N.serve Environmental Services GmbH

CDM Monitoring Report No. 1

“Project for the catalytic reduction of N2O emissions with a secondary catalyst inside the ammonia reactor of the nitric acid plant at Dongbu Hannong Chemicals Ltd., Ulsan, Korea (“Dongbu”)

UNFCCC Ref No. 1443

Monitoring period

From: 01.04.2008

To: 15.05.2008

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1. Introduction

Dongbu Hannong Chemicals Ltd. ("Dongbu") (new name: Dongbu HiTek Co., Ltd)[1], UPC Corporation Ltd, Johnson Matthey PLC and N.serve Environmental Services GmbH have implemented a GHG emission reduction project at the Dongbu nitric acid production plant in Ulsan, Republic of Korea. The GHG emission reductions are achieved by catalytic destruction of N_2O.

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

The monitoring period covered by this report is 01/04/2008 – 15/05/2008. The begin of the project activity with start of the first project campaign was 26/02/2008. The first project campaign started 26/02/2008 and ended 15/05/2008. The emission reductions achieved during this first project campaign are assessed by this report.

Starting date of the project activity :	26/02/2008
Registration date at UNFCCC:	01/04/2008
Registration No. at UNFCCC:	1443
Crediting period is:	01/04/2008 – 31/03/2018
Project scale:	large
Sectoral scope:	5: "Chemical Industry"
Host Party for the Project activity:	Republic of Korea
City/ Town:	Ulsan

2. General description of the project activity

The sole purpose of the proposed project activity is to significantly reduce former levels of N_2O emissions from the production of nitric acid at Dongbu's nitric acid plant in Ulsan, Republic of Korea. The Dongbu nitric acid plant was designed by Weatherly and commissioned in 1992, it is a single burner high pressure plant operated at 13,3 – 15,8 kg/cm².

Dongbu is a producer and supplier of Compound Fertilizers and Nitric Acid.

To produce nitric acid, ammonia (NH_3) is reacted with air over precious metal – normally a platinum/rhodium (Pt-Rh) alloy – catalyst gauze pack in the ammonia oxidation reactor of nitric acid plants. The main product of this reaction is NO, which is detestable at the conditions present in the ammonia oxidation reactor and

[1] The Project Participant Dongbu Hannong Chemicals Ltd. has undergone a change in its legal constitution and now is called Dongbu HiTek Co., Ltd. The Project Participant´s legal entity as such has not changed. Dongbu HiTek Co., Ltd. is the legal successor entity to Dongbu Hannong Chemicals Ltd.

therefore reacts with the available oxygen to form NO_2, which is later absorbed in water to form HNO_3 – nitric acid. Simultaneously, undesired side reactions yield nitrous oxide (N_2O), nitrogen and water. N_2O is a potent greenhouse gas with a Global Warming Potential (GWP) of 310. The project activity involves the installation of a new N_2O abatement technology; a pelletized catalyst that will be installed inside the ammonia oxidation reactor, underneath the precious metal gauzes. This catalyst will in large part reduce the baseline N_2O emissions.

By implementing the project activity, a new, clean technology has been transferred to the Republic of Korea that is not even common industrial practice in Annex 1 countries. Also, the project leads to an enhancement of skills as employees are trained to operate both the N_2O abatement catalyst and the Automated Monitoring System.

Dongbu is certified according to ISO 9001 standards for quality management. The procedures for monitoring, regular calibrations and QA/QC are fully embedded into the procedures required by ISO 9001 and documented in the applicable ISO handbooks.

The financial benefits from the sale of Certified Emission Reductions ("CERs") will be used to offset the capital and operating costs of the project to provide for its continued operation throughout the crediting period.

Through the sale of CERs, Dongbu will also be able to improve its profitability and ensure employment, contribute to economic prosperity in the region.

2.1. Project participants

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Korea (host)	Dongbu Hannong Chemicals Ltd. (Private) ("Dongbu") (new name: Dongbu HiTek Co., Ltd)[2]	No
Republic of Korea (host)	UPC Corporation Ltd. (Private)	No
United Kingdom	Johnson Matthey PLC (Private)	No
United Kingdom	N.serve Environmental Services GmbH, Germany ("N.serve").	No

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3. Technology employed by the project activity

The project activity entails a transfer of

- State-of-the art N_2O abatement technology which is not even applied in Annex I countries.
- Specialised monitoring equipment
- Staff training for installation, operation and maintenance of catalyst & monitoring equipment, etc.

A number of N_2O abatement technologies have become available in the past 2 years after some 10 years of research, development and industrial testing. Only now that N_2O regulation is going to be introduced in the EU by 2007 and with the incentives provided by the Kyoto Protocol nitric acid plant operators are considering adopting these technologies. N_2O abatement technology is now commercially available from a number of catalyst manufacturers, mainly from Germany and the UK. These technologies are proprietary and are sold or leased to nitric acid plants. The financing of this technology is facilitated by the CDM. Hence, the CDM enables nitric acid plants in non-Annex 1 countries to become the pioneers of N_2O abatement of the global nitric acid industry.

Dongbu has installed a secondary abatement catalyst before the successful registration of the Dongbu Nitric Acid plant as a CDM project.

3.1. Catalyst Technology

Dongbu has contracted with Johnson Matthey to install its Amoxis Hybrid® RN20/101 N2O reduction catalyst that consists of a standard precious metal gauze pack with an additional base metal catalyst.

The precious metal gauze pack – i.e. the primary catalyst required for the actual production of nitric acid – has been supplied to Dongbu by Johnson Matthey for a number of years. The design and composition of that gauze pack will remain unchanged during the crediting period.

A secondary catalyst will reduce N2O levels in the gas mix resulting from the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have shown to be of varied effectiveness in N2O abatement catalysts. The Amoxis Hybrid® RN20/101 abatement catalyst is made of clover leave shaped pellets containing a Lanthanum-Cerium-Cobalt-Perovskite. The catalyst has been tried and tested in a number of nitric acid plants in Europe. The abatement efficiency has been shown to be at least 80% in the following reaction:

2N2O → 2N2 + O2

The Amoxis Hybrid® RN20/101 abatement catalyst does not contaminate the nitric acid produced in the respective nitric acid plant, neither with Cobalt nor with any of the other catalyst materials.

The catalyst does not require additional heat or other energy over and above the temperature that is present inside the Ammonia Oxidation Reactor anyway. There are no additional greenhouse gases or other emissions generated by the reactions on at the N_2O abatement catalyst.

3.2. N_2O abatement catalyst installation

The secondary catalyst itself is easily installable during a routine plant shut-down and gauze change. The mini raschig rings are poured into the support basket / heat shield arrangement and raked level. The gauze pack is then installed above this bed using the support mechanism provided by the heat shield.

3.3. Technology transfer and safety issues

The catalyst implementation does not lead to increased NO_X emissions. Neither is the environment directly or indirectly harmed in any other way. Dongbu will ensure that the chosen N_2O abatement catalyst vendor will take back the catalyst at the end of its useful life and refine, recycle or dispose of it according to the then prevailing EU standards.

Once installed, the catalyst itself and the AMS is operated by the local Dongbu-employees.

4. Project boundary of the project activity

The boundary of the project activity includes the complete process equipment of the Dongbu nitric acid plant.

The gases relevant to the proposed project activity (and the nitric acid plant which is subject to it) originate from the ammonia oxidation process that takes place at approximately 920℃ and between 13,3 – 15,8 kg/cm² at the precious metal gauzes inside the plant's ammonia oxidation reactor.

The main product of this reaction is NO created by oxidising ammonia (NH_3) with atmospheric oxygen (O_2) (reaction 1). NO readily oxidises further to form NO_2 (reaction 2) and thereafter put to react with water to form a mix of nitric and nitrous acid (reaction 3). Finally, nitrous acid is also transformed into nitric acid (reaction 4), entailing an emission of NO, which is partially oxidised to NO_2 (reaction 2). These intended chemical reactions (main reactions) are the following:

(1) $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$
(2) $2\ NO + O_2 \rightarrow 2\ NO_2$
(3) $2\ NO_2 + H_2O \rightarrow HNO_3 + HNO_2$
(4) $3\ HNO_2 \rightarrow HNO_3 + NO + H_2O$

The ammonia oxidation process (see reaction 1 above) yields the desired NO molecules with a 95 to 97% probability, depending on the maintenance of the accurate temperature and pressure parameters inside the ammonia burner.

However, these main reactions entail the formation of several unwanted gaseous by-products that usually are emitted into the atmosphere. The undesired by-products

result from the following reactions (side reactions) that also occur in the ammonia oxidation process:

(a) $4\ NH_3 + 3\ O_2 \rightarrow 6\ H_2O + 2\ N_2$
(b) $4\ NH_3 + 4\ O_2 \rightarrow 6\ H_2O + 2\ N_2O$

Side reaction (a) is irrelevant as it only results in the formation of water vapour and nitrogen, both present in the atmosphere in abundance. Reaction (b), however, leads to the emission of N_2O.

On leaving the ammonia oxidation reactor some of the N_2O generated may decompose

- In the high temperature homogenous gas phase inside the ammonia oxidation reactor (especially if the heat exchanger coils are inefficient or not placed directly underneath the ammonia oxidation section)
- At platinum deposits downstream of the ammonia oxidation reactor (provided that sufficient temperature levels coincide with substantial traces of platinum and the gas flow velocity allows a sufficient contact time)
- In sections of the plant downstream of the ammonia oxidation reactor, where temperatures above 300℃ allow N_2O to spontaneously decompose.

An overview of all emission sources within the project boundary is provided below:

	Source	Gas	Included?	Justification / Explanation
Baseline	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	No	The process does not lead to any CO_2 or CH_4 emissions
		CH_4	No	
		N_2O	Yes	
		CO_2		
		CH_4		
		N_2O		
		CO_2		
		CH_4		
		N_2O		
Project Activity	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	No	The process does not lead to any CO_2 or CH_4 emissions
		CH_4	No	
		N_2O	Yes	
	Leakage emissions	CO_2	No	No leakage emissions are expected.
		CH_4	No	
		N_2O	No	

5. Baseline and monitoring methodology applied to the project activity

This project is based on Approved Baseline and Monitoring methodologies AM0034 (Version 02): “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants”.

The project draws on approved baseline methodology AM0028 for the baseline scenario selection and uses the “Tool for the demonstration and assessment of additionality”.

5.1. Determination of the permitted operating conditions of the nitric acid plant to avoid overestimation of baseline emissions:

In order to avoid the possibility that the operating conditions of the nitric acid production plant are modified in such a way that increases N_2O generation during the baseline campaign, the normal ranges for operating conditions were determined for the following parameters: (i) oxidation temperature; (ii) oxidation pressure; (iii) ammonia gas flow rate, and (iv) air input flow rates. The permitted range has been established using the procedures described below. Note that data for these parameters is routinely logged in the process control systems of the plant.

i. Oxidation temperature and pressure:

Process parameters monitored:

OT_h	Oxidation temperature for each hour (℃)
OP_h	Oxidation pressure for each hour (Pa)
OT_{normal}	Normal range for oxidation temperature (℃)
OP_{normal}	Normal range for oxidation pressure (Pa)

ii. Ammonia gas flow rates and ammonia to air ratio input into the ammonia oxidation reactor (AOR):

Parameters monitored:

AFR	Ammonia gas flow rate to the AOR (tNH_3/h)
AFR_{max}	Maximum ammonia gas flow rate to the AOR (tNH_3/h)
AIFR	Ammonia to air ratio (%)
$AIFR_{max}$	Maximum ammonia to air ratio (%)

For the determination of the permitted operating conditions, the historic operating data for OTh, OPh, AFR and AIFR of the previous 5 campaigns were and analysed by using the 2-hourly values. Prior to AMS installation, Dongbu had no continuous log of operational parameters, only manual logs which record the incidental value at every 2 hour interval. Contrary to the statement in the PDD hourly values were not available for the analysis of historical operational data from the plant. However the 2-hourly values are representing the best alternative for determination of permitted operating conditions.

5.2. Determination of baseline emission factor: measurement procedure for N_2O concentration and gas volume flow

N_2O concentration and gas volume flow have been monitored throughout the baseline campaign by an Automated Monitoring System (AMS) which was installed and operated using European Norm 14181 (2004) as guidance where applicable. The AMS provides separate readings for N_2O concentration (NCSG) and gas volume flow (VSG) continuously. Error readings (e.g. downtime or malfunction) and extreme values are to be eliminated from the output data series.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is to be applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure will be applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}$$

The plant specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign has been derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid for that period. The overall uncertainty of the monitoring system (*UNC*) has been determined. The N_2O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) was reduced by the estimated percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) (1 – UNC/100)$$

In the absence of any national or regional regulations for N_2O emissions in Korea, the resulting EF_{BL} has been used as the baseline emission factor.

The gauze supplier and gauze composition during the baseline campaign had been the same as used during the historic campaigns when the permitted operating conditions were established. Therefore, the EF_{BL} derived is valid.

The plant was operating within the permitted range of normal operating conditions for more than 50% of the time, therefore the baseline campaign is valid and the resulting EF_{BL} can be applied to calculate the resulting emission reductions of the project.

5.3. Campaign Length

In order to take into account the variations in campaign length and its influence on N_2O emission levels, the historic campaign lengths and the baseline campaign length are to be determined and compared to the project campaign length. Campaign length is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes.

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has been used as a cap on the length of the baseline campaign as described in the PDD.

If $CL_{BL} \leq CL_{normal}$, then all N_2O values measured during the baseline campaign can be used for the calculation of EF_{BL} (subject to the elimination of data that was monitored during times where the plant was operating outside of the "permitted range").

If $CL_{BL} > CL_{normal}$, then N_2O values that were measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) are to be eliminated from the calculation of EF_{BL}.

5.4. Statistical Tests comparing Baseline Campaign with "normal" operating conditions

In accordance with AM0034, statistical tests should be performed to compare the average values of the permitted operating conditions with the average values obtained during the baseline campaign.

Since no specific statistical tests are prescribed in AM0034, the project proponents used the statistical tests that are already being used in AM0034 to ensure a consistent approach.

If the mean values for OT_h, OP_h, AFR and AIFR obtained during the baseline campaign fall within the 95% confidence interval (1.96 times the standard deviation) of the normal operating conditions, then the baseline campaign is considered to be representative of a normal campaign.

The result of these tests was that the baseline campaign is representative of a normal campaign because all four mean values obtained during the baseline campaign fall within the 95% confidence interval of the normal operating conditions.

5.5. Leakage

As per methodology AM0034, no leakage emission calculation is required since no leakage emissions have occurred as a result of the project activity nor are any expected in future.

5.6. Project Emissions

Over the duration of the project activity, N_2O concentration and gas volume flow in the stack of the nitric acid plant as well as the temperature and pressure of ammonia gas flow and ammonia-to-air ratio will be measured continuously.

The same statistical evaluation that was applied to the baseline data series is applied to the project data series of NCSG and VSG:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$PE_n = VSG * NCSG * 10^{-9} * OH$

In order to take into account possible long-term emissions trends over the duration of the project activity and to take a conservative approach a moving average emission factor shall be estimated as follows:

Step1: estimate campaign specific emissions factor for each campaign during the project's crediting period by dividing the total mass of N_2O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign. For example, for campaign n the campaign specific emission factor would be:

$EF_n = PE_n / NAP_n$

Step 2: A moving average emissions factor be calculated at the end of a campaign n as follows:

$EF_{ma,n} = (EF_1 + EF_2 + \ldots + EF_n) / n$

This process is repeated for each campaign such that a moving average, $EF_{ma,n}$, is established over time, becoming more representative and precise with each additional campaign.

To calculate the total emission reductions achieved in a campaign according to the formula below, the higher of the two values $EF_{ma,n}$ and EF_n shall be applied as the emission factor relevant for the particular campaign to be used to calculate emissions reduction s (EF_p). Thus:

If $EF_{ma,n} > EF_n$ then $EF_p = EF_{ma,n}$
If $EF_{ma,n} < EF_n$ then $EF_p = EF_n$

5.7. Minimum Project Emissions Factor

N_2O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum (EF_{min}). EF_{min} is equal to the lowest EF_n observed during the first 10 campaigns of the project crediting period ($N_2O/tHNO_3$). If any of the later project campaigns results in an EF_n that is lower than EF_{min}, the calculation of the emission reductions for that particular campaign shall used EF_{min} and not EF_n.

5.8. Project Campaign Length

If the length of each individual project campaign CL_n is longer than or equal to the average historic campaign length CL_{normal}, then all N_2O values measured during the baseline campaign can be used for the calculation of EF (subject to the elimination of data from the Ammonia/Air analysis, see above). If $CL_n < CL_{normal}$, recalculate EF_{BL} by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tonnes produced) from the calculation of EF_n.

5.9. Emission Reductions

The emission reductions for the project activity over a specific campaign are determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EF_{BL} – EF_P) * NAP * GWP_{N2O}$$

According to AM0034, the value for Nitric acid production (NAP) during the project campaign shall not exceed the design capacity of the nitric acid plant.

The existing production capacity is 109 500 metric tonnes of 100% concentrated nitric acid per year (based on 365[3] operating days per year and a daily nameplate capacity of 300 $tHNO_3$). Therefore, the Dongbu nitric acid plant shall not be eligible to earn CERs for any tonnes of nitric acid produced exceeding 109 500 in any one year.

5.10. Data and parameters for calculation of Baseline campaign emissions

See Annex 1

5.11. Data and parameters for calculation of Project campaign emissions

See Annex 2

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[3] As per AM0034 page 11.

6. Monitoring plan:

6.1. General description of the monitoring plan

The emission reductions achieved by the project activity are monitored based on the approved monitoring methodology AM0034 as prepared by N.serve Environmental Services GmbH. It is the appropriate monitoring methodology to be used in conjunction with the baseline methodology AM0034, “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants”. Its applicability depends on the same prerequisites as the mentioned baseline methodology.

AM0034 requires the use of the European Norm EN14181 (2004) *“Stationary source emissions - Quality assurance of automated measuring systems”*[4] as a guidance[5] for installing and operating the Automated Monitoring System (AMS) in the nitric acid plants for the monitoring of N_2O emissions.

A complete Automated Monitoring System (AMS) to monitor the mass emissions of N_2O at the stack of Dongbu’s nitric acid plant was commissioned in 2006 and installed before start of the baseline campaign. In February 2008 the N_2O analyzer was replaced by a different type in order to ensure better on site service by a local company.

As an operator of the nitric acid plants for many years, Dongbu staff in general and its Instrument Department in particular is accustomed to operating technical equipment to a high level of quality standards.

The plant manager is responsible for the ongoing operation and maintenance of the N_2O monitoring system. Operation, maintenance, calibration and service intervals are being carried out by staff from the instrumentation department according to the vendor’s specifications and under the guidance of internationally relevant environmental standards, in particular EN 14181 (2004) and EN ISO 14956 (2002). In addition the supplier of the N_2O analyzer (I&A) company is providing service and maintenance for the analyzer at regular intervals.

All monitoring procedures at Dongbu are also conducted and recorded in accordance with the well established procedures under ISO 9001 which is regularly audited by an independent auditing firm accredited for ISO 9001 certification.

Dongbu derives hourly averages for all of the monitored parameters and delivers these data to N.serve. Albrecht von Ruffer, Managing Director of N.serve, is

[4] This standard describes the quality assurance procedures needed to assure that an Automated Measuring System (AMS) installed to measure emissions to air are capable of meeting the uncertainty requirements on measured values given by legislation, e.g. EU Directives, or national legislation, and more generally by competent authorities.

[5] See page 8, last paragraph of AM0034 version 2: “The monitoring system is to be installed using the guidance document EN 14181 …”

responsible for the correct analysis of the delivered data in accordance with the methodology.

6.2. Application of EN 14181 procedures to the project

In the following, it is described how the procedures given in EN14181 for QAL1, 2 and 3 have been practically applied at Dongbu nitric acid plant.

<u>QAL 1</u>

In accordance with EN14181 an AMS shall have been proven suitable for its measuring task (parameter and composition of the flue gas) by use of the QAL1 procedure as specified by EN ISO 14956. Using this standard, it shall be proven that the total uncertainty of the results obtained from the AMS meets the specification for uncertainty stated in the applicable regulations. Such suitability testing has to be carried out under specific conditions by an independent third party on a specific testing site. A test institute shall perform all relevant tests on two identical AMS. These two AMS have to be tested in the laboratory and field.

The Manufacturer and type of the first N_2O Analyser was ADC MGA 3000 Continuous Emissions Analyser. At the time of commissioning of the AMS by Dongbu, only one analyser was available that has been certified suitable for N_2O monitoring under QAL1 of EN 14181 and ISO 14956. However, the ADC MGA 3000 is currently undergoing the necessary procedures under QAL 1 and it is expected that the testing series (performed by MCERTS and TÜV) is successfully completed and certification obtained early 2009.

The final QAL 2 report prepared by SGS (Report no. EZ/07/2023 dated 31/08/2007) however states that the measurement programme (QAL2) covered the most important QAL1 and QAL2 issues for the used N_2O analyzer. The main conclusions as summarized in the report mentioned that ADC MGA3000 emission measurement analyzer and the flow meter Foxboro IVM30 comply with the QAL1 and QAL2 requirements of the European standard EN14181.

In order to guarantee a better service support for the N_2O analyzer a new N_2O analyzer was installed in February 2008 before the start of the first project campaign. The chosen ABB AO2000 URAS 26 gas analyser has fulfilled the requirements of the QAL1 and was successfully tested by TÜV SÜD Industrie Service, Germany[6].

The analyzer was provided by the local ABB distributer company I&A (Instrument & Analyzer), Ulsan. I&A as a local company is providing service and maintenance for the analyzer at regular intervals.

<u>QAL2 and Standard Reference Measurements (SRM)</u>

QAL2 is a procedure for the determination of the calibration function and its variability, and a test of the variability of the measured values of the AMS compared with the uncertainty given by legislation. The QAL2 tests are performed on suitable AMS that have been correctly installed and commissioned on-site (as opposed to QAL 1 which is conducted off-site). QAL 2 tests are to be performed at least every 3

[6] TÜV Süd Industrie Service GmbH, München (Report number 821029) June 2006

years according to EN 14181 but also after major changes to the plant or changes or repairs to the AMS, which will influence the results obtained significantly.

A calibration function is established from the results of a number of parallel measurements performed with a Standard Reference Method (SRM). The variability of the measured values obtained with the AMS is then evaluated against the required uncertainty. According to EN14181, both the QAL 2 procedures and the SRM need to be conducted by an independent “testing house” or laboratory which has to be accredited to EN ISO/IEC 17025.

A series of QAL2 specific reference measurements using a the SRM method as per EN 14181 for guidance has been carried out at the plant in March and June 2007 by an accredited testing house (SGS Environmental Services, Netherlands) to ensure the AMS’ suitability, establish the calibration curve and test the variability of the measurements. The results of these SRM are available to the DOE as part of the verification process. The AMS calibration function as well as the total uncertainty of the AMS was determined. The results were applied in the calculation of EF_{BL}.

After the installation of the new N_2O analyzer in February 2008, a new QAL2 test was performed for the analyzer by Müller-BBM GmbH, Germany in March 2008 an accredited testing laboratory according to ISO/IEC 17025. The tests were performed according to EN 14181 in order to ensure the AMS’ suitability, establish the calibration curve and test the variability of the measurements. The results were applied in the calculation of EF_n.

6.3. AMS calibration and QA/QC procedures

Dongbu is certified according to ISO 9001 standards for quality management. The procedures for monitoring, regular calibrations and QA/QC are fully embedded into the procedures required by ISO 9001 and documented in the applicable ISO handbooks.

Calibration Gas

A certified N_2O Calibration gas (balance being N_2) with a precision of ± 2% is used in the span calibrations. The calibration gas is certified by the manufacturer.

Analyser Zero and Span Calibrations

Zero and span calibrations are conducted manually at least every 3 weeks. For the zero calibration pure nitrogen is used, for the span calibration a certified calibration gas is used. The results of the calibrations are recorded according to the related CDM procedure.

<u>Flow meter calibration procedures</u>
The flow meter is tested once per year during the AST test according to EN 14181. If the flow meter fails to pass the AST test, the pressure transmitter of the instrument needs to be recalibrated by the manufacturer or by the plant operator.

The probe of the flow meter itself does not need to be calibrated since it is a physical devise which will not have drift. Therefore, it is sufficient to regularly inspect the physical condition of the probe.

<u>Training</u>
Operations staff at the nitric acid plant who are responsible for the operation of the AMS and regular calibrations, visual and physical checks have been trained appropriately by the AMS vendors and Dongbu's' own instrumentation engineers.

<u>QAL 3</u>
QAL3 is a procedure which is used to check drift and precision in order to demonstrate that the AMS is in control during its operation so that it continues to function within the required specifications for uncertainty.
This is achieved by conducting periodic zero and span checks on the AMS and then evaluating the results obtained using control charts. Zero and span adjustments or maintenance of the AMS, may be necessary depending on the results of this evaluation. In addition, Annual Surveillance Tests (AST) should be conducted in accordance with EN14181, these are a series of measurements that need to be conducted by independent measurement equipment in parallel to the existing AMS.

6.4. Data acquisition system

Dongbu operates one data acquisition system that accumulates the analogue plant operating data from the Process Control System (PCS) into a PC (OTh, OPh, AFR, Air Flow, AIFR, NAP). The analyser unit contains its own CPU which receives the NCSG and VSG data as well as O_2 concentration (all converted from 4-20 mA analogue data into digital signal). This CPU will store the raw
data of up to 5 years of operation. This CPU generates minute-by-minute average values from the raw data which are sent via Ethernet cable to a PC in the control room that already collects the plant operating data.
Donbgu staff will generate minute-by-minute averages from the plant operating data (OTh, OPh, AFR, Air Flow, AIFR, NAP) to match the minute average data for NCSG and VSG.
As a result, there are now two sets of minute-by-minute average reports:
- Operations Data (OTh, OPh, AFR, Air Flow, AIFR, NAP)
- Emissions Data (N_2O, Flow, O_2, Errors)

From these two files the hourly average values are extracted and converted into EXCEL format to get a complete data set which is then imported into the N.serve Database Management System (N.DBMS).

6.5. Description of the N.serve Database Management System (N.DBMS)

All data necessary for the monitoring and verification procedures related to the project activity are transferred from the nitric acid plant's data acquisition system into a dedicated relational database management system ("N.DBMS") based on Microsoft Access 2002. Database management systems are designed for a structured storage

of large amounts of data providing for minimum redundancy and maximum flexibility to allow best practice data analysis.

6.6. Monitoring Procedures for parameters other than NCSG and VSG

Throughout the crediting period of the project the following parameters shall be monitored and recorded as described in Annex 1 and Annex 2: OT_h, OP_h, AFR, AIFR, NAP, GS, GC, CL, incoming N_2O regulation and changes in the NO_X regulations.

All of the data obtained and used as part of the baseline and during the crediting period of the project will be archived electronically at least 2 years longer than the entire crediting period of the project in at least 2 different locations.

7. GHG Calculations

The results of the N.DBMS data analysis are exported to EXCEL spreadsheets for further analysis and presentation

7.1. Analysis of Historical campaign data

<u>**Historical Query 1 (Raw data): Analysis of the raw historical campaign data**</u>

In a first step, a number of statistical calculations are carried out for the historical and baseline data using Query 1:

- Number of data sets
- Minimum value
- Maximum value
- Mean value and/or sum (depending on the character of the parameter)
- Standard deviation
- 95% confidence interval

The resulting Access table is shown in part below:

Query 1: Without parameter limits

ProjId	CampType	Count(DT)	Count(AFR)	Max(AFR)	Max(AIFR)	Min(Oph)	Max(Oph)	Min(OTh)	Max(OTh)	Sum(NAP)
11	H	4148	4148	333,284	6,691106204	0	12458	0	941	103360,429

For convenience of handling, the data from this Access table is exported into Excel for further analysis. The result of this export is shown below:

N.DBMS	Dongbu (Ulsan, Korea)								
Historical campaigns	**Query 1: Without parameter limits**								
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**		**VSG**	**NAP**
Unit	h	t NH3 / h	ratio	kPa	°C	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count	4.148	4.148	4.126	4.148	4.142				
Minimum		0	0,006	0,00	0				
Maximum		333	6,691	12.458,0	941				
Mean		3,37	0,068	1.201,6	915				
Standard deviation		5,15	0,105	307,5	64				
95% Confidence Interval		10,10	0,206	602,8	125				
Sum									103.360
CL normal									20.672

This set of data also shows the total tonnes of nitric acid produced during the five historic campaigns. This number is divided by five to derive the average historic nitric acid production during those five campaigns, which represents the value of CL_{normal}.

In the next query, lines of data in which at least one value is missing or obviously wrong (e.g. negative or an OPh value of 100 bar etc.) are completely eliminated. To make this more systematic, the following exclusion criteria were applied:

AFR < 10 tNH3/h

OPh < 1500 kPa (i.e. if the ammonia oxidation pressure in the raw data log for a particular point in time is higher than 1500 kPa, the whole line of data is excluded from further analysis - this was done to exclude extreme and nonsensical values)(this excludes 3 values)
AIFR < 0.12 (this excludes only one single value)
OTh > 550℃ (The OTh cut off was chosen at 550℃ to be consistent with the trip criteria applied during the baseline campaign)

Historical Query 2: Analysis of the raw historical campaign data

N.DBMS	**Dongbu (Ulsan, Korea)**								
Historical campaigns	**Query 2: With limits on historical data**								
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	ratio	kPa	°C	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count	4.105	4.105	4.105	4.105	4.105				
Remaining share of data set	99%	99%	99%	99%	99%				
Minimum		0,32	0,006	117,0	817				
Maximum		3,80	0,080	1.301,0	941				
Mean		3,30	0,066	1.200,6	919				
Standard deviation		0,09	0,003	58,7	7				
95% Confidence Interval		0,17	0,005	115,1	13				
Sum									
Limits acc. to consistency check		not blank	not blank	not blank	not blank				
Lower limit					550				
Upper limit		10	0,081	1.500					

In a next step, the remaining historical data are analysed in excel to determine and eliminate the upper and lower 2.5% percentiles for OPh and OTh. In the case of Dongbu, the plant is operating under very stable conditions resulting in fairly narrow "permitted operating ranges" from this analysis of historical data:

OPh range: 1087.5 to 1283.9 kPa
OTh range: 907.3 to 932.0 ℃

This permitted range is then applied in Query 5 below.
The analysis of the historical campaigns is now complete. Next, the analysis of the baseline data can be conducted applying the results of the analysis of the historical data.

7.2. Analysis of Baseline campaign data

<u>Baseline Query 1 (Raw data): Analysis of the raw baseline data without any operating limits applied</u>

Baseline Campaign period: April 6th 2007 – June 14th 2007

N.DBMS	**Dongbu (Ulsan, Korea)**								
Baseline campaign	**Query 1: Without parameter limits**								
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	ratio	kPa	°C	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count	1.507	1.507	1.507	1.507	1.507	1.507		1.507	0
Minimum		1,86	0,060	234,65	661	139	*273*	3.198	
Maximum		3,36	0,143	1.263,00	932	2.300	*4.519*	43.683	
Mean		3,21	0,068	1.185,76	920	1.682	*3.304*	41.297	
Standard deviation		0,09	0,003	72,72	11	198	*390*	2.313	
Sum	1.507								19.027
Baseline emissions	**BE**	*= VSG * NCSG * OH*						t N2O	**205,6**
Emission factor	**EF**	*= BE / NAP*						kg N2O / t HNO3	**10,81**

This table gives the raw results for NAP, OH, NCSG, VSG and EF_{BL}.
Next, in queries 3 and 4, the OPh and OTh values are subjected to the 2.5% percentile analysis and subsequently the complete baseline data set will be subjected to the permitted operating range resulting from the historic operating parameters.

<u>Baseline Query 5: Applying the permitted operating range from historical data</u>

N.DBMS	**Dongbu (Ulsan, Korea)**								
Baseline campaign	**Query 5: Permitted Range applied to BL data, invalid data sets excluded**								
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	ratio	kPa	°C	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count	1.483	1.483	1.483	1.483	1.483	1.483		1.483	
Remaining share of data set	98%	98%	98%	98%	98%	98%		98%	
Minimum		3,08	0,062	1.092,0	907	139	*273*	38.680	
Maximum		3,36	0,075	1.263,0	932	2.262	*4.444*	43.683	
Mean		3,22	0,068	1.191	921	1.680	*3.302*	41.447	
Standard deviation		0,05	0,003	33,1	5	193	*379*	984	
95% Confidence Interval		0,10	0,006	64,9	9	378	*742*	1.928	
Sum	1.506								19.027
Limits acc. to consistency check									
Lower limit		0	0	1.087	907,3				
Upper limit		3,797	0,080	1.284	932,0				
Baseline emissions	**BE**	*= VSG * NCSG * OH*						t N2O	**206,1**
Emission factor	**EF**	*= BE / NAP*						kg N2O / t HNO3	**10,83**

This query excludes those NCSG and VSG data from the calculation of BE that were taken during times when the plant was operating outside of the permitted operating

range during the baseline campaign. Only those VSG and NCSG values were taken into account for which a matching AFR, AIFR, OPh and OTh value was available.

The remaining share of the operating data after Query 5 is 98% of the raw data and therefore meets the criterion set by AM0034 that the plant must be operating within the permitted range at least 50% of the time during the baseline campaign.
The results of this query are the OH (1,506) and NAP (19,026.6) values used for the calculation of BE and EF_{BL} respectively.

Query 6 a + b: Application of 95% confidence interval, AMS UNC and calculation of EFBL

N.DBMS	Dongbu (Ulsan, Korea)								
Baseline campaign	**Query 6a+b: Confidence levels for NCSG and VSG**								
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	ratio	kPa	°C	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count						1.417		1.345	
Minimum		3,080	0,062	1.092,0	907	1.305	2.565	40.078	
Maximum		3,357	0,075	1.263,0	932	2.055	4.038	43.288	
Mean		3,217	0,068	1.191,0	921	1.671	3.282,5	41.585,3	
Standard deviation						162	319	839	
95% Confidence Interval									
Sum	1.506,0								19.026,6
Limits acc. to consistency check		not blank	not blank	not blank	not blank	not blank		not blank	
Lower limit				1.087	907,3	1.303		39.518	
Upper limit		3,797	0,080	1.284	932,0	2.058		43.375	
		Correction factors resulting from QAL2				**0,945**		**1,096**	
Baseline emissions	**BE**	*= VSG * NCSG * OH*						t N2O	**212,9**
Emission factor	**EF**	*= BE / NAP * (1 - UNC/100)*						kg N2O / t HNO3	**10,63**
Uncertainty	UNC								**5,00**

The 95% confidence level of NCSG and VSG values is derived, thereby excluding outliers and determining the mean values that are to be applied to the calculation of BE. Also the correction factors for NCSG and VSG that are determined during QAL2 test during the baseline campaign are applied.

Resulting EFBL

The EFBL derived from this analysis of historic and baseline data is 10.63 kgN2O/tHNO3.

Statistical test if the baseline is representative of a normal campaign
Compare BL campaign with Historic Campaigns

Historic campaigns:	AFR	AIFR	OPh	OTh
Historic upper 95% CI level	3.46	0.071	1315.7	932.5
Baseline mean values	3.22	0.068	1191.0	920.1
Historic lower 95% CI level	3.13	0.060	1085.5	905.9

The values appearing in green letters in the above table indicate that the values during the BL campaign were within 1.96 times the standard deviation of the mean values from the historic 5 campaigns. Therefore, it can be concluded that the baseline is representative of a normal campaign.

7.3. Analysis of Project campaign data

The monitoring period covered by this report is 01/04/2008 – 15/05/2008. The begin of the project activity with start of the first project campaign was 26/02/2008. The first project campaign started 26/02/2008 and ended 15/05/2008.

<u>Query 1 (Raw data): Analysis of the raw project campaign data without any operating limits applied</u>

This set of data shows a summary of the collected raw data for the complete project campaign. Due to the installation of a new N_2O analyzer before the project campaign a new QAL2 test was performed by a laboratory with ISO/IEC 17025 Accreditation (Müller-BBM GmbH)

N.DBMS Project Campaign Calculation Project:	Dongbu (Ulsan, Korea)				Campaign: PC 1				
Project campaign 1	**Query 1: Without parameter limits**								17
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	ratio*100	kPa	oC	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count	1.609	1.572	1.609	1.572	1.572	1.609		1.609	
Minimum		0,00	-0,01	-3,12	410	-3,05	*-5,99*	-60	
Maximum		3,50	10,6	1.284,2	941	2.105	*4.136*	44.981	
Mean		3,17	6,67	1.159,7	893	545	*1.071*	40.602	
Standard deviation		0,835	1,42	304,32	127	262	*516*	10.791	
95% confidence level *(1.96 * Std.dev.)*		*1,64*	*2,77*	*596,47*	*248*	*514*	*1.010*	*21.150*	
Sum	1.609								19.026
Limits acc. to consistency check									
Lower limit									
Upper limit									
Correction factors based on SGS QAL2 reference measurements						1,0210		1,0960	
Campaign emissions	**PE**		*= VSG * NCSG * Oh*					t N2O	**78,3**
Emission factor	**EF_P**		*= PE / NAP*					kg N2O / t HNO3	**4,12**

<u>Query 2: Elimination of faulty data outside operational limits</u>

In this query (Query 2), the operational limits (trip values) of the plant are applied. Lines of data in which at least one value indicates that the plant is out of operation (trip values) are completely eliminated from further analysis. As trip value an AIFR of 0.081 or 8.1% is used, hence the plant trips if the AIFR exceeds 0.081 or 8.1%. Also lines of data in which at least one value is missing or obviously wrong (e.g. negative or an OPh value of 100 bar etc.) are completely eliminated. To make this more systematic, the following exclusion criteria were applied:

AFR < 10 tNH3/h
OPh < 1500 kPa (i.e. if the ammonia oxidation pressure in the raw data log for a particular point in time is higher than 1500 kPa, the whole line of data is excluded from further analysis)
AIFR < 0.081 or 8.1%
OTh > 550℃ (The OTh cut off was chosen at 550℃ to be consistent with the trip criteria applied during the baseline campaign)
For the operating hours 37 h were added for the time period 10. May 2008 – 12. May 2008 when the plant was in operation but due to a PC failure the operational data was not stored.

N.DBMS Project Campaign Calculatio Project:		Dongbu (Ulsan, Korea)				Campaign: PC 1			
Project campaign 1		**Query 2: With operational limits**							24
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	ratio*100	kPa	oC	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count	1.472	1.472	1.472	1.472	1.472	1.472		1.472	
Remaining share of data sets	91%	94%	91%	94%	94%	91%		91%	
Minimum		0,36	2,09	301,94	563	172	*337*	2.825	
Maximum		3,50	6,82	1.284,2	941	2.105	*4.136*	44.981	
Mean		3,38	6,63	1.236,9	926	583	*1.145*	43.327	
Standard deviation		0,176	0,221	68,916	21,6	234	*459*	2.805	
95% confidence level *(1.96 * Std.dev.)*		0,344	0,433	135,075	42,4	458	*901*	5.498	
Sum	1.509								19.026
Limits acc. to consistency check									
Lower limit					550				
Upper limit		10	8,10	1.500,0					
Correction factors based on SGS QAL2 reference measurements						1,0210		1,0960	
Campaign emissions	**PE**		*= VSG * NCSG * Oh*					t N2O	**83,8**
Emission factor	**EF_P**		*= PE / NAP*					kg N2O / t HNO3	**4,40**

Query 6: application of confidence interval to eliminate outliers

The 95% confidence interval for NCSG and VSG values is derived and the outliers excluded individually for VSG and NCSG. Hence, the remaining number of data sets may differ between NCSG and VSG.

N.DBMS Project Campaign Calculatio Project:		Dongbu (Ulsan, Korea)				Campaign: PC 1			
Project campaign 1		**Q6: Q2 + confidence levels**				31		38	24
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	ratio*100	kPa	oC	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count						1.464		1.456	
Remaining share of data sets									
Minimum		0,358	2,09	301,94	563	172	*337*	38.099	
Maximum		3,50	6,82	1.284,2	941	1.040	*2.043*	44.981	
Mean		3,38	6,63	1.236,9	926	579	*1.138*	43.569	
Standard deviation		0,176	0,221	68,916	21,6	229	*449*	995	
95% confidence level *(1.96 * Std.dev.)*		0,344	0,433	135,075	42,4	448	*880*	1.951	
Sum	1.509								19.026
Limits acc. to consistency check									
Lower limit					550	124	244	37.829	
Upper limit						1.041	2.045	48.825	
Correction factors based on SGS QAL2 reference measurements						1,0210		1,0960	
Campaign emissions	**PE**		*= VSG * NCSG * Oh*					t N2O	**83,7**
Emission factor	**EF_P**		*= PE / NAP*					kg N2O / t HNO3	**4,40**

Adjustment of Baseline emissions factor due to EF_{reg}

Should N_2O emissions regulations that apply to nitric acid plants be introduced in the host country or jurisdiction covering the location of the project activity, such regulations shall be compared to the calculated baseline factor for the project (EF_{BL}). If the regulatory limit is lower than the baseline factor determined for the project, the regulatory limit shall serve as the new baseline factor, that is:

If $EF_{BL} > EF_{reg}$,

Then the baseline N_2O emission factor shall be EF_{reg} for all calculations.
Where:

Variable Definition
EF_{BL} Baseline emissions factor ($tN_2O/tHNO_3$)

EF_{reg} Emissions level set by newly introduced policies or regulations ($tN_2O/tHNO_3$).

Such EF_{reg} shall be determined according to the nature of the regulation (e.g. in terms of absolute emission, by-product rate, concentration in stack gas), as described in the approved methodology AM0028.

There is currently no N_2O regulation for nitric acid plants in the Republic of Korea therefore no adjustment of the Baseline emissions factor EF_{BL} is necessary.

Emission reductions

The emission reductions for the project activity during the 1st monitoring period are determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EF_{BL} – EF_P) * NAP * GWP_{N2O} \ (tCO_2e)$$

Where:

ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EF_{BL}	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of EFma,n and EFn)

The UNFCCC registration date for the Project was 01. April 2008 and the start of the project campaign covered by this monitoring report was 26. February 2008. The value for NAP for the calculation of the emission reductions was reduced by the amount of NAP that was produced within the time 26. February 2008 – 31. March 2008. The value for NAP produced since 01. April 2008 is 9.183 t HNO_3.

N.DBMS Project Campaign Calculatio	Project:	Dongbu (Ulsan, Korea)	Campaign: PC 1		
Project campaign 1			31	38	24
Emission factor Baseline	EF_BL			kg N2O / t HNO3	10,63
Emission factor Project Campaign	EF_P			kg N2O / t HNO3	4,40
NAP after Registration (1.4.2008)	NAP			t HNO3	9.183
Greenhouse warming potential N2O	GWP				310
Emission reduction	**ER**			**t CO2e**	**17.733**

The total amount of emission reductions for the project activity of the "Project for the catalytic reduction of N2O emissions with a secondary catalyst inside the ammonia reactor of the nitric acid plant at Dongbu Hannong Chemicals Ltd, Ulsan, Republic of Korea ("Dongbu") during the 1st monitoring period is: 17.733 tCO_2e.

Annex 1: Data and parameters for calculation of Baseline campaign emissions

All of the monitoring equipment used to derive the data for this Monitoring Report has been made part of the ISO 9001 procedures.

All of the data obtained and used as part of the baseline and during the crediting period of the project will be archived electronically for at least 2 years in at least 2 different locations.

Baseline Campaign period: April 6th 2007 – June 14th 2007

Data / Parameter:	**B.1 / $NCSG_{BC}$**
Data unit:	**mg/Nm3**
Description:	N_2O concentration in the stack gas during the baseline campaign.
Source of data used:	NDIR N_2O gas analyser (ADC MGA 3000 gas analyser)
Value applied:	**3,282.5**
Justification of the choice of data or description of measurement methods and procedures actually applied :	AM0034 requires the determination of the concentration of N_2O in the stack gas. NCSG is continuously monitored with the gas analyser installed and commissioned on January 29, 2007 (the original analyser was replaced in April 2007 because it failed the linearity test during the QAL2 test). Monitoring results are recorded for every two seconds of plant operation. Hourly means for NCSG are derived from the collected data. NCSG data taken during times when the respective plant was operating outside the permitted operating range were eliminated. The remaining NCSG values where subjected to the following adjustment. The analyser reads ppmv (parts per million in volume); in order to obtain mg/Nm^3 is necessary use the next equation: $NCSG = ppmv * \frac{RMM}{v}$ Where: *NCSG* is N_2O concentration in the stack gas (mg/N m^3) *ppmv* means parts per million in volume *RMM* means relative molecular mass of N_2O (44.013 mg) *v* means standard volume of an ideal gas (22.4 Nm^3) The resulting hourly average NCSG values are now expressed in mg/Nm^3 as required by AM0034 and where subsequently subjected to the following statistical analysis: a) Calculate the sample mean (x) b) Calculate the sample standard deviation (s) c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation) d) Eliminate all data that lie outside the 95% confidence interval e) Calculate the new sample mean from the remaining NCSG values

	During the QAL2 reference measurements it was determined that the analyser consistently overestimates the N_2O concentration in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 0.945 will have to be applied to all NCSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean NCSG value will be multiplied by 0.945 before going into the calculation of BE_{BC}.
Any comment:	none

Data / Parameter:	**B.2 VSG_{BC}**
Data unit:	**Nm^3/h**
Description:	Normal gas volume flow rate of the stack gas during the baseline campaign.
Source of data used:	Gas Volume Flow meter, Systec DF25
Value applied:	**41585.3**
Justification of the choice of data or description of measurement methods and procedures actually applied :	AM0034 requires the determination of the gas volume flow (VSG) in the stack. VSG is continuously monitored with a flow meter (operational since Jan 29, 2007) and monitoring results are recorded for every two seconds of plant operation. Hourly means for VSG are derived from the collected data. VSG data taken during times when the respective plant was operating outside the permitted operating range were eliminated. The remaining VSG data series has been subjected to the following adjustment. The flow meter was installed with an operational range of 0 – 10 mbar of differential pressure. To obtain the flow (Nm3/h) at normal conditions (101.325 kPa and 0°C) from measured differential pressure the instrument equation - taken from the AMS manual – is used which includes pressure and temperature correction factors. Calculation formula (standard volume flow): $V_n = K_x * \frac{\sqrt{P}}{\sqrt{(273,15+T)}} * \sqrt{dP}$ whereby: $K_x = \frac{0,020763 * D^2 * k}{\sqrt{\rho_N}}$ calculated: Kx = 7774 Where: VSG means standard volume flow (Nm3/h) D means stack inner diameter (mm) ρ_N means standard density (kg/Nm3) k means instrument correction factor (specific for each individual instrument) P means pressure working conditions (mbar) T means temperature working conditions (°C) Δ P means differential pressure (mbar) 0.020763 is the unit conversion factor The resulting hourly average VSG values are now expressed in Nm^3/h as required by AM0034 and where subsequently subjected to the following statistical analysis: a) Calculate the sample mean (x) b) Calculate the sample standard deviation (s) c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation) d) Eliminate all data that lie outside the 95% confidence interval

	e) e) Calculate the new sample mean from the remaining VSG values During the QAL2 reference measurements it was determined that the flow meter's range is set lower than the maximum flow in the stack. As a result, the flow meter consistently underestimates the total gas volume flow in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 1.096 will have to be applied to all VSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean VSG value will be multiplied by 1.096 before going into the calculation of BE_{BC}.
Any comment:	None

Data / Parameter:	**B.3 BE_{BC}**
Data unit:	**tN_2O**
Description:	Total N_2O gas flow for baseline campaign
Source of data used:	Calculation from measured data (B.1 and B.2)
Value applied:	**212.9**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The total mass N_2O emissions during the baseline campaign are determined as a product of NSCG, VSG and the total hours of operation during that baseline campaign: $BE_{BC} = VSG_{BC} * NCSG_{BC} *$ QAL2 correction factors $* 10^{-9} * OH_{BC}$ A special adjustment factor is applied to the mean NCSG and VSG values derived. These correction factors were determined during the QAL2 test.
Any comment:	None

Data / Parameter:	**B.4 OH_{BC}**
Data unit:	**Hours**
Description:	Operating hours
Source of data used:	Process Control System.
Value applied:	**1,506**
Justification of the choice of data or description of measurement methods and procedures actually applied :	Every hour of operation for which there is a record of nitric acid produced will be considered as an operational hour for the purposes of BE_{BC} calculation. However, if the plant exceeds certain design parameters, it will automatically shut down ("trip limits"). Periods during the ongoing campaign during which the plant was considered not in operation will be eliminated from the determination of OH. The plant was considered to be not in operation when any of the following parameters where outside the "trip" limits as determined by the plant manuals: AIFR > 0.081 (i.e. if the mass-flow of Ammonia divided by the mass-flow of air is higher than 0,081%, the plant shuts itself off automatically. The trip value for AIFR given as 0.075 in the manual is actually representative of 0.075 units Ammonia in 1 unit of Air. Therefore, trip value has to be recalculated as 0.075 / (1 - 0.075) = 0.081 in order for it to be comparable with the AFR/Air calculation) The following additional criteria were applied to exclude any obviously nonsensical values and the corresponding operating hours (OH) eliminated: OPh > 1500 kPa OTh < 550°C AFR < 10 t NH3/h (These values were chosen arbitrarily with a view to capture and exclude such values that where obviously not valid or nonsensical) (This analysis was done in

	order to be in line with the determination of the permitted operating conditions even if it has no effect to the sets of data in this case)
Any comment:	None

Data / Parameter:	**B.5 NAP_{BC}**
Data unit:	**$tHNO_3$**
Description:	Metric tonnes of 100% concentrated nitric acid produced during the baseline campaign.
Source of data used:	Tank level measurements
Value applied:	**19,026.6**
Justification of the choice of data or description of measurement methods and procedures actually applied :	Please refer to table P. 5 NAP below for a detailed description of NAP determination. To make the adjusted tank level measurements suitable for monitoring in this CDM project, any adjustments will be done at the end of each campaign (baseline and project), in addition to the irregular intervals throughout each month. At the beginning of the baseline campaign Dongbu took a tank level measurement and adjusted the NAP number accordingly for that day to establish a correct starting point for the determination of NAP throughout the baseline. The same will be done at the end of the campaign.
Any comment:	None

Data / Parameter:	**B.6 TSG**
Data unit:	**°C**
Description:	Temperature in the stack gas
Source of data used:	Stack temperature probe situated directly next to the volume flow meter.
Value applied:	**Not applicable**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The temperature measurement of the stack gas is required to calculate the Normal Volume Flow (Nm3/h) in the stack and is not required to be reported as a separate parameter in accordance with AM0034.
Any comment:	None

Data / Parameter:	**B.7 PSG**
Data unit:	**bar**
Description:	Pressure in the stack
Source of data used:	Probe (part of the gas volume flow meter).
Value applied:	**Not applicable**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The pressure measurement of the stack gas is required to calculate the Normal Volume Flow (Nm3/h) in the stack and is not required to be reported as a separate parameter in accordance with AM0034.
Any comment:	None

Data / Parameter:	**B.8 EF_{BL}**
Data unit:	**tN2O / tHNO3**

Description:	Emissions factor for baseline period
Source of data used:	Calculated from measured data (tons of nitric acid produced / tons of N_2O emitted)
Value applied:	**0.01063**
Justification of the choice of data or description of measurement methods and procedures actually applied :	As required by AM0034 the plant specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid during the baseline campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during the baseline campaign. The overall uncertainty of the monitoring system shall also be determined and the measurement error will be expressed as a percentage (*UNC*). The product of the NCSG, VSG and OH is the total N2O mass emissions during the baseline campaign. The N_2O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) is then reduced by the percentage uncertainty as follows: $EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$
Any comment:	None

Data / Parameter:	**B.9 UNC**
Data unit:	**%**
Description:	Overall measurement uncertainty of the monitoring system
Source of data used:	Calculation of combined uncertainty of the applied monitoring equipment
Value applied:	**5.0**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034 the overall measurement uncertainty of the AMS is applied in the calculation of the baseline emissions factor (EF_{BL}). The overall total uncertainty of the AMS has been determined by SGS Environmental Services, Netherlands (an accredited ISO 17025 testing house) during the on-site QAL2 audit. The QAL2 audit report and the uncertainty calculation are available to the DOE on request.
Any comment:	None.

Data / Parameter:	**B.10 AFR**
Data unit:	**tNH3/h**
Description:	Mean Ammonia gas flow rate to the ammonia oxidation reactor
Source of data used:	Orifice plate – Differential pressure measurement principle
Value applied:	**Not applicable, monitored data of AFR will be used to determine if plant was operating outside of AFR_{max}.**

Justification of the choice of data or description of measurement methods and procedures actually applied :	The monitoring of AFR is required by AM0034 in order to determine when the plant was operating outside of AFR_{max} and to eliminate those NCSG and VSG data. The specification for the orifice is as following. FT-1201A(AFR) : 0-2500 mmH2O (0 - 0.25 kg/cm2) The flowmeter range is 0 - 3.9 tNH3/hr, The standard value of orifice is as followings. Parameter — FT-1201A Temperature (℃) — 121 Pressure (kg/cm2) — 12.8 Specific Gravity — 0.59 Flow (kg/hr) Normal — 3536 Flow (kg/hr) Maximum — 4250 The temperature, pressure and specific gravity are set as fixed value and cannot be changed.
Any comment:	None

Parameter		FT-1201A
Temperature (℃)		121
Pressure (kg/cm2)		12.8
Specific Gravity		0.59
Flow (kg/hr)	Normal	3536
	Maximum	4250

Data / Parameter:	**B.11 AFR_{max}**
Data unit:	**$kgNH_3/h$**
Description:	Maximum Ammonia flow rate to the ammonia oxidation reactor
Source of data used:	Plant operations records from previous five campaigns.
Value applied:	**3,797**
Justification of the choice of data or description of measurement methods and procedures actually applied :	AFR_{max} is used to determine those periods where the plant may be operating outside of the permitted operating conditions. The AFR data from the previous 5 campaigns was used to determine AFRmax during these campaigns. .
Any comment:	None

Data / Parameter:	**B.12 AIFR**
Data unit:	**t NH3/h / t Air/h**
Description:	Mean Ammonia to air ratio into the ammonia oxidation reactor
Source of data used:	Measurements of AFR and primary air flow rates (measured by orifice plate).
Value applied:	**Not applicable, monitored data of AIFR will be used to determine if plant was operating outside of $AIFR_{max}$.**

<table>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td>The monitoring of AIFR is required by AM0034 in order to determine $AIFR_{max}$. The allowable NH_3 to Air ratio is taken from the historic campaigns.

AIFR is obtained by dividing NH3(FT-1201A) feed by air fieed(FT-1201B).

Measurement specification of Air flow rate:
FT-1201B(air) : 0 - 12150 mmH2O (0 - 0.125 kg/cm2)

The standard value of orifice is as followings.
<table>
<tr><td colspan="2">Parameter</td><td>FT-1201B</td></tr>
<tr><td colspan="2">Temperature (℃)</td><td>249</td></tr>
<tr><td colspan="2">Pressure (kg/cm2)</td><td>12</td></tr>
<tr><td colspan="2">Specific Gravity</td><td>1.0</td></tr>
<tr><td rowspan="2">Flow (kg/hr)</td><td>Normal</td><td>52023</td></tr>
<tr><td>Maximum</td><td>60000</td></tr>
</table>
The temperature, pressure and specific gravity are set as fixed value and cannot be changed.</td></tr>
<tr><td>Any comment:</td><td>None</td></tr>
</table>

Data / Parameter:	**B.15 $AIFR_{max}$**
Data unit:	**t NH3/h / t Air/h**
Description:	Maximum Ammonia to air ratio into the ammonia oxidation reactor
Source of data used:	Calculated from measured data of AFR and primary air flow rate
Value applied:	**0.08**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034 $AIFR_{max}$ is used to determine those periods where the plant may be operating outside of the permitted operating conditions. The AIFR data from the previous 5 campaigns was used to determine $AIFR_{max}$ during these campaigns. The value of $AIFR_{max}$ is derived from the monitoring data. However, this still includes extreme values during plant start-up and shut-down. For the determination of the correct OH_{BC} (see B.4 above) the AIFR trip value was in fact applied to the complete data set. Therefore, any NCSG and VSG data measured while the plant was outside the trip values was not considered for the determination of BE_{BC}. As can be seen from the table for query 6 a + b below (section B.6.3), the allowed $AIFR_{max}$ is 0.080 but the maximum value observed from the remaining data is 0.075 and therefore below the trip value of 0.081.
Any comment:	None

Data / Parameter:	**B.13 CL_{BL}**
Data unit:	**tHNO3**
Description:	Length of the baseline campaign measured in metric tonnes of 100% concentrated nitric acid produced during that baseline campaign.
Source of data used:	NAP_{BC}
Value applied:	**19,026.6**
Justification of the choice of data or	CL_{BL} is comprised of each and every tonne of nitric acid produced during the baseline campaign, regardless of whether the measured NCSG and VSG data

description of measurement methods and procedures actually applied :	were excluded from the relevant period. In accordance with AM0034 the respective baseline campaign length for each plant (CL_{BL}) has to be compared to the established average historic campaign length (CL_{normal}); and If $CL_{BL} \leq CL_{normal}$, then all N_2O values measured during the baseline campaign can be used for the calculation of EF_{BL} (subject to the elimination of data that was monitored during times where the plant was operating outside of the "permitted range"). If $CL_{BL} > CL_{normal}$, then N_2O values that were measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) are to be eliminated from the calculation of EF_{BL}. The Baseline campaign was shorter than CL_{normal} and hence no baseline cut has to be conducted.
Any comment:	None

Data / Parameter:	**B.14 CL_{normal}**
Data unit:	**tHNO3**
Description:	Average length of the historic campaigns measured in metric tonnes of 100% concentrated nitric acid produced.
Source of data used:	Production logs
Value applied:	**20,672**
Justification of the choice of data or description of measurement methods and procedures actually applied :	CL_{normal} is used to adjust CL_{BL} and NAP_{BC} in accordance with AM0034. Please refer to table P.5 NAP below for reference. In the past, the regular readjustment of the measured nitric acid storage tank levels of the calculated NAP did not normally coincide with the end of each. campaign. Therefore, it is now impossible to derive adjusted figures for each of the historic campaigns. However, since the adjustments were done several times each month, the small imprecision in one campaign will be corrected by the number in the next campaign. Therefore, the derived average NAP from the five historic campaigns will result in a correct average NAP, which can be used as CLnormal.
Any comment:	None.

Data / Parameter:	**B.16 OT_h**
Data unit:	**°C**
Description:	Oxidation temperature for each hour during the baseline campaign
Source of data used:	Thermocouple inside Ammonia Oxidation Reactor (AOR)
Value applied:	**Not applicable used to determine if OTh during baseline campaign falls outside OT_{normal}.**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034 the oxidation temperature in the ammonia oxidation reactor (OTh) has to be monitored and compared to the Normal range for oxidation temperature (OT_{normal}). VSG and NCSG data obtained during times when OTh was above or below OT_{normal} has to be eliminated from the calculation of EF_{BL}.
Any comment:	None

Data / Parameter:	**B.17 OT_{normal}**
Data unit:	**°C (min and max)**
Description:	Normal range operating temperature during the 5 historic campaigns
Source of data used:	Thermocouples inside Ammonia Oxidation Reactor (AOR) during historical campaigns.
Value applied:	**907.3°C (min.) and 932.0°C (max.)**
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measurements are taken continuously by two thermocouples inside the AOR, all data taken during the 5 historic campaigns have been interpreted as a sample of a stochastic variable. All data falling within the upper and lower 2.5% percentile have been eliminated, the range of the remaining values represents the maximum and minimum normal operating temperatures in the AOR.
Any comment:	None

Data / Parameter:	**B.18 OP_h**
Data unit:	kPa
Description:	Oxidation Pressure for each hour
Source of data used:	Monitored by pressure transmitter.
Value applied:	**Not applicable**, **used to determine if OPh during baseline campaign falls outside OP_{normal}.**
Justification of the choice of data or description of measurement methods and procedures actually applied :	AM0034 requires the monitoring of the oxidation pressure in the ammonia oxidation reactor. In Dongbu's nitric acid plant, the pressure is measured after the air compressor discharge and not inside the ammonia oxidation reactor. However, since the location of this pressure probe remains the same during the historic campaigns, the baseline period and the project campaigns, it is appropriate to use this value for comparison of OPh between these campaigns. In accordance with AM0034 the oxidation pressure in the ammonia oxidation reactor (OPh) has to be monitored and compared to the Normal range for oxidation temperature (OP_{normal}). VSG and NCSG data obtained during times when OPh was above or below OP_{normal} has to be eliminated from the calculation of EF_{BL}.
Any comment:	None

Data / Parameter:	**B.19 OP_{normal}**
Data unit:	kPa
Description:	Oxidation Pressure for each hour during the five historic campaigns.
Source of data used:	Monitored by pressure transmitter
Value applied:	**1087.5 kPa – 1283.9 kPa**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034 the oxidation pressure in the ammonia oxidation reactor during the five historic campaigns is used to determine the normal range of operating pressures (OPnormal). All data taken during the 5 historic campaigns have been interpreted as a sample of a stochastic variable. All data falling within the upper and lower 2.5% percentile have been eliminated; the range of the remaining values represents the maximum and minimum normal operating temperatures in the AOR.

Any comment:	None

Data / Parameter:	**B.20 GS_{normal}**
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the five historic campaigns
Source of data used:	Monitored / Invoices
Value applied:	**Johnson Matthey Noble Metals**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value for GS_{normal} is only a plausibility check; the decisive value in determining if the baseline campaign data is applicable is the comparison of GC_{normal} and GC_{BL}. Dongbu has been using gauzes supplied by Johnson Matthey continuously for the past several years.
Any comment:	None

Data / Parameter:	**B.21 GS_{BL}**
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the baseline campaign
Source of data used:	Monitored / Invoices
Value applied:	**Johnson Matthey Noble Metals**
Justification of the choice of data or description of measurement methods and procedures actually applied :	AM0034 requires the monitoring of the supplier of the ammonia oxidation catalyst gauze. The recorded information is not further processed in the methodology but it is used as a plausibility check against the information for GC.
Any comment:	None

Data / Parameter:	**B.23 GC_{normal}**
Data unit:	**%**
Description:	Gauze composition during the five historic operating campaigns expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Source of data used:	Monitored / Gauze supplier invoices
Value applied:	**Platinum (Pt) 90%** **Rhodium (Rh) 5%** **Palladium (Pd) 5%**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034, if the composition of the ammonia oxidation catalyst used for the baseline campaign and after the implementation of the project are identical to that used in the campaign for setting the operating conditions (previous five campaigns), then there shall be no limitations on N_2O baseline emissions.
Any comment:	None

Data / Parameter:	**B.24 GC_{BL}**
Data unit:	**%**
Description:	Gauze composition during the baseline campaign expressed as percentage by

	weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Source of data used:	Monitored / Gauze supplier invoices
Value applied:	**Platinum (Pt) 90%** **Rhodium (Rh) 5%** **Palladium (Pd) 5%**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034, if the composition of the ammonia oxidation catalyst used for the baseline campaign and after the implementation of the project are identical to that used in the campaign for setting the operating conditions (previous five campaigns), then there shall be no limitations on N_2O baseline emissions. Since the values for GC are the same during the baseline campaign as during the historic campaigns, there is no limitation on the N_2O baseline emissions.
Any comment:	None

Data / Parameter:	**B.26 EF_{reg}**
Data unit:	**$tN_2O/tHNO_3$**
Description:	Emissions cap for N_2O from nitric acid production set by government regulation
Source of data used:	Ministry of Environment
Value applied:	**None**
Justification of the choice of data or description of measurement methods and procedures actually applied :	There is currently no regulation in Korea that limits the emissions of N2O from nitric acid production. The development of regulations will be checked regularly for any possible developments towards a regulatory limit for N2O emissions. If such regulation should be implemented, the corresponding regulatory emissions factor EF_{reg} will be established in accordance with AM0034.
Any comment:	None.

Annex 2: Data and parameters for calculation of Project campaign emissions

All of the monitoring equipment used to derive the data for this Monitoring Report has been made part of the ISO 9001/14001 procedures.

All of the data obtained and used as part of the baseline and during the crediting period of the project will be archived electronically for at least 2 years in at least 2 different locations.

Data / Parameter:	**P.1 NCSG**
Data unit:	**mg / m³**
Description:	N_2O concentration in the stack gas during each project campaign.
Source of data to be used:	NDIR N_2O gas analyser (ABB AO2000 Uras-26)
Value of data applied	**1,138**
Description of measurement methods and procedures to be applied:	AM0034 requires the determination of the concentration of N_2O in the stack gas. NCSG is continuously monitored with the gas analyser (The original gas analyser was replaced by a ABB AO2000 Uras 26 analyser before the first project campaign in order to ensure better on site service by a local company.). Monitoring results are recorded for every two seconds of plant operation. Hourly means for NCSG are derived from the collected data. NCSG data taken during times when the respective plant was operating outside the permitted operating range were eliminated. The remaining NCSG values where subjected to the following adjustment. The analyser reads ppmv (parts per million in volume); in order to obtain mg/Nm³ is necessary use the next equation: $NCSG = ppmv * \frac{RMM}{v}$ Where: *NCSG* is N_2O concentration in the stack gas (mg/N m³) *ppmv* means parts per million in volume *RMM* means relative molecular mass of N_2O (44.013 mg) *v* means standard volume of an ideal gas (22.4 Nm³) The resulting hourly average NCSG values are now expressed in mg/Nm³ as required by AM0034 and where subsequently subjected to the following statistical analysis: a) Calculate the sample mean (x) b) Calculate the sample standard deviation (s) c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation) d) Eliminate all data that lie outside the 95% confidence interval e) Calculate the new sample mean from the remaining NCSG values During the QAL2 reference measurements it was determined that the analyser

	the QAL2 calibration curve, it was determined that a correction factor of 1.021 will have to be applied to all NCSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean NCSG value will be multiplied by 1.021 before going into the calculation of PE_n
QA/QC procedures to be applied:	Manual zero and span calibrations are carried out every three weeks. See Monitoring Plan for more details.
Any comment:	After the installation of the new N_2O analyzer in February 2008, a new QAL2 test was performed for the analyzer in March 2008 by Müller-BBM GmbH, Germany an accredited testing laboratory according to ISO/IEC 17025. The tests were performed according to EN 14181 in order to ensure the AMS' suitability, establish the calibration curve and test the variability of the measurements. The results were applied in the calculation of EF_n.

Data / Parameter:	**P.2 VSG**
Data unit:	**Nm³/h**
Description:	Normal gas volume flow rate of the stack gas during each project campaign.
Source of data to be used:	Gas Volume Flow meter, Systec DF25
Value of data applied	**43,569**
Description of measurement methods and procedures to be applied:	AM0034 requires the determination of the gas volume flow (VSG) in the stack. VSG is continuously monitored with a flow meter (operational since Jan 29, 2007) and monitoring results are recorded for every two seconds of plant operation. Hourly means for VSG are derived from the collected data. VSG data taken during times when the respective plant was operating outside the permitted operating range were eliminated. The remaining VSG data series has been subjected to the following adjustment. The flow meter was installed with an operational range of 0 – 10 mbar of differential pressure. To obtain the flow (Nm3/h) at normal conditions (101.325 kPa and 0°C) from measured differential pressure the instrument equation - taken from the AMS manual – is used which includes pressure and temperature correction factors. Calculation formula (standard volume flow): $V_n = K_x * \frac{\sqrt{P}}{\sqrt{(273,15+T)}} * \sqrt{dP}$ whereby: $K_x = \frac{0,020763 * D^2 * k}{\sqrt{\rho_N}}$ calculated: Kx = 7774 Where: VSG means standard volume flow (Nm3/h) D means stack inner diameter (mm) ρ_N means standard density (kg/Nm3) k means instrument correction factor (specific for each individual instrument) P means pressure working conditions (mbar) T means temperature working conditions (°C) Δ P means differential pressure (mbar) 0.020763 is the unit conversion factor The resulting hourly average VSG values are now expressed in Nm³/h as required

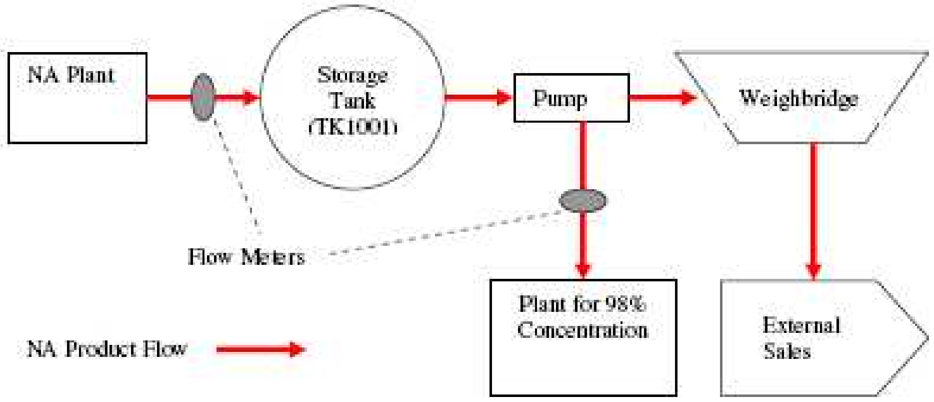
	by AM0034 and where subsequently subjected to the following statistical analysis: a) Calculate the sample mean (x) b) Calculate the sample standard deviation (s) c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation) d) Eliminate all data that lie outside the 95% confidence interval e) e) Calculate the new sample mean from the remaining VSG values f) During the QAL2 reference measurements it was determined that the flow meter's range is set lower than the maximum flow in the stack. As a result, the flow meter consistently underestimates the total gas volume flow in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 1.096 will have to be applied to all VSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean VSG value will be multiplied by 1.096 before going into the calculation of PE_n.
QA/QC procedures to be applied:	The flow meter is tested once per year during the AST test according to EN 14181. If the flow meter fails to pass the AST test, the pressure transmitter of the instrument needs to be recalibrated by the manufacturer or by the plant operator. The probe of the flow meter itself does not need to be calibrated since it is a physical devise which will not have drift. Therefore, it is sufficient to regularly inspect the physical condition of the probe.
Any comment:	None.

Data / Parameter:	**P.3 PE_n**
Data unit:	**tN_2O**
Description:	Total mass N_2O emissions in each project campaign.
Source of data to be used:	Calculated from the measurements from measured data.
Value of data applied	**83,7**
Description of measurement methods and procedures to be applied:	Not applicable, calculated value as per the following formula: $PE_n = VSG * NCSG * 10^{-9} * OH$ A special adjustment factor is applied to the mean NCSG and VSG values derived. During the QAL2 reference measurements it was determined that the analyser consistently underestimates the N_2O concentration in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 1.021 will have to be applied to all NCSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean NCSG value will be multiplied by 1.021 before going into the calculation of PE_n As a result from the QAL2 calibration curve, it was determined that a correction factor of 1.096 will have to be applied to all VSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean VSG value will be multiplied by 1.096 before going into the calculation of PE_n..
QA/QC procedures to be applied:	Not applicable. Calculated value.
Any comment:	None.

Data / Parameter:	P.4 OH_n
Data unit:	**hours**
Description:	Total operating hours during each project campaign
Source of data to be used:	Production log
Value of data applied	**1,509**
Description of measurement methods and procedures to be applied:	Required by AM0034 to determine the total mass emissions of N_2O during each project campaign.
QA/QC procedures to be applied:	Every hour of operation for which there is a record of nitric acid produced will be considered as an operational hour for the purposes of BE_{BC} calculation. However, if the plant exceeds certain design parameters, it will automatically shut down ("trip limits"). Periods during the ongoing campaign during which the plant was considered not in operation will be eliminated from the determination of OH. The plant was considered to be not in operation when any of the following parameters where outside the "trip" limits as determined by the plant manuals: AIFR > 0.081 (i.e. if the Ammonia concentration in Air is higher than 8.1%, the plant shuts itself off automatically. The trip value for AIFR given as 0.075 in the manual is actually representative of 0.075 units Ammonia in 1 unit of Air. Therefore, trip value has to be recalculated as 0.075 / (1 - 0.075) = 0.081 in order for it to be comparable with the AFR/Air calculation) OPh > 1500 kPa The following additional criteria were applied to exclude any obviously nonsensical values and the corresponding operating hours (OH) eliminated: OTh < 550°C AFR = 10 t NH3/h (These values were chosen arbitrarily with a view to capture and exclude such values that where obviously not valid or nonsensical)
Any comment:	None.

Data / Parameter:	P.5 NAP
Data unit:	**$tHNO_3$**
Description:	Metric tonnes of 100% concentrated nitric acid during each project campaign.
Source of data to be used:	Production log
Value of data applied	**19,026**
Description of measurement methods and procedures to be applied:	Dongbu has a liquid flow meter (coriolis) installed in the product line out of the absorption column into the storage tank (TK1001). This flow meter delivers continuous measurements into the control room, logged by hand on daily log sheets and Dongbu's data acquisition system. However, the measurements are assuming standard acid concentration of 65% and standard specific gravity of 1.373. In addition, every day at midnight a measurement of the acid level inside the storage tank is taken.

	Diagram of Dongbu's Nitric Acid Product Flow



Each day at 8:00 a.m. two samples are taken, one from the product line (V1001) before the storage tank and one from the storage tank itself (TK1001), both are then analysed in the on-site lab for temperature and specific gravity. Subsequently the specific concentration is derived from a standard specific gravity table.

The results from this analysis are then used to adjust the flow meter and tank level measurements according to the determined specific concentration.

There are two consumers out of the storage tank: Dongbu's own concentration plant which converts the 65% concentrated nitric acid into 98% concentrated nitric acid and external sales. The product flow pipe to the concentration plant is again equipped with a flow meter. The external sales leave the site by tank-truck each of which has to pass the on-site weighbridge before and after loading to determine the weight of nitric acid sold.
Each day the total production volume of the nitric acid plant is calculated according to the following formula:

  Today's tank level
– Yesterday's tank level
\+ Weighbridge sales
\+ Flow meter measurements from tank to concentration plant
\+ Blending (60, 68 and 70%) nitric acid
– 98% concentrated acid transfer
= Total daily NA Production

The total daily NA production figures are accumulated for monthly NA production.
Dongbu produces nitric acid in two different concentrations (65 and 98%) but it sells nitric acid in five different concentrations (60, 65, 68, 70 and 98%). Therefore, at least once per month the NA production figure is adjusted for these differences in concentrations.
This calculated NA production figure is considered the most reliable and accurate by Dongbu and is therefore the figure used for accounting, planning and reporting purposes. Therefore, this is the figure that will also be used for the purposes of this CDM project.
To make it suitable for monitoring in this CDM project, any adjustments will be done at the end of each campaign (baseline and project), in addition to the

	irregular intervals throughout each month. At the beginning of the baseline period Dongbu will also take a tank level measurement and adjust this number accordingly to establish a correct starting point for the determination of NAP throughout the baseline. In addition to the irregular adjustments throughout each month and in addition to the adjustments at the end of each campaign, Dongbu will also take a tank level measurement and adjust this number accordingly to establish a correct end point for the determination of NAP throughout the baseline. Through this procedure it is ensured that an accurate NAP is established for the baseline period as well as for each project campaign for the correct calculation of EF_{BL} and EF_P. The total value of NAP that can be applied for the calculation of CERs in any one calendar year may not exceed the design capacity (daily plant capacity and assuming 365 days of operation per year). For Dongbu this effective NAP-cap is 300 tHNO3/day * 365 days = 109,500 tHNO3
QA/QC procedures to be applied:	ISO 9001 procedures and documented in the applicable ISO handbooks.
Any comment:	None

Data / Parameter:	**P.6 TSG**
Data unit:	**°C**
Description:	Temperature in the stack gas
Source of data to be used:	Stack temperature probe situated directly next to the volume flow meter.
Value of data applied	**Not applicable**
Description of measurement methods and procedures to be applied:	The temperature measurement of the stack gas is required to calculate the Normal Volume Flow (Nm3/h) in the stack and is not required to be reported as a separate parameter in accordance with AM0034.
QA/QC procedures to be applied:	ISO9001 procedures and documented in the applicable ISO handbooks.
Any comment:	None.

Data / Parameter:	**P.7 PSG**
Data unit:	**bar**
Description:	Pressure in the stack
Source of data to be used:	Probe (part of the gas volume flow meter).
Value of data applied	**Not applicable.**
Description of measurement methods and procedures to be applied:	The pressure measurement of the stack gas is required to calculate the Normal Volume Flow (Nm3/h) in the stack and is not required to be reported as a separate parameter in accordance with AM0034.
QA/QC procedures to be applied:	ISO9001procedures and documented in the applicable ISO handbooks.
Any comment:	None.

Data / Parameter:	**P.8 EF_n**
Data unit:	**$tN_2O/tHNO_3$**

Description:	Emissions factor for campaign n.
Source of data to be used:	Calculation from total mass N_2O emissions of campaign n (PE_n) and total nitric acid production (NAP_n).
Value of data applied	0.0044
Description of measurement methods and procedures to be applied:	The campaign specific emissions factor for each campaign during the project's crediting period is calculated by dividing the total mass of N_2O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign. For campaign n the campaign specific emission factor would be: $EF_n = PE_n / NAP_n$
QA/QC procedures to be applied:	Not applicable.
Any comment:	None

Data / Parameter:	**P.9 $EF_{ma,n}$**
Data unit:	**$tN_2O/tHNO_3$**
Description:	Moving average emissions factor derived over time from campaign specific emissions factors.
Source of data to be used:	Calculation from campaign specific emissions factors EF_n.
Value of data applied	0.0044
Description of measurement methods and procedures to be applied:	In order to take into account possible long-term emissions trends over the duration of the project activity and to take a conservative approach a moving average emission factor shall be estimated as follows: $EF_{ma,n} = (EF_1 + EF_2 + \ldots + EF_n) / n$ This process is repeated for each campaign such that a moving average, $EF_{ma,n}$ is established over time, becoming more representative and precise with each additional campaign.
QA/QC procedures to be applied:	Not applicable.
Any comment:	None

Data / Parameter:	**P.12 CL_n**
Data unit:	**$tHNO_3$**
Description:	Length of each project campaign measured in metric tonnes of 100% concentrated nitric acid produced during that campaign.
Source of data to be used:	NAP
Value of data applied	**19,026**
Description of measurement methods and procedures to be applied:	In accordance with AM0034 the project length (CL_n) has to be compared to the established average historic campaign length (CL_{normal}); and If the length of each individual project campaign CL_n is longer than or equal to the average historic campaign length CL_{normal}, then all N_2O values measured during the baseline campaign can be used for the calculation of EF (subject to the elimination of data from the Ammonia/Air analysis). If $CL_n < CL_{normal}$, recalculate EF_{BL} by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last

	tonnes produced) from the calculation of EF_{BL}.
QA/QC procedures to be applied:	See comments for NAP.
Any comment:	None.

Data / Parameter:	**P.13 EF_p**
Data unit:	**$tN_2O/tHNO_3$**
Description:	Emissions factor used for the specific campaign n to determine the emission reductions of that campaign
Source of data to be used:	Calculation of EF_n and $EF_{ma,n}$.
Value of data applied	0.0044
Description of measurement methods and procedures to be applied:	To calculate the total emission reductions achieved in a campaign, the higher of the two values $EF_{ma,n}$ and EF_n shall be applied as the emission factor relevant for the particular campaign to be used to calculate emissions reductions (EF_P). Thus: If $EF_{ma,n} > EF_n$ then $EF_P = EF_{ma,n}$ If $EF_{ma,n} < EF_n$ then $EF_P = EF_n$
QA/QC procedures to be applied:	Not applicable.
Any comment:	None

Data / Parameter:	**P.14 EF_{min}**
Data unit:	**$tN_2O/tHNO_3$**
Description:	EF_{min} is equal to the lowest EF_n observed during the first 10 campaigns of the project crediting period.
Source of data to be used:	Calculations of $EF_{ma,n}$.
Value of data applied	0.0044
Description of measurement methods and procedures to be applied:	A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum (EF_{min}). If any of the later project campaigns results in a EF_n that is lower than EF_{min}, the calculation of the emission reductions for that particular campaign shall used EF_{min} and not EF_n.
QA/QC procedures to be applied:	Not applicable.
Any comment:	None.

Data / Parameter:	**OP_h**
Data unit:	**bar**
Description:	Oxidation Pressure for each hour
Source of data to be used:	Monitored by pressure transmitter.
Value of data applied	**Not applicable. Used to determine whether the plant is in operation or not**
Description of	AM0034 requires the monitoring of the oxidation pressure in the ammonia

measurement methods and procedures to be applied:	oxidation reactor. In Dongbu's nitric acid plant, the pressure is measured after the air compressor discharge and not inside the ammonia oxidation reactor. However, since the location of this pressure probe remains the same during the historic campaigns, the baseline period and the project campaigns, it is appropriate to use this value for comparison of OPh between these campaigns. In accordance with AM0034 the oxidation pressure in the ammonia oxidation reactor (OPh) has to be monitored and compared to the Normal range for oxidation temperature (OP_{normal}). VSG and NCSG data obtained during times when OPh was above or below OP_{normal} has to be eliminated from the calculation of EF_{BL}. During project campaigns the OPh is only used to define if the plant is in operation or not (trip-value)
QA/QC procedures to be applied:	Subject to ISO 9001 procedures.
Any comment:	None.

Data / Parameter:	**OTh**
Data unit:	**°C**
Description:	Oxidation temperature in the ammonia oxidation reactor (AOR).
Source of data to be used:	Thermocouple inside Ammonia Oxidation Reactor (AOR)
Value of data applied	**Not applicable. Used to determine whether the plant is in operation or not**
Description of measurement methods and procedures to be applied:	In accordance with AM0034 the oxidation temperature in the ammonia oxidation reactor (OTh) has to be monitored and compared to the Normal range for oxidation temperature (OT_{normal}). VSG and NCSG data obtained during times when OTh was above or below OT_{normal} has to be eliminated from the calculation of EF_{BL}. During project campaigns the OTh is only used to define if the plant is in operation or not (trip-value)
QA/QC procedures to be applied:	Subject to ISO 9001 procedures.
Any comment:	None.

Data / Parameter:	**AFR**
Data unit:	**tNH_3/h**
Description:	Ammonia gas flow rate to the ammonia oxidation reactor.
Source of data to be used:	Measurements of AFR and primary air flow rates (measured by orifice plate).
Value of data applied	**Not applicable, monitored data of AFR will be used to determine whether the plant is in operation or not**
Description of measurement methods and procedures to be applied:	The ammonia flow is continuously measured by orifice plate. During project campaigns the AFR is only used to define if the plant is in operation or not (trip-value)

QA/QC procedures to be applied:	Subject to ISO 9001 procedures.
Any comment:	None.

Data / Parameter:	**AIFR**
Data unit:	**% v/v**
Description:	Ammonia to air ratio into the ammonia oxidation reactor
Source of data to be used:	Measurements of AFR and primary air flow rates (measured by orifice plate).
Value of data applied	**Not applicable, monitored data of AIFR will be used to determine whether the plant is in operation or not**
Description of measurement methods and procedures to be applied:	During project campaigns the AIFR is only used to define if the plant is in operation or not (trip-value)
QA/QC procedures to be applied:	Subject to ISO 9001procedures.
Any comment:	None.

Data / Parameter:	**$GS_{project}$**
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the project campaign
Source of data used:	Monitored / Invoices
Value applied:	**Johnson Matthey Noble Metals**
Justification of the choice of data or description of measurement methods and procedures actually applied :	AM0034 requires the monitoring of the supplier of the ammonia oxidation catalyst gauze. The recorded information is not further processed in the methodology but it is used as a plausibility check against the information for GC.
Any comment:	None

Data / Parameter:	**$GC_{project}$**
Data unit:	**%**
Description:	Gauze composition during the project campaign expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Source of data used:	Monitored / Gauze supplier invoices
Value applied:	**Platinum (Pt) 90%** **Rhodium (Rh) 5%** **Palladium (Pd) 5%**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The gauze composition during the baseline and historic campaigns is the same as during the project campaign. Therefore the results of the baseline campaign and the project campaign are fully valid and applicable.
Any comment:	None