Project for the catalytic reduction of N_2O emissions with a secondary catalyst inside the ammonia reactor of the nitric acid plant at Dongbu Hannong Chemicals Ltd., Ulsan, Korea ("Dongbu").

Ref.-Nr. 1443

Application for "Revision to the Monitoring Plan"

Date: 22/03/2012

Extract of relevant passage from registered PDD (version 2.1 dated 30/03/2010).

Section B.7 of PDD with marked Track Changes

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

B.7.1 Data and parameters monitored:

The monitoring procedures as described for each parameter below are an integral part of the company's ISO 9001 QA system, certified to and audited by "The Standards Institution of Korea".

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 N_2O / m^3 (converted from ppmv, if necessary)
Description:	N_2O concentration in the stack gas during each project campaign.
Source of data to be used:	ADC MGA 3000 gas analyser[1]
Value of data applied for the purpose of calculating expected emission reductions in section B.5	To be determined during project campaigns.
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. 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)

[1] The ADC MGA 3000 is currently undergoing the suitability testing to be certified under QAL1 of ISO 14956 and EN14181. It is expected that the suitability testing will be concluded and certification is expected occur by late 2007.

	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
QA/QC procedures to be applied:	Zero calibration gas is pure N2 with a certified accuracy of +/- 2% is supplied by MS General Gas Co. in Korea (analytical report available on site for DOE to inspect). The zero gas cylinder must always be open and connected to the analyser. Analyser is set to automatic zero calibration every 8 hours. At the end of the zero calibration, the zero point is reset automatically by the analyser. Span calibration gas is 2007 μmol/mol N_2O in Air with a certified accuracy of +/- 2% is supplied by Research Institute of Gas Analytical Science (RIGAS) (analytical report available on site for DOE to inspect). Dongbu plant staff conduct a span calibration once per week. At the end of the span calibration, the measuring output of the analyser has to be reset manually by the person conducting the span calibration. The person conducting the calibration has to fill out the calibration log-sheet with the following information
Any comment:	None.

Data / Parameter:	**P.2 VSG**
Data unit:	Nm^3/h
Description:	Normal gas volume flow rate of the stack gas during each project campaign
Source of data to be used:	Systec DF25 [2]
Value of data applied for the purpose of calculating expected emission reductions in section B.5	To be determined during project campaigns.
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 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. $VSG = \frac{0.020763 * D^2 * k}{\sqrt{\rho_N}} * \frac{\sqrt{P}}{\sqrt{(273.15+T)}} * \sqrt{dP}$ Where:

[2] The Systec Flow meter has already been approved by TÜV under the German 17. BImSchV.

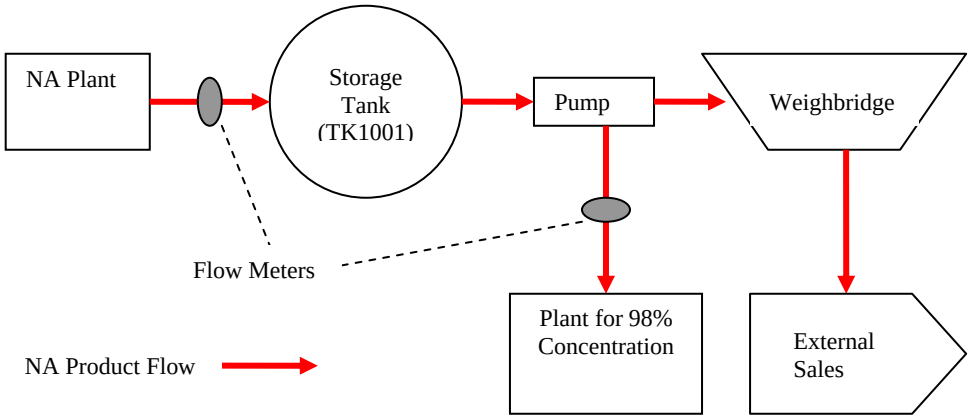
	VSG means standard volume flow (Nm^3/h) *D* means stack inner diameter (mm) ρN means standard density (kg/Nm^3) *k* means instrument correction factor (specific for each individual instrument) *P* means pressure working conditions (mbar) *T* means temperature working conditions (°C) ΔP means differential 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) Calculate the new sample mean from the remaining VSG values
QA/QC procedures to be applied:	After each campaign the flow meter probe and the thermocouple need to be taken out of the stack and inspected for physical condition. The person doing this has to fill out the flow meter inspection log-sheet with the following information: Date, Time, Name, confirmation that flow meter probe and thermocouple were taken out of the stack, general description of the condition of the probes, confirmation that both were re-installed correctly. Also, the differential pressure transmitter is disconnected from the Flow Tube and the transmitter is then connected to an absolute pressure simulator and the pressure transmitter is readjusted as appropriate. Once per year (max. after 14 months of continuous operation), the pressure transducer on the flow meter has to be taken off the flow meter and connected to an absolute pressure simulator for readjustment, if necessary. The flow meter probe (pitot tube) itself does not need to be calibrated since it is a physical device which will not have drift.
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 for the purpose of calculating expected emission reductions in	To be determined during project campaigns.

section B.5	
Description of measurement methods and procedures to be applied:	Not applicable, calculated value as per the following formula: $PE_n = VSG * NCSG * 10^{-9} * OH$
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 for the purpose of calculating expected emission reductions in section B.5	To be determined during project campaigns.
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 (PE_n).
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"). The plant is considered to be not in operation when any of the following parameters is outside the "trip" limits as determined by the plant manuals: AIFR > 0.075 (i.e. if the Ammonia concentration in Air is higher than 7.5%) OTh > 955°C OPh < 10.55 bar Periods during the ongoing campaign during which the plant was outside the trip limits will be eliminated from the determination of OH.
Any comment:	None.

Data / Parameter:	**P.5 NAP**
Data unit:	$tHNO_3$
Description:	Metric tonnes of 100% concentrated nitric acid produced during each project campaign.
Source of data to be used:	Coriolis mass flow meter (possibly production log and lab records)
Value of data applied for the purpose of calculating expected	To be determined during project campaigns.

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	***1.) Description of original means for NAP determination (used until 20/10/2010)*** 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. <u>Diagramme of Dongbu's Nitric Acid Product Flow:</u>  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 specific concentration and specific gravity. The results from this analysis are then used to adjust the flow meter and tank level measurements according to the measured specific concentration and gravity. 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 $tHNO_3$/day * 365 days = 109,500 $tHNO_3$ ***2.) Description of new means for NAP determination (used as primary determination method from 21/10/2010 onwards)*** A new and calibrated coriolis mass flow meter (Tag-Nr. FQI-1303) was installed into the product line between the outlet of the nitric acid plant and the first storage tank (TK1001) on 25/06/2010. This new device is used for direct measurement of NAP during project operation thus replacing the previously used (multi source) determination method (see above). The device provides for mass flow measurement with integrated concentration measurement (coriolis flow meter). The mass flow is measured at actual concentration, however by using the integrated concentration measurement the mass flow is also transferred to mass flow at 100% concentration. Both mass flow signals at “actual” and “100%” concentration can be extracted.

	In addition to the automatic measurement of nitric acid concentration by the coriolis flow meter, the nitric acid concentration is also measured manually by regular sampling and laboratory analysis (as detailed above). In case the automatic concentration measurement of the coriolis meter fails or is not available the results from the manual determination of nitric acid concentration (sampling and laboratory analysis) will be used instead. Moreover in case of complete failure of the newly installed coriolis mass flow meter the previously used multi source determination method will be re-activated as a quick back-up/fall-back option in order to cover the time period until adequate replacement of the device (coriolis flow meter) has taken place.
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:	Temperature Probe (part of gas volume flow meter)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable
Description of measurement methods and procedures to be applied:	The temperature measurements of the stack gas are required to calculate the Normal Volume Flow (Nm^3/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.6 TSG**
Data unit:	°C
Description:	Temperature in the stack gas
Source of data to be used:	Temperature Probe (part of gas volume flow meter)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable
Description of measurement methods and procedures to be applied:	The temperature measurements of the stack gas are required to calculate the Normal Volume Flow (Nm^3/h) in the stack and is not required to be reported as a separate parameter in accordance with AM0034.
QA/QC procedures to	ISO9001 procedures and documented in the applicable ISO handbooks.

be applied:	
Any comment:	None.

Data / Parameter:	**P.7 PSG**
Data unit:	bar
Description:	Pressure of stack gas
Source of data to be used:	Pressure Probe (part of gas volume flow meter)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable.
Description of measurement methods and procedures to be applied:	AM0034 requires the determination of gas volume flow at normal conditions in the stack. In order to calculate from the measured VSG values to VSG at normal conditions, the actual pressure in the stack has to be determined and applied to each hourly mean VSG value. The measurements are taken continuously by a pressure probe inside the stack very close to the stack gas volume flow meter.
QA/QC procedures to be applied:	ISO9001/14001 procedures 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 for the purpose of calculating expected emission reductions in section B.5	To be determined during project campaigns.
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 for the purpose of calculating expected emission reductions in section B.5	To be determined during project campaigns, starting with the second project campaign.
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.10 AFR**
Data unit:	$kgNH_3/h$
Description:	Ammonia gas flow rate to the Ammonia Oxidation Reactor (AOR)
Source of data to be used:	Monitored by Orifice plate
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable, monitored data of AFR will be used to determine if plant was operating outside of AFR_{max}.
Description of measurement methods and procedures to be applied:	The ammonia flow is continuously measured by orifice plate.
QA/QC procedures to be applied:	ISO9001 procedures and documented in the applicable ISO handbooks.
Any comment:	A new ammonia gas mass flow meter or dp volume meter will be installed shortly.

Data / Parameter:	**P.11 AIFR**
Data unit:	% v/v
Description:	Ammonia to air ratio into the ammonia oxidation reactor
Source of data to be used:	Calculation for each hour of plant operation based on measurements of AFR and primary air flow rates.

Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable, monitored data of AIFR will be used to determine if plant was operating outside of $AIFR_{max}$.
Description of measurement methods and procedures to be applied:	The monitoring of AIFR is required by AM0034 in order to determine whether the plant was operating within the permitted operating range. During the analysis of the measured data, any of the NCSG and VSG data obtained from an hour during which the AIFR was above $AIFR_{max}$ will be eliminated from the calculation of EF_P.
QA/QC procedures to be applied:	ISO9001 procedures and documented in the applicable ISO handbooks.
Any comment:	AM0034 (Version 02) states that the units for AIFR should be m^3/h, this is a mistake. AIFR should be expressed as a ratio or percentage volume by volume of Ammonia in Air.

Data / Parameter:	**P.12 CL_p**
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 for the purpose of calculating expected emission reductions in section B.5	To be determined during project campaigns.
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_n.
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 for the purpose of calculating expected emission reductions in section B.5	To be determined during project campaigns.
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 for the purpose of calculating expected emission reductions in section B.5	Not available yet.
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:	**P.15 OPh**
Data unit:	Bar (gauge)
Description:	Oxidation Pressure for each hour during each project campaign.
Source of data to be used:	Monitored by pressure transmitter.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. Used to determine when plant is operating outside of permitted range (OP_{normal})

Description of measurement methods and procedures to be 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 OP_h between these campaigns. In accordance with AM0034 the oxidation pressure in the ammonia oxidation reactor (OP_h) 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}. The design level of OPh is 1188 Kpa.
QA/QC procedures to be applied:	Subject to ISO 9001 procedures.
Any comment:	None.

Data / Parameter:	**P.16 OTh**
Data unit:	°C
Description:	Oxidation temperature in the ammonia oxidation reactor (AOR).
Source of data to be used:	2 thermocouples inside Ammonia Oxidation Reactor (AOR)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. Used to determine when plant is operating outside of permitted range.
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_n.
QA/QC procedures to be applied:	Subject to ISO 9001 procedures.
Any comment:	None.

Data / Parameter:	**P.17 GS_{PC}**
Data unit:	Name of supplier.
Description:	Gauze supplier for the project campaign
Source of data used:	Monitored / Invoices
Value applied:	Not available yet.
Justification of the choice of data or description of measurement methods and procedures actually applied :	See B.20.

Any comment:	Dongbu expects to continue to source its gauzes from Johnson Matthey in the foreseeable future.

Data / Parameter:	**P.18 $GC_{project}$**
Data unit:	%
Description:	Gauze composition during each 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 / Invoices
Value applied:	To be obtained during the project campaigns.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The gauze composition during the project needs to be monitored and compared to GC_{BL}. If the operator has changed the gauze composition during a project campaign to a composition not used during the baseline campaign, the baseline campaign may have to be repeated or a conservative IPCC default emissions factor applied.
Any comment:	None.

B.7.2 Description of the monitoring plan:

The emission reductions achieved by the project activity will be monitored using 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"*[3] as a guidance 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' nitric acid plant was installed and commissioned on 29 January. As an operator of the nitric acid plants for many years and of dedicated NO_X and other emissions monitoring equipment, 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).

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.

Please see Annex 4 for a detailed description of the Automated Monitoring System (AMS) installed at Dongbu' nitric acid plant and for background information on EN 14181 and the practical implications for using this standard for guidance in the implementation of this CDM project activity.

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

QAL 1

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.

At the time of commissioning of the AMS by Dongbu in January 2007, only one analyser was available that has been certified suitable for N_2O monitoring under QAL 1 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 is successfully completed and certification obtained before the end of 2007.

[3] 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.

The flow meter has been tested and certified by TÜV Nord under 17. BImSchV and therefore does not require an additional QAL1 certification.

The Analyser and Flow Meter were calibrated by the vendors (ADC and Systec) prior to shipment and installation in the nitric acid plant.

QAL2 and Standard Reference Measurements (SRM)

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 5 years according to EN 14181 but also after major changes to the plant or changes or repairs to the AMS.

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.

The difficulty again with fully complying with EN14181 again is the lack of a regulatory N_2O emissions level and lack of a testing house or laboratory in Korea that would meet the accreditation requirements of EN14181.

However, a series of QAL2 specific reference measurements using a the SRM method as per EN 14181 has been carried out at the plant in March and June 2007 by an accredited testing house to ensure the AMS' suitability, establish the calibration curve and test the variability of the measurements. The results of these SRM and QAL2 are available to the DOE as part of the validation 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}.

AMS calibration and QA/QC procedures

The calibration procedures for the complete AMS are an integral part of the company's ISO 9001 QA system, certified to and audited by an accredited ISO 9001 auditing company.

Zero Calibration

Zero calibration gas is pure N2 with a certified accuracy of +/- 2% is supplied by MS General Gas Co. in Korea (analytical report available on site for DOE to inspect). The zero gas cylinder must always be open and connected to the analyser.

Analyser is set to automatic zero calibration every 24 hours. At the end of the zero calibration, the zero point is reset automatically by the analyser.

Span Calibration

The analyser range is 3000ppmv. Span calibration gas is 2096 μmol/mol (i.e. 2096ppm) N_2O in Air with a certified accuracy of +/- 2% is supplied by Research Institute of Gas Analytical Science (RIGAS) (analytical report available on site for DOE to inspect).

Before the beginning of the first project campaign the analyser will be re-ranged to 1000 or 1500 ppmv and a new bottle of calibration gas should be purchased with an N_2O concentration of between 60% and 80% of the new range of the analyser.

Dongbu plant staff conduct a span calibration once per week. At the end of the span calibration, the measuring output of the analyser has to be reset manually by the person conducting the span calibration. The person conducting the calibration has to fill out the calibration log-sheet with the following information:

Date, Time, Name, Reading of analyser with span calibration gas, confirm resetting of analyser.

Alarm settings & corresponding analyser output

The following alarm conditions are programmed in the analyser and CEM-Suite software

1. Analyser Calibration: OK / Alarm
2. Analyser Flow: OK / Alarm
3. Dryer Temperature: OK / Alarm
4. Dryer Flow: OK / Alarm

Alarm procedures:

→ 2. + 4. means that there is no compressed air flow ("purge air")

→ 2. + 3. Dryer Temperature too low, which is likely to be a failure of the heater-dryer system. If the failure is permanent, the heater will have to be replaced. Korins will have spare heater available to be delivered on site.

→ 2. means that the flow to the analyser is too high or too low. Since the Dryer flow is not showing up, the problem is not with the Dryer but either with the sample line (e.g. blockage) or with the flow directly into the analyser.

a) turn off the flow of the sample pump in the cabinet (red button at front of cabinet)

b) investigate the problem (e.g. the sample pipes etc.)

Minigas Dryer and Pump

The operating condition data readings of the Minigas Dryer at the stack should be visually checked once per day by a person climbing up the stack. The correct operating conditions are as follows:

- Sample Flow: approximately 20 litres / minute
- Pressure: approximately 15 PSI
- Temperature: approximately 80 - 90 °C

Also, the filter in the Minigas Dryer need to be visually checked once per week (no need to open and unscrew, simply look at the visible filter). The filter should be white at the start, getting browner over time. After between 3 to 6 months, when the filter has a dirty brown colour, it needs to be replaced with a new one.

Flow Meter (Stack Gas)

After each campaign the flow meter probe and the thermocouple need to be taken out of the stack and inspected for physical condition. The person doing this has to fill out the flow meter inspection log-sheet with the following information:

Date, Time, Name, confirmation that flow meter probe and thermocouple were taken out of the stack, general description of the condition of the probes, confirmation that both were re-installed correctly.

Once per year (max. after 14 months of continuous operation), the pressure transducer on the flow meter has to be taken off the flow meter and sent away for recalibration. The recalibration can either be carried out by the manufacturer of the pressure transducer or by Foxbrow at their local workshop in Korea.

QAL 3

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 based on EN14181, these are a series of measurements that need to be conducted by independent measurement equipment in parallel to the existing AMS.

In essence, Dongbu staff performs QAL 3 procedures through the established calibration procedures described above. However, similarly to QAL2, there is no independent, qualified and certified entity in Korea that could conduct the QAL 3 procedures and particularly the AST in accordance with EN14181. Therefore, a sufficiently qualified (but not certified in accordance with EN14181) technical surveillance company or laboratory will have to be identified who could perform the independent QAL 3 procedures.

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)

The two files are then merged to get a complete data set which is then imported into the N.serve Database Management System (N.DBMS) as described in section B.6.3 above.

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 section B.7.1 above: OTh, OPh, AFR, AIFR, NAP, GS, GC, CL, incoming N_2O regulation and changes in the NO_X regulations.

NAP measurement

For detailed information on the nitric acid production (NAP) please refer to respective parameter table (P.5) in above section B.7.1.

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.