MONITORING REPORT FORM (CDM-MR) *
Version 01 - in effect as of: 28/09/2010

CONTENTS

* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

MONITORING REPORT
Version 01 – 01/03/2012

Catalytic N_2O destruction project at the new nitric acid plant PANNA 4 of Enaex S.A.
UNFCCC 5393
Monitoring Period # 01: 19/12/2011 – 31/01/2012

SECTION A. General description of the project activity

A.1. Brief description of the project activity: >>

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1. The purpose of the proposed project activity is to significantly reduce expected levels of N_2O emissions from the production of nitric acid at the PANNA 4 plant of Enaex S.A., Chile (secondary N_2O abatement).The PANNA 4 nitric acid plant was erected in 2010 as part of the Enaex S.A. chemical complex site, Prillex® America, at Mejillones. The new nitric acid plant, designed for a capacity of 925 metric tonnes of HNO_3 per day (100% of weight), has been commercially operational since November 5th, 2010 and produces nitric acid as an intermediate product for the ammonium nitrate plant within the complex.

2. Under the project activity, a N_2O catalyst was inserted below the primary catalyst (NH_3 catalyst) in the ammonia oxidation reactor. The N_2O catalyst largely results in decomposition of N_2O to nitrogen (N_2) and oxygen (O_2) without any further energy, nor material inputs. Catalytic decomposition of N_2O occurs when the N_2O is split into its constituent elements by contact with a catalyst. A catalyst is a material which accelerates speed of the reaction without itself being transformed or consumed by the reaction.

3. The secondary N_2O abatement system was installed at the end of November 2011, with a commissioning phase of the technical equipment during the first weeks of December 2011.

4. Total emission reductions achieved in this monitoring period: **45,909 tCO_2e**

A.2. Project Participants

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Name of Party involved	Project participants (as applicable)	Party involved considered as project participant
Republic of Chile (Host)	Enaex S.A.	No
Republic of Austria	Carbon Climate Protection GmbH	No

Project applicant, sponsor and operator is **Enaex S.A.** (herein after called Enaex), a private owned entity registered under the laws of the Republic of Chile and an incorporated company listed on the Santiago stock exchange, major shareholder is Sigdo Koppers S.A. Enaex is a leading producer of ammonium nitrate to produce explosive that will be used in the mining industry. Based in Chile, the company´s major customer is Enaex Servicios – an associated company of Enaex S.A. Other customers are the most important mining companies of South America, such as CODELCO, BHP Billiton, Anglo American, Antofagasta Minerals, Southern Perú Copper, Phelps Dodge and Placer Dome.

Project participant, Carbon Climate Protection GmbH (herein after called CARBON), is a limited liability company located and registered under Austrian law. CARBON is responsible for the project development. The company is an experienced financing and investment company, focussing on the development and implementation of Greenhouse Gas reduction projects according to Article 6 and Article 12 of the Kyoto Protocol. CARBON has experience with CDM project development in Africa, Latin America and Asia and is specialised in the catalytic N_2O destruction in the tail gas of nitric acid plants. It has developed the methodology for destruction of N_2O in the tail gas of nitric acid plants (AM0028) and has implemented the first N_2O destruction CDM project at nitric acid plants at Abu Qir

Fertilizer Company in Egypt as well as similar CDM project at nitric acid plants at Hu-Chems Fine Chemicals Corporation in Korea and Enaex S.A. in Chile.

A.3. Location of the project activity:

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City: Mejillones
Province: Province of Antofagasta
Country: Republic of Chile

Latitude: 23° 5' 50.64"S
Longitude: 70° 25' 48.55"W

Figure 1: Location of the project within the Prillex® América Plant (green arrow)

A.4. Technical description of the project

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General description

Nitrous oxide (N_2O) is an unwanted, invisible and previously neglected by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide (NO) during the catalytic oxidation of ammonia in air over noble metal gauzes. N_2O is a potent greenhouse gas with a Global Warming Potential (GWP) of 310. This value is valid for the current commitment period and was used for the ex-ante calculation of the emission reduction (also after 2012). The production of nitric acid takes place in three main process steps as indicated by the following reactions:

1. Ammonia (NH_3) combustion to form nitric oxide (NO):

   Ammonia is reacted with air on noble metal catalyst in the oxidation section of nitric acid plants. Nitric oxide and water are formed in this process according to the following equation:

   $$4\,NH_3 + 5\,O_2 \rightarrow 4\,NO + 6\,H_2O \quad \text{(main reaction 1)} \quad \textbf{(1)}$$

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

   $$4\,NH_3 + 3\,O_2 \rightarrow 2\,N_2 + 6\,H_2O \quad \text{(side reaction 1)} \quad \textbf{(2)}$$

   $$4\,NH_3 + 4\,O_2 \rightarrow 2\,N_2O + 6\,H_2O \quad \text{(side reaction 2)} \quad \textbf{(3)}$$

NO yield depends mainly on pressure and temperature in the ammonia oxidation process and usually is in a range of 95% to 97%.

2. NO is oxidised to nitrogen dioxide (NO_2):

$$2\,NO + O_2 \rightarrow 2\,NO_2 \qquad \text{(main reaction 2)} \qquad \textbf{(4)}$$

3. (According to the technical process) Absorption of NO_2 in water to form nitric acid (HNO_3):

$$3\,NO_2 + H_2O \rightarrow 2\,HNO_3 + NO \qquad \text{(main reaction 3)} \qquad \textbf{(5)}$$

(NO is oxidised to NO_2 according to main reaction 2)

Nitric acid plants are, in the vast majority of cases, part of a chemical complex and are built and operated to supply acid for consumption in downstream process units. The most common use for nitric acid is for fertilizers, with smaller quantities going into the manufacture of organic compounds and mining explosives. In the case of PANNA 4, nitric acid is employed as a feed stock to produce ammonium nitrate (NH_4NO_3), which is used as a raw material for mining and civil explosives, which are used in the mining and construction industries. The nitric acid is also used as raw material for other explosives (PETN and Nitro-glycerine), which are also used as civil and mining explosives.

Project specific description

Under the project activity, an N_2O catalyst was inserted below the primary catalyst (NH_3 catalyst) in the ammonia oxidation reactor. The N_2O catalyst largely results in decomposition of N_2O to nitrogen (N_2) and oxygen (O_2) without any further energy, nor material inputs. Catalytic decomposition of N_2O occurs when the N_2O is split into its constituent elements by contact with a catalyst. A catalyst is a material which accelerates speed of the reaction without itself being transformed or consumed by the reaction.

Overall reaction:

$$2\,N_2O \rightarrow 2\,N_2 + O_2 \qquad \textbf{(6)}$$

The new PANNA 4 nitric acid plant was designed to produce nitric acid as an intermediate product for the ammonium nitrate production plant in this complex with a designed capacity of 925 metric tonnes of HNO_3 per day (100% of weight). The plant is designed to operate as a dual pressure nitric acid plant, whereas the ammonia oxidation reactor is operated at a design pressure of about 4.5 bar (medium pressure combustion plant) and the absorption tower at a design pressure of 10.2 bar. The reactor is operated at a design temperature in zone 1 of 220°C, in zone 2 of 480°C, in zone 3 of 910°C and in zone 4 of 520°C.

The PANNA 4 nitric acid plant is equipped with a secondary N_2O abatement, by installing baskets inside the ammonia oxidation reactor and equipping them with the N_2O decomposition catalyst right below the platinum gauze in the high temperature zone of the reactor. The measurement devices for the monitoring of N_2O concentration and tail gas flow are located directly in the stack.

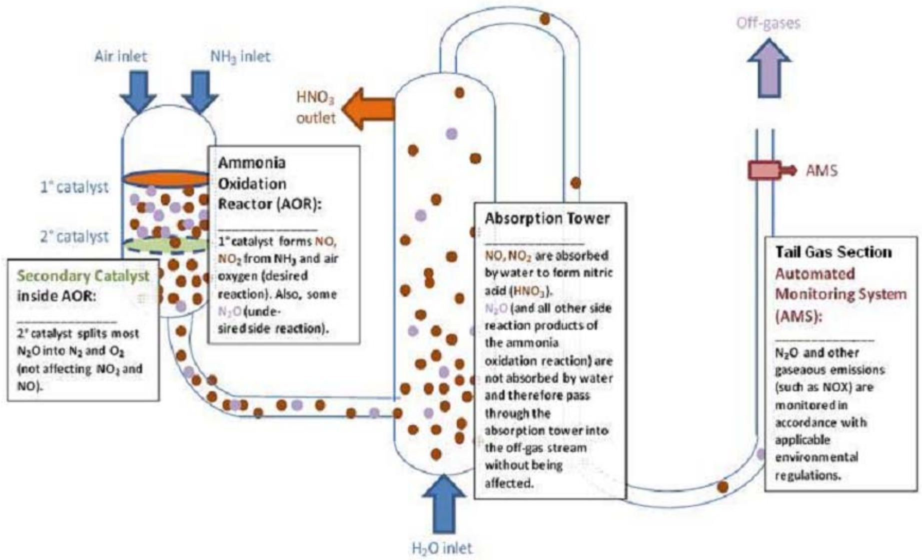

Figure 2: Project boundary

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

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Applied baseline and monitoring methodology:
Approved consolidated baseline and monitoring methodology ACM0019 "N_2O abatement from nitric acid production" (Version 01.0.0)

Applied tool:
"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)

A.6. Registration date of the project activity:

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30/11/2011 (UNFCCC 5393)

Project Design Document:
"Catalytic N_2O destruction project at the new nitric acid plant PANNA 4 of Enaex S.A."
Version 1.2
Date of Completion: 28/09/2011

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

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Starting date of the first crediting period:	01/12/2011
End date of the first crediting period:	30/11/2021
Length of the first crediting period:	10 years (Fixed)

Project Participants have requested a change to the start date of the crediting period by informing the secretariat. The start date of the crediting period shall be changed to 19/12/2011. The revised crediting period shall last from 19 December 2011 to 18 December 2021.
This procedure was on-going on the data of finalizing this monitoring report (01/03/2012).

A.8.	**Name of responsible person(s)/entity(ies):**

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Responsible for completing the CDM-MR:

Enaex S.A.			
Name	Alex Illge	José Contreras	Ricardo Camus
Position	Prillex® America Plant Manager	Production Superintendent	Project Leader
Email	aillge@enaex.cl	jcontreras@enaex.cl	rcamus@enaex.cl
Phone Number	+56 55 353425	+56 55 353591	+56 55 353569

Supervision:

Carbon Climate Protection GmbH			
Name	Gerald Dunkel	Sonja Haderer	Hans-Jürgen Salmhofer
Position	JI/CDM Director	Project Manager	Project Manager
Email	dunkel@carbon-austria.com	haderer@carbon-austria.com	salmhofer@carbon-austria.com
Phone Number	+43 2734 322 70-30	+43 2734 322 70-70	+43 2734 322 70-80

SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

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1. **Starting date of operation of the project activity:** The project has been implemented and is operated as per the registered PDD with all physical features (technology, project equipment, and monitoring and metering equipment) in place, monitoring is done according to the applied methodology and the monitoring plan. The operation of the project activity started in December 2011.

2. **Actual operation of the Project Activity during the covered monitoring period**

<u>Shutdown periods of the nitric acid plant</u>

Table 1: Shutdown periods of Nitric Acid plant

Start		End		Description
Date	**Time**	**Date**	**Time**	
24/12/2011	15:00	25/12/2011	08:00	Nitric acid plant shutdown
26/12/2011	23:00	28/12/2011	03:00	Nitric acid plant shutdown
07/01/2012	06:00	07/01/2012	22:00	Nitric acid plant shutdown

Relevant hours of Nitric Acid plant (and consequently secondary N_2O abatement system) shutdown periods have not been considered in overall calculations of Emission Reductions, in accordance with the methodology. For the respective hours no Emission Reductions will be claimed. This approach ensures the most conservative way to determine Emission Reductions, concrete resulting in zero Emission Reductions for respective hours of Nitric Acid plant shutdown.

<u>Manual Changes (due to shutdown periods of the nitric acid plant</u>

Table 2: Manual Changes

Start		End		Description
Date	**Time**	**Date**	**Time**	
25/12/2011	08:00	25/12/2011	10:00	Manual Change
28/12/2011	03:00	28/12/2011	04:00	Manual Change
07/01/2012	22:00	07/01/2012	23:00	Manual Change

Relevant hours subsequent to a Nitric Acid plant shutdown periods have not been considered in overall calculations of Emission Reductions. For the respective hours no Emission Reductions will be claimed. This approach ensures the most conservative way to determine Emission Reductions, concrete resulting in zero Emission Reductions for respective hours subsequent to a Nitric Acid plant shutdown

<u>Service works (calibration & maintenance)</u>

Table 3: Service works (calibration & maintenance)

Start		End		Description
Date	**Time**	**Date**	**Time**	
11/01/2012	16:00	11/01/2012	20:00	Nitric acid flow meter service

13/01/2012	14:00	13/01/2012	19:00	Volume flow (pressure) service activities

For relevant hours a conservative calculation was applied, in accordance with provisions of the methodology. During the nitric acid flow meter service it has been proven that the nitric acid plant and consequently the secondary N_2O abatement system has been in full operation. A conservative criteria (minimum production during monitoring period) has been applied for the respective hours.

Other issues

Table 4: Other issues

Start		End		Description
Date	Time	Date	Time	
19/12/2011	16:00	19/12/2011	17:00	No volume flow measurement (software download)
25/12/2011	10:00	26/12/2011	16:00	QAL 3 correction
28/12/2011	04:00	28/12/2011	12:00	Analyzer out of operation (blockage of sample lines)
29/12/2011	10:00	29/12/2011	18:00	QAL 3 correction

For relevant hours a conservative calculation in accordance with the methodology was applied.

3. **Events or situations with impact on the applicability of the methodology:** No such events or situations occurred during the covered monitoring period.

B.2. Revision of the monitoring plan

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The monitoring plan has not been revised.

B.3. Request for deviation applied to this monitoring period

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No deviation has been applied to this monitoring period.

B.4. Notification or request of approval of changes

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No notification or request of approval of changes from the project activity as described in the registered CDM PDD applies to this monitoring period.

SECTION C. Description of the monitoring system

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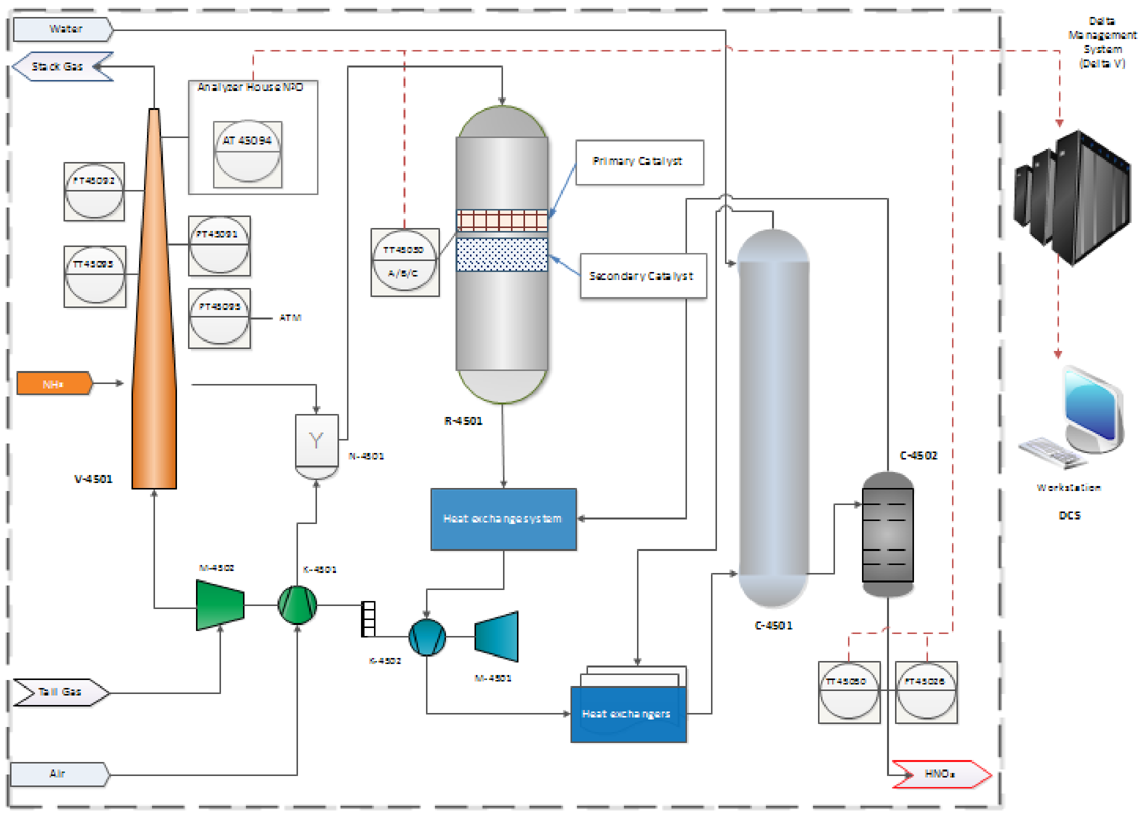
1. **Information Flow / Data collection procedures:**

The instruments transmitters continuously provide a 4 – 20 mA analogue signal according to range and units configured. These signals are transmitted to I/O cards (analogue input/output cards) and collected by the Delta V Processor. Resulting digital values are made available in the network to be further processed (e.g. in controller blocks, calculation of other variables) and are stored as 1 second raw data in the protected continuous historian server (CHS).

Modifications of the Delta V, which are protected by security levels by the supplier, are tracked by a Version Control Tool.



	TAG	DESCRIPTION	TAG	DESCRIPTION		
INSTRUMENTS	PT-45091	Differential pressure between the gaseous stream and atmosphere	PT-45095	Atmospheric pressure	ENAEX S.A	
	FT-45092	Volumetric flow of the gaseous stream	FT-45026	Nitric acid produced		
	TT-45093	Temperature of the gaseous stream	TT-45030A/B/C	Reactor Temperature (T1, T2, T3)	Project	"Catalytic N2O destruction project at the new nitric acid plant PANNA 4 of Enaex S.A"
	AT-45094C	Volumetric fraction of greenhouse gas (N2O)	TT-45050	Nitric acid temperature	Version	1
EQUIPMENTS	V-4501	Stack gas PANNA 4	C-4501	Absorption Tower	Date	February 29th, 2012
	M-4502	Expander	C-4502	Cleaning Tower	Project Engineer	Ricardo Camus
	K-4501	Air Compressor	K-4502	Process gas compressor	Project Chief	Ricardo Camus
	N-4501	Ammonia/Air Mixer	M-4501	Steam turbine	Process Engineers	Carlos Araneda / Claudia Bravo
	R-4501	Oxidation Reactor				

Figure 3: Line diagram showing all relevant monitoring points

The reporting module of the Delta V system automatically generates aggregated daily reports based on the stored raw data from the continuous historian server. Daily reports contain following kinds of data relevant for calculation of claimed emission reductions:

- Concentrations of N_2O at stack gas of PANNA 4 system ($V_{i,t,db}$)
- Volume Flow ($V_{t,,db}$ / T_t / P_t)
- Operating parameters of the nitric acid plant (T_1,T_2,T_3)
- Nitric Acid Production ($P_{NA,n}$)

Relevant parameters as above (Concentrations, Volume Flows, Operating parameters of the nitric acid plant and Nitric Acid Production) are exported from the digitally available daily reports to excel sheets for presentation of required parameters and calculation of baseline emissions (BE_n), project emissions (PE_n / $PE_{n2O,n}$ / $Q_{N2O,tail\ gas,\ n}$), and emission reductions (ER_n) according to the formula as required.
Details on source of data can be found directly at the respective parameter tables in *Section D*.

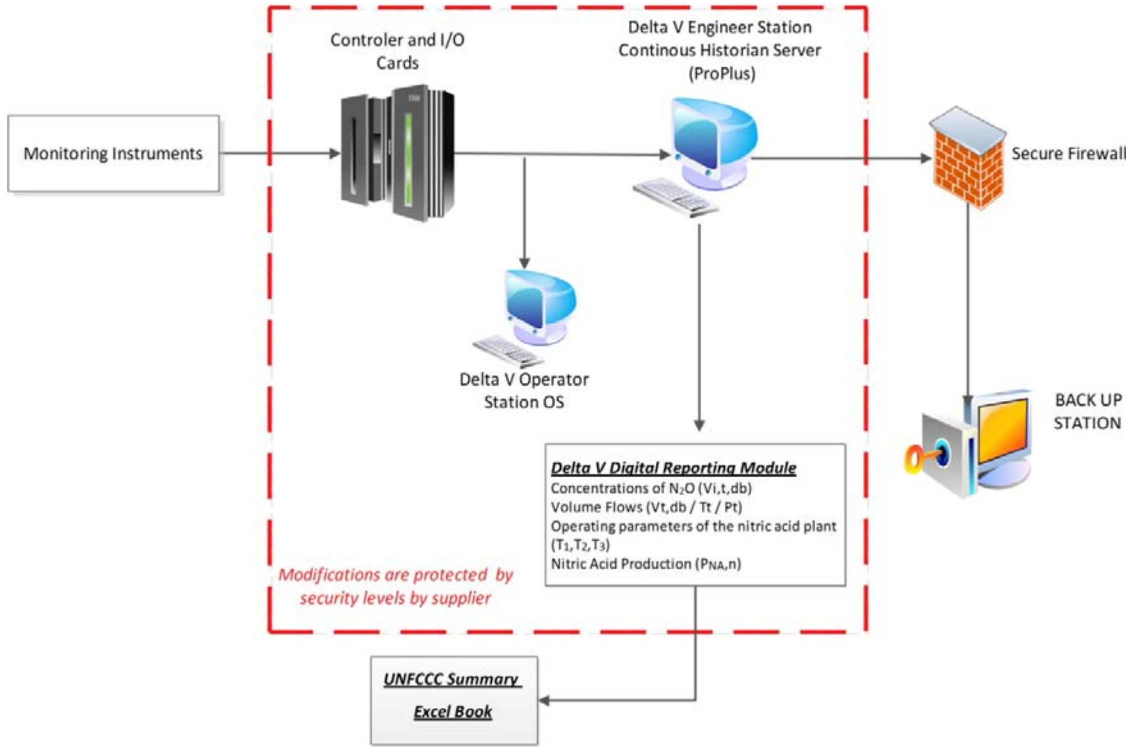


Figure 4: Information flow diagram

This approach and all implemented formulas in the Delta V system fully comply with the approved Consolidated Baseline and Monitoring Methodology AMC0019 Version 01.0.0 "N_2O abatement for Nitric Acid production" and the registered project documentation (Monitoring Plan and respective PDD).

2. **Roles and responsibilities of personnel**

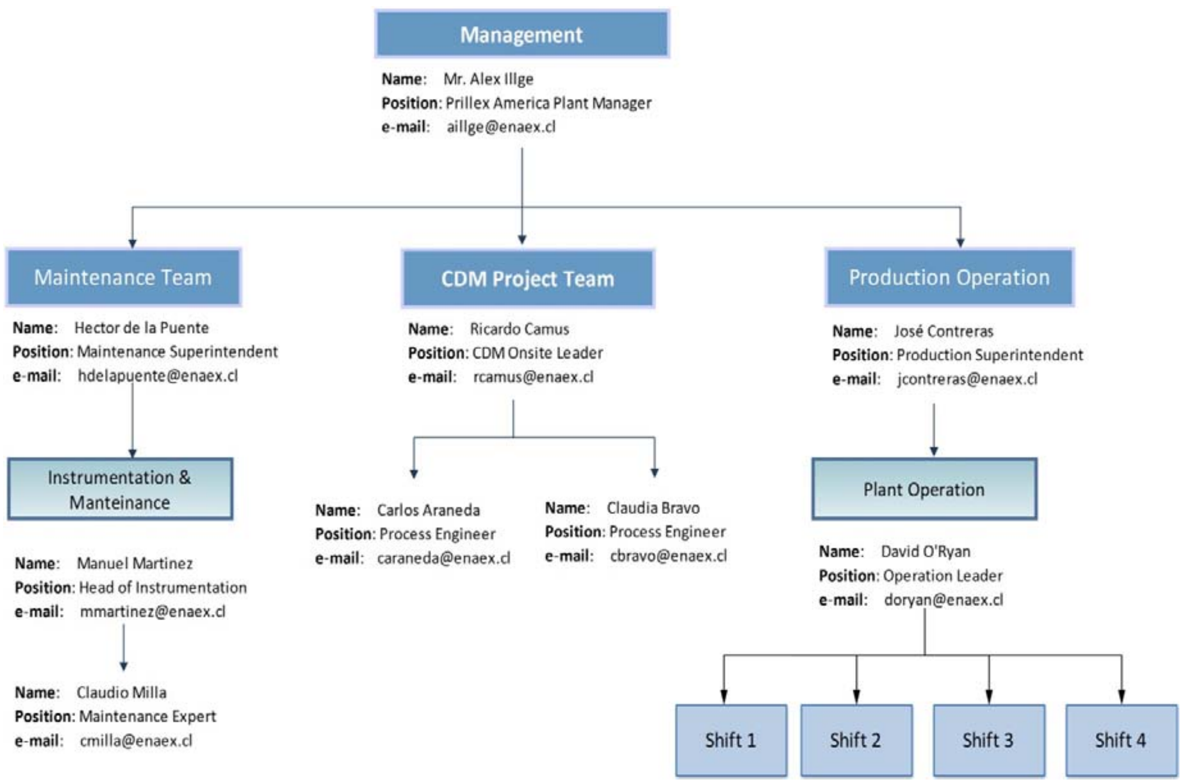
Project Operator is Enaex S.A. (furthermore called "Enaex"), a private owned entity registered under the laws of the Republic of Chile and an incorporated company listed on the Santiago stock exchange, major shareholder is Sigdo Koppers S.A. Enaex is a leading producer of ammonium nitrate and explosives for rock fragmentation.

The Prillex® América production facility of Enaex, of which PANNA 4 is one of the plants, is certified according to ISO 9001:2008 NCh 9001 of 2009.

The PANNA 4 CDM operating team has been trained by the technology provider Heraeus (secondary N_2O abatement system) and the supplier of the digital process control system, INECO (Delta V, EMERSON process management).

Enaex CDM team is responsible for monitoring and reporting of data under the CDM Project. In terms of performing general supervision and cross-checks of monitoring and reporting data Carbon Austria supports Enaex. Carbon Austria gives their final approval on the supporting documents as well as the CDM-MR before submitting to the respective DOE for periodic verification.

Figure 5: Organizational Chart: Onsite structure at Enaex



3. **Back up plans / Emergency procedures for monitoring system**

Back Up Plans for measuring systems / Periodically observation of the automated monitoring system

PANNA 4 – automatic DCS system:

The PANNA 4 automatic DCS system is designed for automatic operation, so that activities by the operation personnel are not required for during normal operation. However, all alarms and any action taken by the operating personnel (events) are automatically logged at the engineering and the operation station (Alarm & Event List) of the DCS system.

Malfunction of system components is indicated on the operator console in the control room as an alarm. Occurrence of such an alarm requires the operator to immediately take measures to remedy the problem. This is done by informing Enaex maintenance personnel and CDM Project team. It is then deciding whether the problem can be fixed immediately by themselves or whether external support from Emerson is required. In addition to the quality control and quality assurance procedures according to Enaex quality management system and in order to avoid possible failures of the automated monitoring system several procedures are implemented for the project activity.

Back Up – Delta V and Analyzer support
In order to avoid possible failures of the automated monitoring system Delta V, Enaex is in negotiations to contract Emerson Argentina Group to execute periodic on-site **Health Checks.**
The health checks visits are to conduct observation of the PANNA 4 automatic DCS system, the monitoring equipment required for the CDM project and the automated monitoring system.

Back Up – Weekly inspection
The responsible project managers of Enaex are carrying out **on-site inspections** on a weekly basis.

Back Up – Spare Parts on Stock On-site:
As a further important part of the back-up plan to deal with events like measuring equipment out of service, Enaex stocks a comprehensive range of spare part devices on-site.

Back Up – Certified standard gases
Pressure levels of standard gases used for the regular, automatic calibration of the inlet and outlet analysers are constantly monitored during the regular inspection by Enaex. Spare bottles of standard gases are purchased in proper time. Specifications of standard gases are available and submitted to the DOE for verification.

The following table summarizes the periodically observations of the AMS.

Table 5: AMS observation overview

Organization	Action	Frequency	Output
ENAEX CDM Team	Inspection	Weekly	Weekly Checklist
ENAEX CDM Team	Supervision	Daily	Plausibility Check of Daily Reporting
CARBON	Supervision	Periodically	Plausibility Check of Daily Reporting

All resulting documents are analyzed and evaluated by Enaex. In case of any upcoming problem or failure of the PANNA 4 system and/or the automated monitoring system Enaex immediately take measure to remedy the problem.

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data / Parameter:	**$EF_{default,y}$**
Data unit:	**$kgN_2O/tHNO_3$**
Description:	Default N_2O baseline emissions factor in the calendar year y of the monitoring period n
Source of data used:	According to PDD
Value(s) :	**Year** / **Emission factor (kgN_2O/HNO_3)**: 2011 – 4.10; 2012 – 3.90; 2013 – 3.70; 2014 – 3.50; 2015 – 3.40; 2016 – 3.20; 2017 – 3.00; 2018 – 2.80; 2019 – 2.70; 2020 – 2.50; 2021 – 2.50; … – …; Year n – 2.50
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Additional comment:	The decrease in the value for the baseline emission factor over time is to reflect the technological development.

Year	Emission factor (kgN_2O/HNO_3)
2011	4.10
2012	3.90
2013	3.70
2014	3.50
2015	3.40
2016	3.20
2017	3.00
2018	2.80
2019	2.70
2020	2.50
2021	2.50
…	…
Year n	2.50

Data / Parameter:	**GWP_{N2O}**
Data unit:	**tCO_2e/tN_2O**
Description:	Global warming potential of N_2O valid for the commitment period
Source of data used:	According to PDD
Value(s) :	**310 tCO_2e/tN_2O**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission calculation
Additional comment:	Not applicable (NA)

Data / Parameter:	**R_u**
Data unit:	**$Pa.m^3/kmol.K$**
Description:	Universal ideal gases constant
Source of data used:	According to PDD
Value(s) :	**8,314 $Pa.m^3/kmol.K$**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Additional comment:	NA

Data / Parameter:	**MM_i**
Data unit:	**kg/kmol**

Description:	Molecular mass of greenhouse gas i		
Source of data used:	According to PDD		
Value(s) :	**Compound**	**Structure**	**Molecular mass (kg/kmol)**
	Nitrous oxide	N_2O	44.02
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation		
Additional comment:	NA		

D.2. Data and parameters monitored	
Data / Parameter:	$P_{NA,n}$
Data unit:	**$tHNO_3$**
Description:	Nitric acid produced in the monitoring period n
Measured /Calculated /Default:	Measured
Source of data:	Production Logs The actual nitric acid production is measured according to the installed instruments. The coriolis type mass flow meter and the integrated density measurement deliver values, which are used as basis for calculation of the concentration (taking into consideration the measured temperature of the nitric acid). The nitric acid at 100% is calculated by multiplying the mass flow with the concentration. Please also refer to *Section C – 1 (Information Flow / Data collection procedures)* of this Monitoring Report.
Value(s) of monitored parameter:	**41,498 $tHNO_3$**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**FT 45026** Type: Coriolis flow and density transmitter Accuracy class: 0.15% of instrument range Serial number: EB024716000 Calibration frequency: 2 years Date of last calibration: 09/11/2011 Validity: 08/11/2013 **TT 45050** Type: Temperature transmitter Accuracy class: 0.1% of range Serial number: N0909.842183/VO336261 Calibration frequency: 2 years Date of last calibration: 30/11/2011 Validity: 30/11/2013
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA

QA/QC procedures applied:	Periodic calibration is performed according to manufacturer's recommendation. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2000.

Data / Parameter:	$\mathbf{h_n}$
Data unit:	**NA**
Description:	Number of hours of operation in a monitoring period n
Measured /Calculated /Default:	Measured
Source of data:	Field instruments / Monitoring system (Delta V) The operation temperature of the oxidation burner ranges from 850 – 905°C (as defined by the technology supplier) and this range corresponds to the real operation hours of the reactor. The temperature is reported automatically by three independent measurement points (tag numbers TT45030 A, B and C) measuring the temperature at the same time. The value of the instrument with the tag number TT 45030A was selected as main signal for monitoring the operation temperature; TT 45030B and TT 45030C are used as backup signals in case TT 45030A is not fully functional. Please also refer to *Section C – 1 (Information Flow / Data collection procedures)* of this Monitoring Report.
Value(s) of monitored parameter:	**991 hours**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**TT-45030A** Type: Temperature transmitter Accuracy class: 0.4% of range Serial number: 3F0AF4X Calibration frequency: 2 years Date of last calibration: 13/09/2010 Validity: 12/09/2012 **TT-45030B** Type: Temperature transmitter Accuracy class: 0.4% of range Serial number: 3F0AF4Y Calibration frequency: 2 years Date of last calibration: 13/09/2010 Validity: 12/09/2012 **TT-45030C** Type: Temperature transmitter Accuracy class: 0.4% of range Serial number: 3F0AF4W Calibration frequency: 2 years Date of last calibration: 13/09/2010 Validity: 12/09/2012
Measuring/ Reading/	Measuring: Continuously

Recording frequency:	Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures applied:	Periodic calibration is performed according to manufacturer's recommendation. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2000.

Data / Parameter:	$\mathbf{V_{t,db}}$
Data unit:	**m³ dry gas/h**
Description:	Volumetric flow of the gaseous stream in time interval t on a dry basis
Measured /Calculated /Default:	Measured
Source of data:	Flow meter / Field instruments/ Monitoring system (Delta V) Please also refer to *Section C – 1 (Information Flow / Data collection procedures)* of this Monitoring Report.
Value(s) of monitored parameter:	**190,584 m³ dry gas/h**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**FT 45092** Type: Differential pressure transmitter. Accuracy class: 2% of range Serial number: 265DS6600071043 Calibration frequency: 2 years Date of last calibration: 13/07/2011 Validity: 12/07/2013
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures applied:	Periodic calibration (QAL2) against a primary device by an independent accredited laboratory. Periodic calibration is performed according to manufacturer's recommendation. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2000

Data / Parameter:	$v_{i,t,db}$
Data unit:	m³ gas i/m³ dry gas
Description:	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Measured /Calculated /Default:	Measured
Source of data:	Non-dispersive infrared photometry (NDIR) for N_2O (Gas analyzer equipment)

	Please also refer to *Section C – 1 (Information Flow / Data collection procedures)* of this Monitoring Report.
Value(s) of monitored parameter:	**$5.75*10^{-5}$ m³ gas i/m³ dry gas**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**AT 45094** Type: Volumetric fraction of N_2O in the tail gas analyzer Accuracy class: 1% of range Serial number: 3709103038248 Calibration frequency: 3 years (QAL 2) Date of last calibration: 17/12/2011 Validity: 16/12/2014
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures applied:	According to European Norm 14181 The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2000

Data / Parameter:	**$C_{H2O,t,db,n}$**
Data unit:	**mg H_2O/m³ dry gas**
Description:	Moisture content of the gaseous stream at normal conditions, in time interval t
Measured /Calculated /Default:	Measured
Source of data:	Measurements according to USEPA CF 42 method 4 – Gravimetric determination of water content (QAL2 Report) Date of last determination: 17/12/2011 Next determination until: 16/12/2012
Value(s) of monitored parameter:	**0.0024 kg H_2O/m^3 dry gas** (Highest measured value) Option A of the tool can be applied, as the moisture content is less than 0.05 kg H_2O/m³ dry gas.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	Measuring / Reading / Recording: Yearly
Calculation method (if applicable):	NA
QA/QC procedures applied:	NA

Data / Parameter:	**T_t**
Data unit:	**K**
Description:	Temperature of the gaseous stream in time interval t
Measured /Calculated /Default:	Measured
Source of data:	Temperature Transmitter Please also refer to *Section C – 1 (Information Flow / Data collection procedures)* of this Monitoring Report.
Value(s) of monitored parameter:	**390.29 K**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	**TT 45093** Type: Tail gas temperature transmitter Accuracy class: 0.4 °C Serial number: 706088 Calibration frequency: 2 years Date of last calibration: 16/11/2011 Validity: 15/11/2013
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures applied:	Periodic calibration against a primary device provided by an independent accredited laboratory. Calibration and frequency of calibration is according to manufacturer´s specifications. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2000

Data / Parameter:	**P_t**
Data unit:	**Pa**
Description:	Pressure of the gaseous stream in time interval t
Measured /Calculated /Default:	Measured
Source of data:	Pressure Transmitters The pressure of the gaseous stream is determined by the sum of the static pressure inside the stack and the barometric pressure. Please also refer to *Section C – 1 (Information Flow / Data collection procedures)* of this Monitoring Report.
Value(s) of monitored parameter:	**100,120 Pa**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration	**PT 45091** Type: Differential pressure transmitter Accuracy class: 0.1% of range

frequency, date of last calibration, validity)	Serial number: 58154 Calibration frequency: Monthly Date of factory calibration: 17/11/2011 Date of Commissioning: 15/12/2011 Date of last calibration: 13/01/2012 Validity: 12/02/2012 **PT 45095** Type: Barometric pressure transmitter Accuracy class: 0.1% of range Serial number: 58157 Calibration frequency: Monthly Date of factory calibration: 17/11/2011 Date of Commissioning: 15/12/2011 Date of last calibration: 13/01/2012 Validity: 12/02/2012
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures applied:	Periodic calibration against a primary device provided by an independent accredited laboratory. Calibration and frequency of calibration is according to manufacturer´s specifications. Pressure transmitter will be calibrated according to the PDD on a monthly basis. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2000

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

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Baseline emissions are given by the following equation:

$$BE_n = P_{NA,n} * EF_{BL,N2O,n} * GWP_{N2O} * 10^{-3}$$

Where:

BE_n	=	Baseline emissions in monitoring period n (tCO_2e)
$P_{NA,n}$	=	Nitric acid produced in the monitoring period n ($tHNO_3$)
$EF_{BL,N2O,n}$	=	Baseline N_2O emission factor for nitric acid production in the monitoring period n (kgN_2O / $tHNO_3$)
GWP_{N2O}	=	Global Warming Potential of N_2O valid for the commitment period

Determination of the baseline N_2O emission factor ($EF_{BL,N2O,n}$)

The baseline N_2O emission factor in the monitoring period n ($EF_{BL,N2O,n}$) shall be determined as a default emission factor $EF_{default,y}$ given for each calendar year y for which BE_n is calculated, as follows:

$$EF_{BL,N2O,n} = EF_{default,y}$$

Where:

$EF_{BL,N2O,n}$	=	Baseline N_2O emission factor for nitric acid production in the monitoring period n (kgN_2O / $tHNO_3$)
$EF_{default,y}$	=	Default N_2O baseline emissions factor in the calendar year y of the monitoring period n (kgN_2O / $tHNO_3$)

If the monitoring period n spans across two (or more) calendar years, the baseline emissions (BE_n) shall be calculated separately for each calendar year, first establishing $EF_{BL,N2O,n}$ and then applying this to the nitric acid production of that calendar year.

The values for the present period are:

Parameter	Value	Unit
BE_n	50,850	tCO_2e
$P_{NA,n}$	41,498	$tHNO_3$
$EF_{BL,N2O,2011}$	4.10	kgN_2O / $tHNO_3$
$EF_{BL,N2O,2012}$	3.90	kgN_2O / $tHNO_3$
GWP_{N2O}	310	-

E.2. Project emissions calculation

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Project emissions are calculated as follows:

$$PE_n = PE_{N2O,n} + PE_{CO2,tertiary,n}$$

Where:

PE_n	=	Project emissions in monitoring period n (tCO_2e)
$PE_{N2O,n}$	=	Project emissions of N_2O from the project plant in monitoring period n (tCO_2e)

$PE_{CO2,tertiary,n}$ = Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in monitoring period n (tCO_2)

Parameter	Value	Unit
PE_n	4,941	tCO_2e
$PE_{N2O,n}$	4,941	tCO_2e
$PE_{CO2,tertiary,n}$	0	tCO_2e

Project emissions of N_2O from the project plant ($PE_{N2O,n}$)

The amount of N_2O emissions from the project activity includes two emission sources:

a) The N_2O contained in the tail gas stream of the plant which is released to the atmosphere; and
b) In the case of a tertiary N_2O abatement, the N_2O contained in any by-pass streams to the tertiary N_2O abatement facility. As the proposed CDM project activity does not comprise the installation of a tertiary N_2O abatement technology, no emissions need to be considered or monitored.

Accordingly, $PE_{N2O,n}$ is determined as follows:

$$PE_{N2O,n} = (Q_{N2O,tailgas,n} + Q_{N2O,by-pass,n}) * GWP_{N2O}$$

Where:

$PE_{N2O,n}$ = Project emissions of N_2O from the project plant in monitoring period n (tCO_2e)

$Q_{N2O,tail\ gas,n}$ = Amount of N_2O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN_2O)

$Q_{N2O,by-pass,n}$ = Amount of N_2O released through the by-pass to a tertiary N_2O abatement system to the atmosphere in monitoring period n (tN_2O)

GWP_{N2O} = Global Warming Potential of N_2O valid for the commitment period

Parameter	Value	Unit
$PE_{N2O,n}$	4,941	tCO_2e
$Q_{N2O,tail\ gas,n}$	15.94	tN_2O
$Q_{N2O,by-pass,n}$	0	tN_2O
GWP_{N2O}	310	-

Determination of $Q_{N2O,tail\ gas,n}$

The amount of N_2O emissions from the tail gas stream of the project plant shall be determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. In applying the tool, the following provisions apply:

- Throughout the crediting periods of the project activity, the N_2O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is to be installed and maintained throughout the crediting period based on the European Norm 14181 (2004), or any more recent update of that standard;
- The monitoring system should provide separate hourly average values for the N_2O concentration and the volume or mass flow of the tail gas based on 2 seconds (or shorter) interval readings that are recorded and stored electronically. These N_2O data sets shall be identified by means of a unique time / date key indicating when exactly the values were observed;

- The correction factors derived from the calibration curve of the QAL2 audit for the monitoring components as determined during the QAL2-test in accordance with EN14181 must be applied to both the N_2O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions;
- If data for either the N_2O concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of N_2O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N_2O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N_2O calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values;

According to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) the mass flow of greenhouse gas i in the gaseous stream in time interval t ($F_{i,t}$) is calculated based on measurements of (a) the total volume flow or mass flow of the gas stream, (b) the volumetric fraction of the gas in the gaseous stream and (c) the gas composition and water content. The flow and volumetric fraction may be measured on a dry basis or wet basis. The tool covers the possible measurement combinations, providing six different calculation options to determine the mass flow of a particular greenhouse gas (Option A to F).

Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use option A. There are two ways to do this:

a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or
b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

Option A of the tool (measurement options: volume flow of gaseous stream on dry basis, volumetric fraction on dry or wet basis) was applied, since it was demonstrated by QAL 2 Report 2011 by AIRTEC that the gaseous stream is dry. The measurement was done according USEPA CF42 method 4. The measured moisture content in the stack gas is less than 0.05 $kg/m^3_{dry\ gas}$.

Table 6: Moisture content measurements (according to QAL2 report)

Measuring Sequence	Date	Moisture content
1	13/12/2011	0.0021 $kgH_2O/m^3_{dry\ gas}$
2	13/12/2011	0.0024 $kgH_2O/m^3_{dry\ gas}$
3	14/12/2011	0.0022 $kgH_2O/m^3_{dry\ gas}$

The mass flow of greenhouse gas i ($F_{i,t}$)[1] is calculated as follows:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$

With

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t} =$$

[1] $F_{i,t}$ corresponds to the parameter $F_{N2O,tail\ gas,h}$ of the methodology ACM0019.

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval t on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m^3 gas i/m^3 dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m^3 gas i)
P_t	=	Absolute pressure of the gaseous stream in time interval t (Pa)
MM_i	=	Molecular mass of greenhouse gas i (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m^3/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval t (K)

For detailed calculation please refer to excel book in the Annex of this monitoring report.

The hourly values are aggregated for the duration of the monitoring period n, as follows:

$$Q_{N2O,tailgas,n} = \sum_{h=1}^{h=h_n} F_{N2O,tailgas,h} * 10^{-3}$$

Where:

$Q_{N2O,tail\ gas,n}$	=	Amount of N_2O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN_2O)
$F_{N2O,tail\ gas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kgN_2O/h)
h_n	=	Number of hours in monitoring period n during which the plant was in operation

For detailed calculation please refer to excel book in the Annex of this monitoring report.

E.3. Leakage calculation

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According to the methodology any leakage emissions sources are deemed to be negligible.

E.4. Emission reductions calculation / table

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The total emission reduction achieved by this project activity during the monitoring period is the difference between baseline emissions (BE_n) and project emissions (PE_n) and are calculated as follows:

$$ER_n = BE_n - PE_n$$

Where:

ER_n	=	Emission reductions in monitoring period n (tCO_2e)
BE_n	=	Baseline emissions in monitoring period n (tCO_2e)
PE_n	=	Project emissions in monitoring period n (tCO_2e)

Parameter	Value	Unit
ER_n	45,909	tCO_2e
BE_n	50,850	tCO_2e

PE_n	4,941	tCO_2e

Total baseline emissions: 50,850 tCO_2e
Total project emissions: 4,941 tCO_2e
Total leakage: 0
Total emission reductions: 45,909 tCO_2e (conservatively rounded down) *)

*) *Note that actual calculation of emissions reductions as presented in chapter E1 to E4 has been done in the excel book. Rounding in chapters E1 to E4 has just been done for ease of presentation. Please note that conservative rounding has been made for final ER_n calculation only. This can be traced in the excel book attached to this monitoring report.*

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

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This section shall include a comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the registered CDM-PDD.

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO_2e)	**2011: 13,005 (13 days)** **2012: 29,877 (31 days)** **Total: 42,882 (44 days)**	**45,909 (44 days)**

E.6. Remarks on difference from estimated value in the PDD

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The emissions reductions in this Monitoring Period are 45,909 tonnes of CO_2 equivalents. The yearly expected emissions reductions according to the registered PDD is 31,011 tonnes of CO_2 equivalents in 2011 and 351,773 tonnes of CO_2 equivalents in 2012. This corresponds to emissions reductions of 42,882 tonnes of CO_2 equivalents in 44 days, hence the observed emissions reduction is slightly higher than expected.

The reason is:

- An observed higher HNO_3 production yield of approx 1,004 $tHNO_3$/day (average) in this Monitoring Period compared to the value of 925 $tHNO_3$/day used for calculation of ex-ante emission reductions in the PDD. This is due to the high demand of the end product during the monitoring period.

It should be noted that the ex-ante estimation of emissions reductions was generally based on conservative assumptions.

ANNEX 1

An Excel book containing monitored data and calculations of baseline emissions, project emissions and emission reductions and additional checks and information is attached:

MP 1_PANNA4 (5393)_UNFCCC SUMMARY_v1.xlsx

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History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Guideline, Form **Business Function**: Issuance		