 19/July/2009).

End

Annex-1

The parameters to be determined monitored *ex ante* or as the default values are listed below.

Data / Parameter:	GWP_{N2O}
Data unit:	tCO_2e/tN_2O
Description:	Global warming potential of the nitric oxide
Source of data used:	IPCC, The Second Assessment Report
Value applied:	310
Justification of the choice of data or description of measurement methods and procedures actually applied:	Specified in the methodology.
Any comment:	The value may be altered in the 2nd Commitment Period if COP/MOP decided so.

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential of the methane
Source of data used:	IPCC, The Second Assessment Report
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Specified in the methodology.
Any comment:	The value may be altered in the 2nd Commitment Period if COP/MOP decided so.

Data / Parameter:	Reg_{Nox}
Data unit:	tNO_X/m^3
Description:	National regulation on NOx emissions to be checked and applied
Source of data used:	National environmental legislation in the Republic of Korea
Value applied:	$2.92 * 10^{-7}$ (tNO_X/m^3)

Justification of the choice of data or description of measurement methods and procedures actually applied:	Clean Air Conservation Act of the Republic of Korea Currently, NOx regulation requires to limit the emissions below 200 ppmv. By the way, in Onsan plant, NO/NO_2 ratio of the tail gas before NH_3 SCR installation was 2.1 : 1. But after NH_3 SCR installation, NO/NO_2 average ratio has been 4.9 : 1. Therefore, NOx 200ppmv equals to NO 166ppmv plus NO_2 34ppmv. NO 166ppmv is $2.22 * 10^{-7}$ tonNO/m^3 and NO_2 34ppmv is $0.70 *10^{-7}$ tonNO$_2$/m^3. And the Sum of NO and NO_2 equals to $2.92 *10^{-7}$ tonNOx/m^3.
Any comment:	This is used to check whether the host company complies with the regulation.

Data / Parameter:	$P_{product,max}$
Data unit:	$tHNO_3/yr$
Description:	Design capacity of nitric acid production of the targeted line
Source of data used:	Manufacturer's specification
Value applied:	107,100 ($tHNO_3/yr$)
Justification of the choice of data or description of measurement methods and procedures actually applied:	Specified in the methodology. HWC has experienced maximum daily production 306ton/day in 1992 and maximum operating days 350day in 2002. Therefore, yearly maximum is as follows; 306 [HNO_3/day]*350[day/yr]
Any comment:	The amount of emission reductions is capped by $P_{product,max}$.

Data / Parameter:	$T_{g,hist}$
Data unit:	°C
Description:	Historical operating temperature range of the ammonia oxidation reactor
Source of data used:	Production reports Daily average temperature from hourly snapshot data.
Value applied:	867.4–905.2 °C
Justification of the choice of data or description of measurement methods	Specified in the methodology. The permitted range of operating temperatures are set based on historical data (Jan.2000 - Nov.2003 and Jan.2005 - Oct.2006). The lower limit is 2.5% lower value of these available data and the upper limit is

and procedures actually applied :	2.5% upper value of them. If the actual average daily operating temperature in the ammonia oxidation reactor (T_g) is outside this "permitted range", the baseline N_2O emissions for that period are capped at 4.5kgN_2O/tonne of nitric acid conservatively applying the IPCC default value.
Any comment:	The data is used to check whether the ammonia oxidization reactor is operated normally.

Data / Parameter:	$P_{g,hist}$
Data unit:	Pa
Description:	Historical operating pressure range of the ammonia oxidation reactor
Source of data used:	Production reports Daily average pressure from hourly snapshot data.
Value applied:	8.084-9.780 *10^5 Pa abs (7.071–8.767 *10^5 Pa gauge)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Specified in the methodology. The permitted range of operating pressures are set based on historical data (Jan.2000 - Nov.2003 and Jan.2005 - Oct.2006). Operating pressure is measured at two points. One is between air compressor and NH_3 air mixer (since Jan.2000), and another is between NH_3 air mixer and NH_3 air filter (since Jan.2005). The permitted range is determined based on data measured at the former which the number of acquisition records is larger. The lower limit is 2.5% lower value of these available data and the upper limit is 2.5% upper value of them. If the actual average daily operating pressure in the ammonia oxidation reactor (P_g) is outside this "permitted range", the baseline N_2O emissions for that period are capped at 4.5kgN_2O/tonne of nitric acid conservatively applying the IPCC default value.
Any comment:	The data is used to check whether the ammonia oxidization reactor is operated normally.

Data / Parameter:	$G_{sup,hist}$
Data unit:	-
Description:	Historical supplier's information of the ammonia oxidization catalyst

Source of data used:	Ammonia oxidization catalyst supplier
Value applied:	Name of the supplier: Johnson Matthey
Justification of the choice of data or description of measurement methods and procedures actually applied:	Specified in the methodology.
Any comment:	No.

Data / Parameter:	$G_{com,hist}$
Data unit:	%
Description:	Historical composition of the ammonia oxidization catalyst
Source of data used:	Ammonia oxidization catalyst supplier
Value applied:	Pt: 95%, Rh: 5%
Justification of the choice of data or description of measurement methods and procedures actually applied:	Specified in the methodology.
Any comment:	No.

Data / Parameter:	SE_{N2O}
Data unit:	$kgN_2O/tHNO_3$
Description:	N_2O emission rate per ton of nitric acid
Source of data used:	Pre-publication Draft 2006 IPCC Guidelines accepted by the 21st Session of the IPCC
Value applied:	4.5 $kgN_2O/tHNO_3$
Justification of the choice of data or description of measurement methods	Specified in the methodology. This value is the conservative IPCC default value of Nitric Acid Plants which is based on the default emission factor for low-pressure plants.

and procedures actually applied:	(5kgN_2O/tonne of nitric acid, accounting for 10% uncertainty factor)
Any comment:	No.

Data / Parameter:	$A_{OR,hist}$
Data unit:	tNH_3/day
Description:	Maximum of historical ammonia flow rate of the ammonia oxidization reactor
Source of data used:	Production reports
Value applied:	88 tNH_3/day
Justification of the choice of data or description of measurement methods and procedures actually applied:	Specified in the methodology. This is a maximum value of daily ammonia flow rates based on historical data (Jan.2000 - Nov.2003 and Jan.2005 - Oct.2006). If the daily ammonia input to the oxidation reactor ($A_{OR,d}$) exceeds maximum historical ammonia input to oxidation reactor ($A_{OR,hist}$), the baseline N_2O emissions for that period are capped at 4.5kgN_2O/tonne of nitric acid conservatively applying the IPCC default value.
Any comment:	No.

Data / Parameter:	$OXID_{NMHC}$
Data unit:	%
Description:	Oxidization factor of the hydrocarbon (Non-methane part of the natural gas)
Source of data used:	AM0028 version03
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Specified in the methodology. For this project, fraction of methane not converted will not be measured due to unreasonable costs, so 100% is applied for this parameter based on AM0028 version03.
Any comment:	Very minor contribution

Data / Parameter:	$OXID_{CH4}$

Data unit:	%
Description:	Oxidization factor of methane (Methane part of the natural gas)
Source of data used:	AM0028 version03
Value applied:	0%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Specified in the methodology. For this project, fraction of methane not converted will not be measured due to unreasonable costs, so 0% is applied for this parameter based on AM0028 version03.
Any comment:	No.

Data / Parameter:	EF_{RCS}
Data unit:	tCO_2e/MWh
Description:	Emission factor of the electricity for running the DeN_2O unit
Source of data used:	2000~2004 Statistics of electric power in Korea (The Korea Electrical Power Corporation (KEPCO), http://www.kepco.co.kr)
Value applied:	0.62 (tCO_2e/MWh) for national power gird in the Republic of KEPCO.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The emission factor is reffering to baseline emissions factor described in PDD of "Youngduk Wind Park Project" which was already registered as CDM (http://cdm.unfccc.int/UserManagement/FileStorage/XH4MZ6TAOURT6745ZMBZEGWQH6QVUS). And it is calculated by combined margin(CM) based on data in 2000~2004 shown by source the yearly book of KEPCO 2001~2005. The value is calculated as ACM0002 option 1, ex-ante based.
Any comment:	Very minor contribution

Data / Parameter:	M_i
Data unit:	Hour
Description:	Measuring interval
Source of data used:	Defined in the technical specifications of data logging system
Value applied:	1 hour
Justification of the	QA/QC procedures will be applied by regular maintenance of the data logging

choice of data or description of measurement methods and procedures actually applied :	system.
Any comment:	No.

Annex-2

Data / Parameter:	*ER_y*
Data unit:	Ton CO_2e
Description:	Emissions Reductions of the project activity
Source of data to be used:	Monitoring system
Value of data	221,995ton CO_2e
Description of measurement methods and procedures to be applied:	As per the supplement sheet

Data / Parameter:	*BE_y*
Data unit:	Ton CO_2e
Description:	Baseline emission
Source of data to be used:	Monitoring system
Value of data	264,913ton CO_2e
Description of measurement methods and procedures to be applied:	As per the supplement sheet

Data / Parameter:	*PE_y*
Data unit:	Ton CO_2e
Description:	Project emission
Source of data to be used:	Monitoring system
Value of data	42,717ton CO_2e
Description of measurement methods and procedures to be applied:	As per the supplement sheet

Data / Parameter:	*PE_ND,y*
Data unit:	Ton CO_2e

Description:	Project emission from N_2O not destroyed
Source of data to be used:	Monitoring system
Value of data	39,415ton CO_2e
Description of measurement methods and procedures to be applied:	As per the supplement sheet

Data / Parameter:	*PE_DF,y*
Data unit:	Ton CO_2e
Description:	Project emission from destruction facility
Source of data to be used:	Monitoring system
Value of data	3,302 ton CO_2e
Description of measurement methods and procedures to be applied:	Calculation as per the supplement sheet

Data / Parameter:	*LE_y*
Data unit:	Ton CO_2e
Description:	Leakage
Source of data to be used:	Monitoring system
Value of data	201 ton CO_2e
Description of measurement methods and procedures to be applied:	Calculation as per the supplement sheet

Annex-3

The parameters to be monitored are listed below.

Data / Parameter:	$F_{TE,i}$
Data unit:	Nm^3
Description:	Volume flow rate at the exit of gas the destruction facility
Source of data to be used:	Flow meter
Value of data	**286,411,680** Nm^3 **(total volume from 01/January/2009 to 31/Dec/2009, from the actual data)**
Description of measurement methods and procedures to be applied:	● Measuring device : Multiple-point sampling tube type flow meter ● Measuring period : Continuously ● Data record : New logging system ● Sampling range :0–60,000 Nm^3/hr Flow metering system will automatically record continuously volume flow adjusted to standard temperature and pressure. The estimated total uncertainty is 3.2%.
QA/QC procedures to be applied:	Refer to QA / QC procedures cited below. FTI Both parameters shall be cross-checked to ensure that no leak of N_2O is taking place. In case of discrepancy, conservative calculation of emission reduction shall be provided.
Any comment:	In the event that the monitoring system is down, as referring to PDD, the highest measured byproduct rate during the project activity will be applied for the downtime period for the campaign emission factor.

Data / Parameter:	$CO_{N2O,i}$
Data unit:	tN_2O/Nm^3
Description:	N_2O concentration at destruction facility outlet.
Source of data to be used:	Non-dispersion infrared absorption analyzer (NDIR)
Value of data	**4.381981 E-07** tN_2O/Nm^3 (=**223** ppmv*44/22.4)

	(average concentration from 01/January/2009 to 31/Dec/2009, from the actual data)
Description of measurement methods and procedures to be applied:	● Measuring device : Non-dispersion infrared absorption analyzer ● Measuring period : Continuously ● Data record : New logging system ● Sampling range : 0–500 ppmv until Oct 19, 2007 and 0-300ppmv from Oct 20, 2007 which is based on the PDD. At the initial stage, we started operation with the range of 0-500 ppmv. After a few months operation, the operator found that the range of 0-300 ppmv will be suitable, so we revised it from Oct. 20, 2007. The estimated total uncertainty is 2.84%.
QA/QC procedures to be applied:	In case Non-dispersion infrared absorption analyzer is used, it shall be checked by sampling by gas chromatography periodically. QA/QC for the analyzer shall be subjected to the EN14181 or equivalent standards available in the Republic of Korea.
Any comment:	In the event that the monitoring system is down, the highest measured byproduct rate during the project activity will be applied for the downtime period for the campaign emission factor.

Data / Parameter:	$P_{product,y}$
Data unit:	$tHNO_3$
Description:	Plant output of HNO_3.
Source of data to be used:	ERP (Enterprise Resource Planning) Report and magnetic flow meter
Value of data	**85,587**$tHNO_3$ **(total volume from 01/January/2009 to 31/Dec/2009, from the actual data)**
Description of measurement methods and procedures to be applied:	● Measuring device : Magnetic flow meter ● Measuring period : Continuously ● Data record : Existing ERP (Enterprise Resource Planning) Report The magnetic flow meter can measure the range of 0-30 m^3/hr. And its error % is average ±0.3% based on full scale.
QA/QC procedures to be applied:	Cross – check of production, marketing and stock change data. Measurement devices such as weighbridge can be subjected to QA /QC scheme consistent with the procedures in T_g, P_g, $F_{TI,i}$, $F_{TE,i}$, $C_{ON2O,i}$, $CI_{N2O,i}$, M_i, $Q_{HC,y}$ and SE_{N2O}, with respect to equipment certification, installation and performance.
Any comment:	No.

Data / Parameter:	$F_{TI,i}$
Data unit:	Nm^3
Description:	Volume flow rate at the inlet of the destruction facility
Source of data to be used:	Flow meter
Value of data	**276,774,482** Nm^3 **(total volume from 01/January/2009 to 31/Dec/2009, from the actual data)**
Description of measurement methods and procedures to be applied:	● Measuring device : Multiple-point sampling tube type flow meter ● Measuring period : Continuously ● Data record : New logging system ● Sampling range :0–60,000 Nm^3/hr Flow metering system will automatically record continuously volume flow rate adjusted to standard temperature and pressure. The estimated total uncertainty is 3.2%.
QA/QC procedures to be applied:	Refer to QA / QC procedures cited below. FTI Both parameters shall be cross-checked to ensure that no leak of N_2O is taking place. In case of discrepancy, conservative calculation of emission reduction shall be provided.
Any comment:	In the event that the monitoring system is down, the lowest between the conservative default value established in the methodology or the last measured byproduct rate (whichever the lower) will be valid and applied for the downtime period for the baseline emission factor.

Data / Parameter:	$CI_{N2O,i}$
Data unit:	tN_2O/m^3
Description:	N_2O concentration at destruction facility inlet.
Source of data to be used:	Non-dispersion infrared absorption analyzer (NDIR)
Value of data	**3.008098 E-06** tN_2O/Nm^3 (=**1,532** ppmv*44/22.4) **(average concentration from 01/January/2009 to 31/Dec/2009, from the actual data)**
Description of	● Measuring device : Non-dispersion infrared absorption analyzer ● Measuring period : Continuously

measurement methods and procedures to be applied:	● Data record : New logging system ● Sampling range :0–3,000 ppmv The estimated total uncertainty is 2.85%.
QA/QC procedures to be applied:	In case Non-dispersion infrared absorption analyzer is used, it shall be checked by sampling by gas chromatography periodically. QA/QC for the analyzer shall be subjected to the EN14181 or equivalent standards available in the Republic of Korea. Refer to Annex 4.
Any comment:	In the event that the monitoring system is down, the lowest between the conservative default value established in the methodology or the last measured byproduct rate (whichever the lower) will be valid and applied for the downtime period for the baseline emission factor.

Data / Parameter:	T_g
Data unit:	°C
Description:	Actual operating temperature of the ammonia oxidation reactor
Source of data to be used:	Thermo-couple (Type "R")
Value of data	Not needed.
Description of measurement methods and procedures to be applied:	● Measuring device : Existing thermo-couple ● Measuring period : Continuously ● Measuring range : 0 - 1,200 ℃ Data record : Existing DCS system (distributed control system) This parameter is measured at catalyst basket filled with Raschig ring Estimated uncertainty from temperature measurement with thermo-couple : ± 6 ℃ If the actual average daily operating temperature in the ammonia oxidation reactor (T_g) is outside this "permitted range", the baseline N_2O emissions for that period are capped at 4.5kgN_2O/tonne of nitric acid conservatively applying the IPCC default value.
QA/QC procedures to be applied:	Maintenance and testing regime

Any comment:	To check whether "normal" operation is undertaken.

Data / Parameter:	P_g
Data unit:	Pa
Description:	Actual operating pressure ammonia of the oxidation reactor
Source of data to be used:	Pressure transmitter
Value of data	Not needed.
Description of measurement methods and procedures to be applied:	● Measuring device : Existing pressure transmitter ● Measuring period : Continuously ● Measuring range : 0-16 kgf/cm^2 gauge ● Measuring point : Two points. One is between air compressor and NH_3 air mixer (since Jan.2000), and another is between NH_3 air mixer and NH_3 air filter (since Jan.2005). $P_{g,hist}$ is based on data measured at the former which the number of acquisition records is larger. ● Data record : Existing DCS system (distributed control system) Estimated uncertainty from this pressure measurement: ±4.0 Pa If the actual average daily operating pressure in the ammonia oxidation reactor (P_g) is outside this "permitted range", the baseline N_2O emissions for that period are capped at 4.5kgN_2O/tonne of nitric acid conservatively applying the IPCC default value. As mentioned in the Item 9.2. (page-15), Nitric Acid Plant was operated outside the permitted range of pressure in 36days during the period for which IPCC default value was applied.
QA/QC procedures to be applied:	Maintenance and testing regime
Any comment:	To check whether "normal" operation is undertaken.

Data / Parameter:	G_{sup}
Data unit:	-
Description:	Supplier's information of the ammonia oxidization catalyst
Source of data to be	Ammonia oxidization catalyst supplier

used:	
Value of data	Name of supplier: **Johnson Matthey**
Description of measurement methods and procedures to be applied:	HWC will most likely use Johnson Matthey in the future. However, HWC does not guarantee to use only Johnson Matthey in the future. So the supplier's information will be monitored.
QA/QC procedures to be applied:	Not needed
Any comment:	No.

Data / Parameter:	G_{com}
Data unit:	%
Description:	Composition of the ammonia oxidization catalyst
Source of data to be used:	Ammonia oxidization catalyst supplier
Value of data	Pt: **95** %, Rh: **5** %
Description of measurement methods and procedures to be applied:	HWC has been using the Pt 95%, Rh 5% catalyst of Johnson Matthey. HWC will use the catalyst which is common practice in the region and supplied by a reputable manufacturer or which composition is reported as being in use in the relevant literature.
QA/QC procedures to be applied:	Not needed
Any comment:	No.

Data / Parameter:	$A_{\mathrm{OR},d}$
Data unit:	tNH_3/day
Description:	Actual ammonia flow rate to the ammonia oxidation reactor
Source of data to be used:	Orifice flow meter and differential pressure transmitter
Value of data	If the daily ammonia input to oxidation reactor ($A_{\mathrm{OR},d}$) exceeds maximum histrical ammonia input to oxidation reactor ($A_{\mathrm{OR,hist}}$), the baseline N_2O emissions for thet period are capped at 4.5kg N_2O/tonne of nitric acid conservatively applying the IPCC default value.

Description of measurement methods and procedures to be applied:	• Measuring device : Orifice flow meter and differential pressure transmitter • Measuring period : Continuously • Measuring range : 0-6,000 Nm^3/hr • Measuring position : NH_3 air mixer • Data record : Existing DCS system (distributed control system) Estimated uncertainty from this flow measurement : ± 5,760 Nm^3/day (= 4.4 tonNH_3/day
QA/QC procedures to be applied:	Maintenance and testing regime
Any comment:	To check whether "normal" operation is undertaken.

Data / Parameter:	$EI_{RCS,y}$
Data unit:	MWh/yr
Description:	Additional electricity input for running the DeN_2O unit
Source of data to be used:	Wattmeter or electricity accumulator
Value of data	**324,580** KWh (01/January/2009—31/Dec/2009)
Description of measurement methods and procedures to be applied:	• Measuring device : Wattmeter or electricity accumulator • Measuring period : Monthly • Data record : Handwriting
QA/QC procedures to be applied:	Not needed because its contribution is much below the uncertainty level
Any comment:	No.

Data / Parameter:	$Q_{NG,y}$
Data unit:	Nm^3
Description:	Hydrocarbon (natural gas) input
Source of data to be used:	Vortex flow meter or other measuring device
Value of data	**230,313** Nm^3 (01/January/2009—31/Dec/2009)
Description of measurement methods and procedures to be	• Measuring device : Vortex flow meter • Measuring period : Once a day • Data record : New data logger

applied:	Estimated uncertainty from this flow measurement : ± 21.6 Nm^3/day
QA/QC procedures to be applied:	Not needed because its contribution is much below the uncertainty level Flow of hydrocarbon is measured at atmospheric condition. Temperature and pressure adjustments are preferable but not necessary if it costs a lot.
Any comment:	This parameter is shown in normal condition (0 ^{o}C,1atm).

Data / Parameter:	C_{HNC}
Data unit:	%
Description:	Methane content of hydrocarbon (natural gas)
Source of data to be used:	Hydrocarbon supplier
Value of data	**91.2817** %
Description of measurement methods and procedures to be applied:	Data from local supplier ● Measuring period : Monthly ● Data record : Handwriting ● Name of supplier : Kyungdong City Gas Corporation
QA/QC procedures to be applied:	Not needed.
Any comment:	No.

Data / Parameter:	$Q_{NMHC,y}$
Data unit:	Nm^3
Description:	Hydrocarbon (Non-methane part of the natural gas) input
Source of data to be used:	Calculated by the flow rate and the methane content of the natural gas
Value of data	**20,079.38** Nm^3 This parameter is calculated as follows; $Q_{NMHC,y} = Q_{NG,y} * (1 - C_{HNC}/100)$
Description of measurement methods and procedures to be applied:	Calculated by the flow rate and the methane content of the natural gas

QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown in normal condition (0 ^{o}C,1atm).

Data / Parameter:	$Q_{HNC,y}$
Data unit:	Nm^3
Description:	Methane (Methane part of the natural gas) used
Source of data to be used:	Calculated by the flow rate and the methane content of the natural gas
Value of data	**210,233.62** Nm^3 This parameter is calculated as follows; $Q_{HNC,y} = Q_{NG,y} * C_{HNC}/100$
Description of measurement methods and procedures to be applied:	Calculated by the flow rate and the methane content of the natural gas
QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown in normal condition (0 ^{o}C,1atm).

Data / Parameter:	ρ_{NG}
Data unit:	t/Nm^3
Description:	Density of the hydrocarbon (natural gas).
Source of data to be used:	Hydrocarbon supplier
Value of data	**0.0007969** t/Nm^3
Description of measurement methods and procedures to be applied:	Data from local supplier ● Measuring period : Monthly ● Data record : Handwriting ● Name of supplier : Kyungdong City Gas Corporation
QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown by the density in normal condition (0 ^{o}C,1atm).

Data / Parameter:	ρ_{HNC}
Data unit:	t/Nm^3
Description:	Density of the hydrocarbon (Methane part of the natural gas).
Source of data to be used:	Theoretical calculation
Value of data	0.000714 t/Nm^3 (=16gCH_4/22.4)
Description of measurement methods and procedures to be applied:	Can be theoretically calculated in case of the normal condition (0℃,1atm).
QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown by the density in normal condition (0 ^{o}C,1atm).

Data / Parameter:	ρ_{NMHC}
Data unit:	t/Nm^3
Description:	Density of the hydrocarbon (Non-methane part of the natural gas).
Source of data to be used:	Calculated by data of the natural gas and methane
Value of data	**0.001664873** t/Nm^3 This parameter is calculated as follows; $\rho_{NMHC} = (\rho_{NG} - \rho_{HNC} * C_{HNC}/100)/ (1-(C_{HNC}/100)$
Description of measurement methods and procedures to be applied:	Calculated by data of the natural gas and methane
QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown by the density in normal condition (0 ^{o}C,1atm).

Data / Parameter:	NCV_{NG}
Data unit:	Kcal/Nm^3

Description:	Net calorific value of the natural gas
Source of data to be used:	Hydrocarbon supplier
Value of data	**10,413** kcal/Nm^3
Description of measurement methods and procedures to be applied:	Local data are preferable. ● Measuring period : Monthly ● Data record : Handwriting
QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown by the net calorific value in normal condition (0 ^oC,1atm).

Data / Parameter:	EF_{NG}
Data unit:	tCO_2/tNG
Description:	Emission factor of the hydrocarbon (natural gas)
Source of data to be used:	IPCC 1996 GHG Inventory Guidelines and data provided by the natural gas supplier
Value of data	**3.06**tCO_2/tNG This parameter is calculated as follows; $EF_{NG} = COEF_{NG} *44/12*NCV_{NG} *4.18605/\rho_{NG} *10^{-9}$ where $COEF_{NG}$: Hydrocarbon emission factor [tC/TJ] 15.3[tC/TJ]by IPCC 1996 GHG Inventory Guidelines
Description of measurement methods and procedures to be applied:	Calculated by IPCC defoult value and data provided by the natural gas supplier
QA/QC procedures to be applied:	Not needed.
Any comment:	No.

Data / Parameter:	EF_{HNC}
Data unit:	tCO_2/tCH_4
Description:	Emission factor of methane

Source of data to be used:	Theoretical calculation
Value of data	2.75(tCO_2/tCH_4) =(44 gCO_2/16gCH_4)
Description of measurement methods and procedures to be applied:	Theoretical calculation
QA/QC procedures to be applied:	Not needed.
Any comment:	No.

Data / Parameter:	EF_{NMHC}
Data unit:	tCO_2/tNMHC
Description:	Emission factor of hydrocarbon (Non-methane part of the natural gas)
Source of data to be used:	Calculated by data of the natural gas and methane
Value of data	**4.4991** tCO_2/tNMHC This parameter is calculated as follows; $EF_{NMHC} = (EF_{NG} * \rho_{NG} - EF_{HNC} * \rho_{HNC} * C_{HNC}/100) / (1 - C_{HNC}/100) / \rho_{NMHC}$
Description of measurement methods and procedures to be applied:	Calculated by data of the natural gas and methane
QA/QC procedures to be applied:	Not needed.
Any comment:	No.

Data / Parameter:	$Type_{HC}$
Data unit:	-
Description:	Hydrocarbon (natural gas) supplier information
Source of data to be used:	Hydrocarbon supplier

Value of data	Kyungdong City Gas Corporation
Description of measurement methods and procedures to be applied:	For this project, natural gas will be used, but this parameter is monitored.
QA/QC procedures to be applied:	Not needed.
Any comment:	No.

Data / Parameter:	$QR_{N2O,y}$
Data unit:	tN_2O
Description:	Regulation based on annual quantity N_2O limited
Source of data to be used:	National environmental legislation in the Republic of Korea In case national regulations concerning N_2O emissions are implemented during the crediting period, the impact on baseline N_2O emissions is considered without any delay by adjusting the measured N_2O emissions at the time the regulation has to be implemented.
Value of data	Baseline N_2O emissions are limited by the absolute quantity of N_2O emissions given by the regulation. If the measured baseline N_2O emissions are exceeding the regulatory limit, then measured baseline N_2O emissions are substituted by the regulatory limit.
Description of measurement methods and procedures to be applied:	If, $QI_{N2O,y} > QR_{N2O,y}$ then, $BE_{N2O,y} = QR_{N2O,y}$ else, $BE_{N2O,y} = \min \text{ of } [QI_{N2O,y}, SE_{N2O,y} * P_{product,max}]$ where: $QI_{N2O,y}$: Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O) $QR_{N2O,y}$: Regulatory limit of N_2O emissions in year y (tN_2O) $BE_{N2O,y}$: Baseline emissions of N_2O in year y (tN_2O) $SE_{N2O,y}$: Specific N_2O emissions per unit of output of nitric acid in year y ($tN_2O/tHNO_3$) $P_{product,y}$: Production of nitric acid in year y ($tHNO_3$) The quantity of N_2O emissions at the inlet of the N_2O destruction facility (DF) is calculated based on continuous measurement of the tail gas volume flow rate and the N_2O concentration at the inlet of the N_2O destruction facility.

QA/QC procedures to be applied:	Not needed.
Any comment:	Change in NO_X or N_2O regulations will automatically cause a re-assessment of the baseline scenario.

Data / Parameter:	$RSE_{N2O,y}$
Data unit:	$tN_2O/tHNO_3$
Description:	Regulation based on N_2O emissions per unit of nitric acid
Source of data to be used:	National environmental legislation in the Republic of Korea In case national regulations concerning N_2O emissions are implemented during the crediting period, the impact on baseline N_2O emissions is considered without any delay by adjusting the measured N_2O emissions at the time the regulation has to be implemented.
Value of data	Regulation setting of a threshold for specific N_2O emissions per unit of product
Description of measurement methods and procedures to be applied:	If, $SE_{N2O,y} > RSE_{N2O}$ then, $BE_{N2O,y}$ = min of [$RSE_{N2O} * P_{product,y}$, $SE_{N2O,y} * P_{product,max}$] else, $BE_{N2O,y}$ = min of [$QI_{N2O,y}$, $SE_{N2O,y} * P_{product,max}$] where: $SE_{N2O,y}$: Specific N_2O emissions per unit of output of nitric acid in year y ($tN_2O/tHNO_3$) RSE_{N2O} : Regulatory limit of N_2O emissions per unit of output of nitric acid ($tN_2O/tHNO_3$) $BE_{N2O,y}$: Baseline emissions of N_2O in year y (tN_2O) $P_{product,y}$: Production of nitric acid in year y ($tHNO_3$) $QI_{N2O,y}$: Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O) The specific N_2O emissions per unit of output of nitric acid is defined as: $SE_{N2O,y} = QI_{N2O,y} / P_{product,y}$ where: $SE_{N2O,y}$: Specific N_2O emissions per unit of output of nitric acid in year y ($tN_2O/tHNO_3$) $QI_{N2O,y}$: Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O) $P_{product,y}$: Production of nitric acid in year y ($tHNO_3$)

	The quantity of N_2O emissions at the inlet of the N_2O destruction facility is calculated based on continuous measurement of the tail gas volume flow rate and the N_2O concentration at the inlet of the N_2O destruction facility.
QA/QC procedures to be applied:	Not needed.
Any comment:	Change in NO_X or N_2O regulations will automatically cause a re-assessment of the baseline scenario.

Data / Parameter:	$CR_{N2O,y}$
Data unit:	tN_2O/m^3
Description:	Regulation based on N_2O concentration in tail gas limited
Source of data to be used:	National environmental legislation in the Republic of Korea In case national regulations concerning N_2O emissions are implemented during the crediting period, the impact on baseline N_2O emissions is considered without any delay by adjusting the measured N_2O emissions at the time the regulation has to be implemented.
Value of data	Regulation setting of a threshold for N_2O concentration in the tail gas
Description of measurement methods and procedures to be applied:	If, $CN_{2O,y} > CR_{N2O}$ then $BE_{N2O,y} = \sum_{i=1}^{n} C_{N2O,i} * [F_{TG,i} * M_i]$ where $C_{N2O,i}$ is min [C_{N2O},y, CR_{N2O}, and {($SE_{N2O,y}$ *$P_{product,max}$)/(sum($F_{TE,i}$ * M_i)}] else, $BE_{N2O,y} = QI_{N2O,y}$ where: $C_{N2O,I}$: N_2O concentration a destruction facility inlet during interval i (tN_2O/m^3) $CR_{N2O,i}$: Regulatory limit for specific N2O concentration during interval i (tN_2O/m^3) $BE_{N2O,y}$: Baseline emissions of N_2O in year y (tN_2O) $F_{TE,i}$: Volume flow rate at the exit of the destruction facility during interval i (m^3/h) M_i : Length of measuring interval i (h) i : interval n : number of intervals during the year $QI_{N2O,y}$: Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O)

	The quantity of N_2O emissions at the inlet of the N_2O destruction facility is calculated based on continuous measurement of the tail gas volume flow rate and the N_2O concentration at the inlet of the N_2O destruction facility.
QA/QC procedures to be applied:	Not needed.
Any comment:	Change in NO_X or N_2O regulations will automatically cause a re-assessment of the baseline scenario.