

Mitsubishi Corporation

2-3-1, Marunouchi, Chiyoda-ku, Tokyo, Japan

CDM Monitoring Report No.1 :

“ Catalytic N₂O 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 June 27, 2007 to December 31, 2007

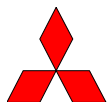
**Version 1
January 28, 2008**

Mitsubishi Corporation

2-3-1, Marunouchi, Chiyoda-ku, Tokyo, Japan

Tel : +81 3 6405 7574

Fax: +81 3 6405 7708

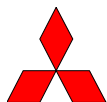


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Table of Contents

1. Introduction	page 3
2. Reference	page 3
3. Definition	page 4
4. General Description of Project	
4.1 Project Activity	page 4
4.2 General Introduction	page 4
4.3 Process Chart	page 5
4.4 Project Participants	page 5
4.5 Focal Point	page 6
5. Baseline Methodology	
5.1 Justification of the Baseline Methodology	page 6
5.2 Project Boundary	page 6
6. Monitoring Methodology and Plan	page 8
7. Quality Control (QC) and Quality Assurance (QA)	
7.1 Quality Management System	page 8
7.2 Quality Control and Quality Assurance Procedures undertaken data monitored	page 9
7.3 Calibration and Maintenance	page 9
7.4 Environmental Impact	page 9
8. GHG Calculation	
8.1 Baseline Emissions	page 10
8.2 Project Emissions	page 11
8.3 Leakage Emissions	page 13
8.4 Emission Reductions	page 13
9. Monitoring against baseline requirement	
9.1 Operating Temperature	page 13
9.2 Operating Pressure	page 13
9.3 Composition of the Ammonia Oxidation Catalyst	page 13
9.4 Ammonia Flow Rate to the Ammonia Oxidation Reactor	page 14
9.5 Production of Nitric Acid	page 14
Annex-1	page 15



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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 June 27, 2007 to December 31, 2007 as the period of first 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 has implemented the project of GHG emission reduction by abating N₂O 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 N₂O Destruction in tail gas of Nitric Acid or Caprolactam Production Plants”.

Approved Monitoring Methodology :

AM0028 Version 3 : “Catalytic N₂O Destruction in tail gas of Nitric Acid or Caprolactam Production Plants”.

Project Design Document :

“Catalytic N₂O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea”

Version : 08

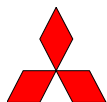
Date : November 17, 2006

Validation Report :

Validation of the CDM Project : “Catalytic N₂O 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 Industrie Service GmbH, Germany.

Report No. : 910471

Date : November 21, 2006



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CDM Registration :

“Catalytic N₂O 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

y : Monitoring Period “in this report, June 27, 2007 to December 31, 2007.”, which is exactly 188 days.

PDD : Project Design Document of this project “Catalytic N₂O 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 N₂O. In the production process of nitric acid (HNO₃), NO is produced as an intermediate material from ammonia (NH₃). The associated chemical reactions of oxidizing ammonia and simultaneous unwanted reactions are as follows :

4.2 General Introduction :

Nitrous oxide (N₂O) 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 ;



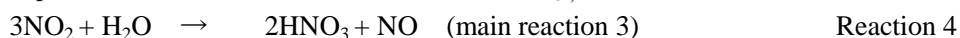
Ammonia (NH₃) combustion to form nitric oxide (NO) ;



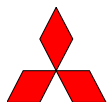
NO is oxidized to nitrogen dioxide (NO₂) ;



Absorption of NO₂ in water to form nitric acid HNO₃ ;



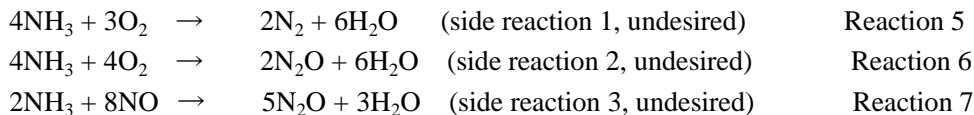
Simultaneously nitrous oxide (N₂O), nitrogen (N) and water (H₂O) are formed as well, in accordance



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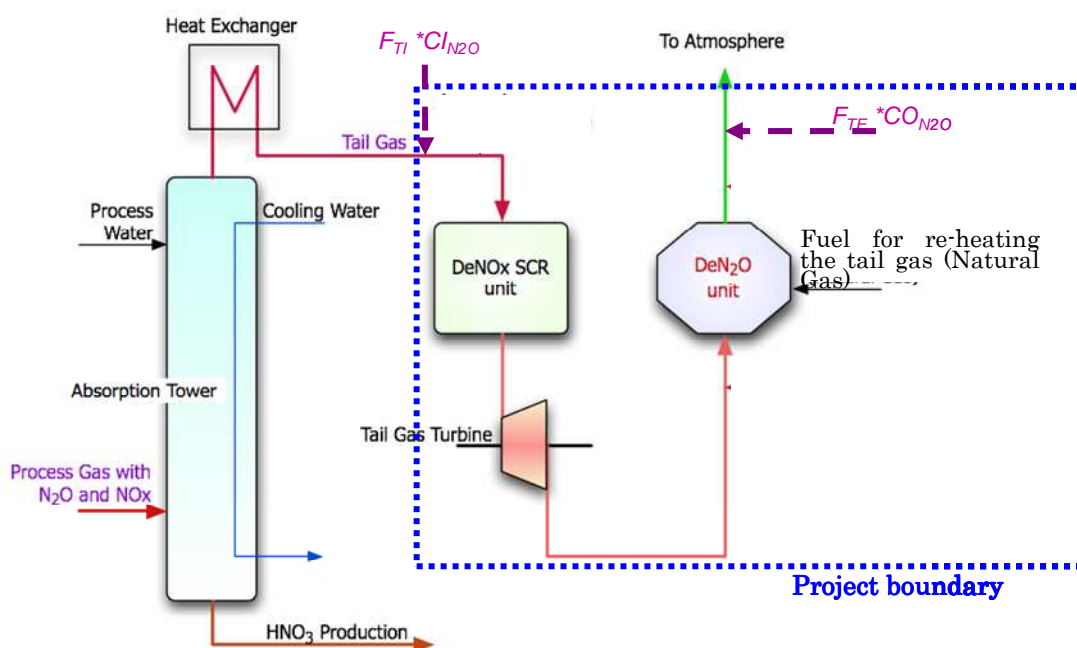
with the following equations :



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 NH_3 SCR before the Stack, has been introduced and N_2O is decomposed as below : (side reaction 2, undesired)



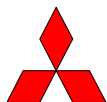
4.3 Process Chart



DeNOx unit based on NH_3 SCR process has been installed in July, 2005, about 2 years before the installation of DeN₂O 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)
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Republic of Korea (host)	Hanwha Corporation (HWC) [owner and operator of the nitric acid plant]
	Mitsubishi Corporation (Korea) Ltd. [developer and co-financer of this CDM project]
Japan	Mitsubishi Corporation [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 N₂O 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:

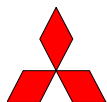
- 1) The methodology is applied to the existing design production capacity of Nitric Acid Plant which was installed before December 31, 2005.
- 2) HWC has not installed any N₂O destruction or abatement technologies prior to the start of the project.
- 3) The project activity does not affect the nitric acid production level.
- 4) The applied technology is the tail gas system. Therefore, the project activity does not cause the increase of NO_x emissions.
- 5) Selective Catalytic Reduction (SCR) DeNO_x unit was installed prior to the project activity.
- 6) N₂O concentration in the flow at the inlet and the outlet of catalytic N₂O 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 N₂O 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 :



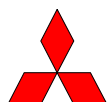
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Source	Gas		Explanations
Emissions of N ₂ O as a result of side reaction to the nitric acid production process	N ₂ O	Included	Main emission source, taking national N ₂ O emission regulations into account.
Emissions related to the production of ammonia used for NO _x reduction	CO ₂ CH ₄ N ₂ O	Included	Since SCR DeNO _x 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 NO _x reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation.
N ₂ O emissions from SCR DeNO _x -unit	N ₂ O	Excluded	The presence of a SCR DeNO _x unit tends to increase the N ₂ O emissions. Therefore the ex post measurement of the baseline emissions at the inlet of the N ₂ O destruction facility represents a conservative determination of the baseline N ₂ O emissions.

5.2 Project Emissions and Leakage:

Source	Gas		Explanations
Emissions of N ₂ O as a result of side reaction to the nitric acid production process (project emissions)	N ₂ O	Included	Main emission source that remains in the tail gas after the N ₂ O destruction facility
Emissions related to the production of ammonia used for NO _x reduction (project emissions)	CO ₂ CH ₄ N ₂ O	Included	Since SCR DeNO _x 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 NO _x 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 ₂ O	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.



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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 ₂ O	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 ₂ O	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 N₂O 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 N₂O emissions either by catalytic decomposition or catalytic reduction of N₂O 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.

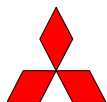
7 Quality Control (QC) and Quality Assurance (QA)

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



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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 N₂O for the project will be responsible by Production Team and the operation and maintenance of N₂O Monitoring system will incorporate the ISO9001 / 2000 standard procedures. The Monitoring of the relevant data will be done by the N₂O Monitoring System and recorded onto the electric media.

Production Team will be appointed to be responsible for the operation of the N₂O 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 Methodology 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 the national Environmental Law in Korea, Environmental Impacts are :

Gaseous matter : There is no additional pollution. The N₂O destructed into harmless N₂ and O₂.

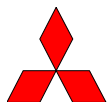
Particular matter : There is no additional pollution.

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



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In terms of the Approved Methodology (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 (tCO₂e)
 BE_y baseline emissions during the year y (tCO₂e)
 PE_y project emissions during the year y (tCO₂e)
 LE_y leakage emissions in the year y (tCO₂e)

8.1. Baseline Emissions :

It has been checked that there are no Korean regulation in place that would limit the quality of N₂O 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 N₂O emitted in the baseline scenario, taking national regulations, production levels and operating conditions into consideration. The quantity of N₂O is determined based on the measurement of the N₂O at the inlet of DeNOx unit, which results in a conservative estimation of baseline emissions.

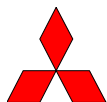
Baseline emissions are limited to the design capacity of the nitric acid plant, According to AM0028 version 3, the design capacity is measured in tons of nitric acid per year. The actual nitric acid production in the covered monitoring period does not exceed the design capacity.

$$BE_y = \text{Minimum}(P_{\text{product,max}} \quad P_{\text{product,y}} / P_{\text{product,max}} * \sum_{i=1}^n [F_{\text{TL,i}} * CI_{\text{N}_2\text{O,i}} * M_i * GWP_{\text{N}_2\text{O}}]$$

i : Interval,
 n : Number of intervals during the year (1/yr),
 F_{TL,i} : Volume flow rate at the inlet of the destruction facility during interval i (Nm³/h),
 CI_{N₂O,i} : N₂O concentration a destruction facility inlet during interval i (tN₂O/Nm³),
 GWP_{N₂O} : Global warming potential of N₂O,
 P_{product,max} : Design capacity (tHNO₃/yr), and
 P_{product,y} : Production of nitric acid in a year y (tHNO₃/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 N₂O emissions for that period are capped at 4.5kgN₂O/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 N₂O baseline emissions.



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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 N₂O 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 N₂O 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 N₂O 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 N₂O emissions of previous periods (tN₂O/tHNO₃), 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 N₂O emissions per ton HNO₃ of product of nitric acid in year y (tN₂O/tHNO₃)

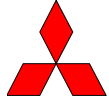
In the event that the monitoring system is down, the lowest between the conservative default value established in the methodology or the last measured byproduct rate (whichever the lower) will be valid and applied for the downtime period for the baseline emission factor, and the highest measured byproduct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

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

8.2. Project Emissions :

The emissions due to the project activity are composed of (a) the emission of not destroyed N₂O and (b) emissions from auxiliary hydrocarbons input resulting from the operation of the nitric acid plant. N₂O emissions not destroyed by the project activity are calculated based on the continuous measurement of the N₂O 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 N₂O 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



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covered monitoring period does not exceed the design capacity.

$$\begin{aligned} PE_{_y} &= PE_{ND,y} + PE_{DF,y} \\ &= PE_{ND,y} + HCE_{C,y} + HCE_{NC,y} \end{aligned}$$

- $PE_{ND,y}$: 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)

$$PE_{ND,y} = \sum_{i=1}^n [F_{TE,i} * CO_{N_2O,i} * M_i * GWP_{N_2O}]$$

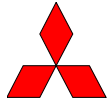
- i : Interval,
 n : Number of intervals during the year (1/yr)
 $F_{TE,i}$: Volume flow rate at the exit of the destruction facility during interval i (Nm^3/h),
 $CO_{N_2O,i}$: N_2O concentration in the tail gas of the N_2O destruction facility during interval i (tN_2O/Nm^3),
 M_i : Length of measuring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

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.

$$\begin{aligned} HCE_{C,y} &= \rho_{NMHC} * Q_{NMHC,y} * OXID_{NMHC}/100 * EF_{NMHC} + \rho_{HNC} * Q_{HNC,y} * OXID_{CH_4}/100 * EF_{HNC} \\ &= \rho_{NMHC} * Q_{NMHC,y} * EF_{NMHC} \end{aligned}$$

$$\begin{aligned} HCE_{NC,y} &= \rho_{HNC} * Q_{HNC,y} * (1 - OXID_{CH_4}/100) * GWP_{CH_4} \\ &= \rho_{HNC} * Q_{HNC,y} * GWP_{CH_4} \end{aligned}$$

- 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),
 $OXID_{CH_4}$: Oxidation factor of methane (Methane part of the natural gas) (%), and
 GWP_{CH_4} : Global warming potential of methane.



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For this project, fraction of Methane not converted is not be measured due to unreasonable costs.

So, 0% is applied to $\text{OXID}_{\text{CH}_4}$ and 100% is applied to $\text{OXID}_{\text{NMHC}}$.

8.3. Leakage Emissions :

Additional power such as DeN₂O unit running will be needed by the project implementation. The CO₂ emission related to the electricity consumption is insignificant, but monitored and counted as leakage in conservative manner.

$$\text{LE}_y = \text{EI}_{\text{RCS},y} * \text{EF}_{\text{RCS}}$$

$\text{EI}_{\text{RCS},y}$: Additional electricity input for running the DeN₂O unit (MWh/yr), and

EF_{RCS} : Emissions factor for running the DeN₂O unit.

8.4. Emission Reductions :

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

$$\begin{aligned} \text{ER}_y &= \text{BE}_y - \text{PE}_y - \text{LE}_y \\ &= 133,993.83 - 8,621.81 - 87.74 \\ &= 125,284.28 \end{aligned}$$

The total amount of emission reductions is calculated as **125,284.28 tons CO₂e**.

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 N₂O 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 is within the permitted range for all days covered by this monitoring report.

Parameters are Annex-1

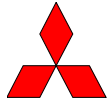
9.2. Operating Pressure

The actual average daily operating pressure in the ammonia oxidation reactor is 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



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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

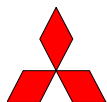
Production of Nitric Acid during the project period is 50,655tons, which is

--- volume of 65% of HNO_3 is 77,932tons

--- $77,932 \times 65\% = 50,655\text{tons}$

whereas, $P_{\text{product,max}}$ specified in the PDD, based on the manufacturer's specification is 107,100tons, which is $306 [\text{HNO}_3/\text{day}] \times 350 [\text{day/yr}]$. Therefore, during the period, maximum production is calculated as $306 \times 188 = 57,528\text{tons}$.

Thus actual production of 50,655tons is less than 57,528tons.



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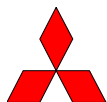
Annex-1

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

Data / Parameter:	GWP_{N_2O}
Data unit:	tCO ₂ e/tN ₂ O
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 2 nd Commitment Period if COP/MOP decided so.

Data / Parameter:	GWP_{CH_4}
Data unit:	tCO ₂ e/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 2 nd Commitment Period if COP/MOP decided so.

Data / Parameter:	Reg _{NO_x}
Data unit:	tNO _x /m ³
Description:	Regulation on NO _x emissions in the Republic of Korea to assessed ex ante
Source of data used:	National environmental legislation in the Republic of Korea
Value applied:	$2.92 * 10^{-7}$ (tNO _x /m ³)



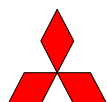
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Justification of the choice of data or description of measurement methods and procedures actually applied:	<p>Clean Air Conservation Act of the Republic of Korea</p> <p>Currently, NO_x regulation requires to limit the emissions below 200 ppmv.</p> <p>By the way, in Onsan plant, NO/NO₂ ratio of the tail gas before NH₃ SCR installation was 2.1 : 1. But after NH₃ SCR installation, NO/NO₂ average ratio has been 4.9 : 1.</p> <p>Therefore, NO_x 200ppmv equals to NO 166ppmv plus NO₂ 34ppmv.</p> <p>NO 166ppmv is 2.22×10^{-7} tonNO/m³ and NO₂ 34ppmv is 0.70×10^{-7} tonNO₂/m³.</p> <p>And the Sum of NO and NO₂ equals to 2.92×10^{-7} tonNO_x/m³.</p>
Any comment:	This is used to check whether the host company complies with the regulation.

Data / Parameter:	$P_{\text{product,max}}$
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:	<p>Specified in the methodology.</p> <p>HWC has experienced maximum daily production 306ton/day in 1992 and maximum operating days 350day in 2002.</p> <p>Therefore, yearly maximum is as follows;</p> <p>306 [HNO₃/day]*350[day/yr]</p>
Any comment:	The amount of emission reductions is capped by $P_{\text{product,max}}$ through the formula (4).

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



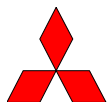
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applied :	If the actual average daily operating temperature in the ammonia oxidation reactor (T_g) is outside this “permitted range”, the baseline N_2O emissions for that period are capped at 4.5kg N_2O /tonne of nitric acid conservatively applying 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
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 :	<p>Specified in the methodology.</p> <p>The permitted range of operating pressures are set based on historical data (Jan.2000—Nov.2003 and Jan.2005—Oct.2006).</p> <p>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.</p> <p>The lower limit is 2.5% lower value of these available data and the upper limit is 2.5% upper value of them.</p> <p>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.</p>
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:



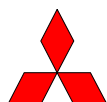
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	Johnson Matthey
Justification of the choice of data or description of measurement methods and procedures actually applied:	Specified in the methodology.
Any comment:	No.

Data / Parameter:	$G_{\text{com,hist}}$
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:	$SE_{\text{N}_2\text{O}}$
Data unit:	kgN ₂ O/tHNO ₃
Description:	N ₂ O emission rate per ton of nitric acid
Source of data used:	Pre-publication Draft 2006 IPCC Guidelines accepted by the 21 st Session of the IPCC
Value applied:	4.5 kgN ₂ O/tHNO ₃
Justification of the choice of data or description of measurement methods and procedures actually applied:	<p>Specified in the methodology.</p> <p>This value is the conservative IPCC default value of Nitric Acid Plants which is based on the default emission factor for low-pressure plants. (5kgN₂O/tonne of nitric acid, accounting for 10% uncertainty factor)</p>



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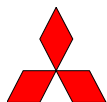
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Any comment:	No.
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Data / Parameter:	$A_{OR,hist}$
Data unit:	tNH ₃ /day
Description:	Maximum of historical ammonia flow rate of the ammonia oxidization reactor
Source of data used:	Production reports
Value applied:	88 tNH ₃ /day
Justification of the choice of data or description of measurement methods and procedures actually applied:	<p>Specified in the methodology.</p> <p>This is a maximum value of daily ammonia flow rates based on historical data (Jan.2000—Nov.2003 and Jan.2005—Oct.2006).</p> <p>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 N₂O emissions for that period are capped at 4.5kgN₂O/tonne of nitric acid conservatively applying the IPCC default value.</p>
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 :	<p>Specified in the methodology.</p> <p>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.</p>
Any comment:	Very minor contribution

Data / Parameter:	$OXID_{CH_4}$
Data unit:	%
Description:	Oxidization factor of methane (Methane part of the natural gas)
Source of data used:	AM0028 version03



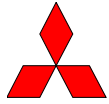
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Value applied:	0%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Specified in the methodology. For this project, fraction of methane not converted will not be measured due to unreasonable costs, so 0% is applied for this parameter based on AM0028 version03.
Any comment:	No.

Data / Parameter:	EF_{RCS}
Data unit:	
Description:	Emission factor of the electricity for running the DeN ₂ O unit
Source of data used:	Government of the Republic of Korea
Value applied:	0.62 (tCO ₂ e/MWh) for national power grid in the Republic of Korea(the Korea Electrical Power Company (KEPCO)).
Justification of the choice of data or description of measurement methods and procedures actually applied :	The emission factor is referring to Baseline Emissions Factor described in PDD of "Youngduk Wind Park Project" which was already registered as CDM. And it is calculated by combined margin(CM) based on data in 2000-2004 shown by source the yearly book of KEPCO 2001-2005.
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 choice of data or description of measurement methods and procedures actually applied :	QA/QC procedures will be applied by regular maintenance of the data logging system.

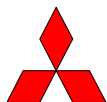


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Any comment:

No.



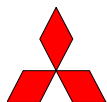
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The parameters to be monitored are listed below.

Data / Parameter:	$F_{TE,i}$
Data unit:	Nm ³ /h
Description:	Volume flow rate at the exit of gas the destruction facility
Source of data to be used:	Flow meter
Value of data	170,311,135 Nm³/hr (total volume from 27/June/2007 to 31/Dec/2007, from the actual data)
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Multiple-point sampling tube type flow meter ● Measuring period : Continuously ● Data record : New logging system ● Sampling range :0–60,000 m³/hr <p>Flow metering system will automatically record continuously volume flow adjusted to standard temperature and pressure.</p> <p>The estimated total uncertainty is 2.5%.</p>
QA/QC procedures to be applied:	<p>Refer to QA / QC procedures cited below. FTI Both parameters shall be cross-checked to ensure that no leak of N₂O is taking place.</p> <p>In case of discrepancy, conservative calculation of emission reduction shall be provided.</p>
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:	$CO_{N2O,i}$
Data unit:	tN ₂ O/Nm ³
Description:	N ₂ O concentration at destruction facility outlet.
Source of data to be used:	Non-dispersion infrared absorption analyzer (NDIR)
Value of data	2.64722 E-07 tN₂O/Nm³ (=135.07 ppmv*44/22.4) (average concentration from 27/June/2007 to 31/Dec/2007, from the actual data)
Description of	<ul style="list-style-type: none"> ● Measuring device : Non-dispersion infrared absorption analyzer



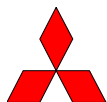
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measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring period : Continuously ● Data record : New logging system ● Sampling range : 0–300 ppmv <p>The estimated total uncertainty is 4%.</p>
QA/QC procedures to be applied:	<p>In case Non-dispersion infrared absorption analyzer is used, it shall be checked by sampling by gas chromatography periodically.</p> <p>QA/QC for the analyzer shall be subjected to the EN14181 or equivalent standards available in the Republic of Korea.</p>
Any comment:	<p>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.</p>

Data / Parameter:	$P_{\text{product},y}$
Data unit:	tHNO ₃ /yr
Description:	Plant output of HNO ₃ .
Source of data to be used:	ERP (Enterprise Resource Planning) Report and magnetic flow meter
Value of data	50,655 tHNO₃ (total volume from 27/June/2007 to 31/Dec/2007, from the actual data)
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Magnetic flow meter ● Measuring period : Continuously ● Data record : Existing ERP (Enterprise Resource Planning) Report <p>The magnetic flow meter can measure the range of 0-30 m³/hr. And its error % is average ±0.3% based on full scale.</p>
QA/QC procedures to be applied:	<p>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, $F_{\text{TL},i}$, $F_{\text{TE},i}$, $C_{\text{ON2O},i}$, $CI_{\text{N2O},i}$, M_i, $Q_{\text{HC},y}$ and SE_{N2O}, with respect to equipment certification, installation and performance.</p>
Any comment:	No.

Data / Parameter:	$F_{\text{TL},i}$
Data unit:	Nm ³ /h
Description:	Volume flow rate at the inlet of the destruction facility
Source of data to be	Flow meter

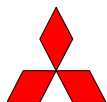


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used:	
Value of data	165,975,147 Nm³/hr (total volume from 27/June/2007 to 31/Dec/2007, from the actual data)
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Multiple-point sampling tube type flow meter ● Measuring period : Continuously ● Data record : New logging system ● Sampling range :0–60,000 m³/hr <p>Flow metering system will automatically record continuously volume flow rate adjusted to standard temperature and pressure.</p> <p>The estimated total uncertainty is 2.5%.</p>
QA/QC procedures to be applied:	<p>Refer to QA / QC procedures cited below. FTI Both parameters shall be cross-checked to ensure that no leak of N₂O is taking place.</p> <p>In case of discrepancy, conservative calculation of emission reduction shall be provided.</p>
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:	$CI_{N_2O,i}$
Data unit:	tN ₂ O/m ³
Description:	N ₂ O concentration at destruction facility inlet.
Source of data to be used:	Non-dispersion infrared absorption analyzer (NDIR)
Value of data	3.308 E-06 tN₂O/Nm³ (=1,684.46 ppmv*44/22.4) (average concentration from 27/June/2007 to 31/Dec/2007, from the actual data)
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Non-dispersion infrared absorption analyzer ● Measuring period : Continuously ● Data record : New logging system ● Sampling range :0–3,000 ppmv <p>The estimated total uncertainty is 4%.</p>
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.



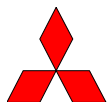
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	QA/QC for the analyzer shall be subjected to the EN14181 or equivalent standards available in the Republic of Korea. Refer to Annex 4.
Any comment:	In the event that the monitoring system is down, the lowest between the conservative default value 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
Value of data	Not needed.
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Existing thermo-couple ● Measuring period : Continuously ● Measuring range : 0 - 1,200 °C <p>Data record : Existing DCS system (distributed control system)</p> <p>This parameter is measured at catalyst basket filled with Raschig ring</p> <p>Estimated uncertainty from temperature measurement with thermo-couple : ± 6 °C</p> <p>If the actual average daily operating temperature in the ammonia oxidation reactor (T_g) is outside this “permitted range”, the baseline N₂O emissions for that period are capped at 4.5kgN₂O/tonne of nitric acid conservatively applying the IPCC default value.</p>
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	Pressure transmitter



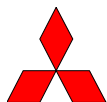
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used:	
Value of data	Not needed.
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Existing pressure transmitter— ● Measuring period : Continuously ● Measuring range : 0-16 kgf/cm² gauge ● Measuring point : Two points. <p>One is between air compressor and NH₃ air mixer (since Jan.2000), and another is between NH₃ air mixer and NH₃ air filter (since Jan.2005). $P_{g,hist}$ is based on data measured at the former which the number of acquisition records is larger.</p> <ul style="list-style-type: none"> ● Data record : Existing DCS system (distributed control system) <p><u>Estimated uncertainty from this pressure measurement: ± 4.0 Pa</u></p> <p>If the actual average daily operating pressure in the ammonia oxidation reactor (P_g) is outside this “permitted range”, the baseline N₂O emissions for that period are capped at 4.5kgN₂O/tonne of nitric acid conservatively applying the IPCC default value.</p>
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 used:	Ammonia oxidization catalyst supplier
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}
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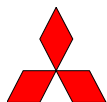
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Data unit:	%
Description:	Composition of the ammonia oxidization catalyst
Source of data to be used:	Ammonia oxidization catalyst supplier
Value of data	Pt: 95 %, Rh: 5 %
Description of measurement methods and procedures to be applied:	HWC has been 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:	$A_{OR,d}$
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	Not needed.
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Orifice flow meter and differential pressure transmitter ● Measuring period : Continuously ● Measuring range : 0-6,000 m³/hr ● Measuring position : NH₃ air mixer ● Data record : Existing DCS system (distributed control system) <p><u>Estimated uncertainty from this flow measurement : $\pm 5,760 \text{ Nm}^3/\text{day}$ (= 4.4 tonNH₃/day)</u></p>
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 ₂ O unit
Source of data to be	Wattmeter or electricity accumulator



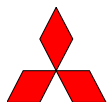
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used:	
Value of data	141,520 MWh/yr (27/June/2007—31/Dec/2007)
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Wattmeter or electricity accumulator ● Measuring period : Monthly ● 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
Value of data	101,701 Nm ³ /yr (27/June/2007—31/Dec/2007)
Description of measurement methods and procedures to be applied:	<ul style="list-style-type: none"> ● Measuring device : Vortex flow meter ● Measuring period : Once a day ● Data record : New data logger <p>Estimated uncertainty from this flow measurement : ± 21.6 Nm³/day</p>
QA/QC procedures to be applied:	<p>Not needed because its contribution is much below the uncertainty level Flow of hydrocarbon is measured at atmospheric condition.</p> <p>Temperature and pressure adjustments are preferable but not necessary if it costs a lot.</p>
Any comment:	This parameter is shown in normal condition (0 °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	90.9959 %
Description of measurement methods	<p>Local data are preferable.</p> <ul style="list-style-type: none"> ● Measuring period : <i>Annually</i>



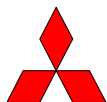
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and procedures to be applied:	● Data record : Handwriting
QA/QC procedures to be applied:	Not needed.
Any comment:	No.

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	9,157.16 Nm^3/yr 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 °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	92,543,74 Nm^3/yr 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



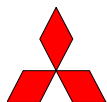
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QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown in normal condition (0 °C,1atm).

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	0.0008007 t/Nm ³
Description of measurement methods and procedures to be applied:	Local data are preferable. <ul style="list-style-type: none"> ● Measuring period : <i>Annually</i> ● Data record : Handwriting
QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown by the density in normal condition (0 °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°C,1atm).
QA/QC procedures to be applied:	Not needed.
Any comment:	This parameter is shown by the density in normal condition (0 °C,1atm).



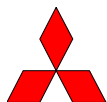
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Data / Parameter:	ρ_{NMHC}
Data unit:	t/Nm ³
Description:	Density of the hydrocarbon (Non-methane part of the natural gas).
Source of data to be used:	Calculated by data of the natural gas and methane
Value of data	0.001676895 t/Nm ³ This parameter is calculated as follows; $\rho_{\text{NMHC}} = (\rho_{\text{NG}} - \rho_{\text{HNC}} * C_{\text{HNC}}/100) / (1 - (C_{\text{HNC}}/100))$
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 °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	10,433 kcal/Nm ³
Description of measurement methods and procedures to be applied:	Local data are preferable. <ul style="list-style-type: none"> ● Measuring period : <i>Annually</i> ● 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 °C, 1atm).

Data / Parameter:	EF _{NG}
Data unit:	tCO ₂ /tNG
Description:	Emission factor of the hydrocarbon (natural gas)



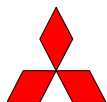
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Source of data to be used:	IPCC 1996 GHG Inventory Guidelines and data provided by the natural gas supplier
Value of data	3.03 tCO₂/tNG This parameter is calculated as follows; $EF_{NG} = COEF_{NG} * 44/12 * NCV_{NG} * 4.18605 / \rho_{NG} * 10^{-9}$ 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 default 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	$2.75(tCO_2/tCH_4)$ $= (44 \text{ gCO}_2/16\text{gCH}_4)$
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



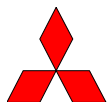
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Value of data	4.3934 tCO₂/tNMHC This parameter is calculated as follows; $EF_{NMHC} = (EF_{NG} * \rho_{NG} - EF_{HNC} * \rho_{HNC} * C_{HNC}/100) / (1 - C_{HNC}/100) / \rho_{NMHC}$
Description of measurement methods and procedures to be applied:	Calculated 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:	$QR_{N_2O,y}$
Data unit:	tN ₂ O
Description:	Regulation based on annual quantity N ₂ O limited
Source of data to be used:	National environmental legislation in the Republic of Korea In case national regulations concerning N ₂ O emissions are implemented during the crediting period, the impact on baseline N ₂ O emissions is considered without any delay by adjusting the measured N ₂ O emissions at the time the regulation has to be implemented.
Value of data	Baseline N ₂ O emissions are limited by the absolute quantity of N ₂ O emissions given by the regulation. If the measured baseline N ₂ O emissions are exceeding the regulatory limit, then

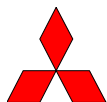


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	measured baseline N ₂ O emissions are substituted by the regulatory limit.
Description of measurement methods and procedures to be applied:	<p>If, $QI_{N_2O,y} > QR_{N_2O,y}$ then,</p> $BE_{N_2O,y} = QR_{N_2O,y}$ <p>else,</p> $BE_{N_2O,y} = \min \text{ of } [QI_{N_2O,y}, SE_{N_2O,y} * P_{\text{product,max}}]$ <p>where:</p> <p>$QI_{N_2O,y}$: Quantity of N₂O emissions at the inlet of the destruction facility in year y (tN₂O)</p> <p>$QR_{N_2O,y}$: Regulatory limit of N₂O emissions in year y (tN₂O)</p> <p>$BE_{N_2O,y}$: Baseline emissions of N₂O in year y (tN₂O)</p> <p>$SE_{N_2O,y}$: Specific N₂O emissions per unit of output of nitric acid in year y (tN₂O/tHNO₃)</p> <p>$P_{\text{product,y}}$: Production of nitric acid in year y (tHNO₃)</p> <p>The quantity of N₂O emissions at the inlet of the N₂O destruction facility (DF) is calculated based on continuous measurement of the tail gas volume flow rate and the N₂O concentration at the inlet of the N₂O destruction facility.</p>
QA/QC procedures to be applied:	Not needed.
Any comment:	Change in NO _x or N ₂ O regulations will automatically cause a re-assessment of the baseline scenario.

Data / Parameter:	$RSE_{N_2O,y}$
Data unit:	tN ₂ O/tHNO ₃
Description:	Regulation based on N ₂ O 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 ₂ O emissions are implemented during the crediting period, the impact on baseline N ₂ O emissions is considered without any delay by adjusting the measured N ₂ O emissions at the time the regulation has to be implemented.
Value of data	Regulation setting of a threshold for specific N ₂ O emissions per unit of product
Description of measurement methods and procedures to be applied:	<p>If, $SE_{N_2O,y} > RSE_{N_2O}$ then,</p> $BE_{N_2O,y} = \min \text{ of } [RSE_{N_2O} * P_{\text{product,y}}, SE_{N_2O,y} * P_{\text{product,max}}]$ <p>else,</p> $BE_{N_2O,y} = \min \text{ of } [QI_{N_2O,y}, SE_{N_2O,y} * P_{\text{product,max}}]$ <p>where:</p>

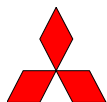


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	<p>$SE_{N_2O,y}$: Specific N_2O emissions per unit of output of nitric acid in year y ($tN_2O/tHNO_3$)</p> <p>RSE_{N_2O} : Regulatory limit of N_2O emissions per unit of output of nitric acid ($tN_2O/tHNO_3$)</p> <p>$BE_{N_2O,y}$: Baseline emissions of N_2O in year y (tN_2O)</p> <p>$P_{product,y}$: Production of nitric acid in year y ($tHNO_3$)</p> <p>$QI_{N_2O,y}$: Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O)</p> <p>The specific N_2O emissions per unit of output of nitric acid is defined as:</p> $SE_{N_2O,y} = QI_{N_2O,y} / P_{product,y}$ <p>where:</p> <p>$SE_{N_2O,y}$: Specific N_2O emissions per unit of output of nitric acid in year y ($tN_2O/tHNO_3$)</p> <p>$QI_{N_2O,y}$: Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O)</p> <p>$P_{product,y}$: Production of nitric acid in year y ($tHNO_3$)</p> <p>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.</p>
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:	$CR_{N_2O,y}$
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	<p>If, $CN_{2O,y} > CR_{N_2O}$ then</p> $BE_{N_2O,y} = \sum_{i=1}^n C_{N_2O,i} * [F_{TG,i} * M_i]$



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and procedures to be applied:	<p>where $C_{N_2O,i}$ is $\min [C_{N_2O,y}, CR_{N_2O}, \text{ and } \{(SE_{N_2O,y} * P_{\text{product,max}}) / (\sum(F_{TE,i} * M_i))\}]$</p> <p>else,</p> $BE_{N_2O,y} = QI_{N_2O,y}$ <p>where:</p> <p>$C_{N_2O,i}$: N_2O concentration a destruction facility inlet during interval i (tN_2O/m^3)</p> <p>$CR_{N_2O,i}$: Regulatory limit for specific N_2O concentration during interval i (tN_2O/m^3)</p> <p>$BE_{N_2O,y}$: Baseline emissions of N_2O in year y (tN_2O)</p> <p>$F_{TE,i}$: Volume flow rate at the exit of the destruction facility during interval i (m^3/h)</p> <p>M_i : Length of measuring interval i (h)</p> <p>i : interval</p> <p>n : number of intervals during the year</p> <p>$QI_{N_2O,y}$: Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O)</p> <p>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.</p>
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.