

**MONITORING REPORT FORM (F-CDM-MR)**  
**Version 02.0****MONITORING REPORT**

<b>Title of the project activity</b>	Catalytic N <sub>2</sub> O destruction project at the new nitric acid plant PANNA 4 of Enaex S.A.
<b>Reference number of the project activity</b>	5393
<b>Version number of the monitoring report</b>	Version 2
<b>Completion date of the monitoring report</b>	18/12/2012
<b>Registration date of the project activity</b>	30/11/2011
<b>Monitoring period number and duration of this monitoring period</b>	Monitoring period number: 3 Duration: 01/07/2012 – 30/09/2012
<b>Project participant(s)</b>	Enaex S.A. Carbon Climate Protection GmbH Mitsubishi Corporation
<b>Host Party(ies)</b>	Republic of Chile
<b>Sectoral scope(s) and applied methodology(ies)</b>	Sectoral scope 5: Chemical industries  ACM0019 “N <sub>2</sub> O abatement from nitric acid production” (Version 01.0.0)
<b>Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD</b>	88,666 (92 days)
<b>Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period</b>	50,763 (92 days)

## SECTION A. Description of project activity

### A.1. Purpose and general description of project activity

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1. The purpose of the proposed project activity is to significantly reduce expected levels of  $\text{N}_2\text{O}$  emissions from the production of nitric acid at the PANNA 4 plant of Enaex S.A., Chile (secondary  $\text{N}_2\text{O}$  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  $\text{HNO}_3$  per day (100% of weight), has been commercially operational since November 5<sup>th</sup>, 2010 and produces nitric acid as an intermediate product for the ammonium nitrate plant within the complex.
2. Under the project activity, a  $\text{N}_2\text{O}$  catalyst was inserted below the primary catalyst ( $\text{NH}_3$  catalyst) in the ammonia oxidation reactor. The  $\text{N}_2\text{O}$  catalyst largely results in decomposition of  $\text{N}_2\text{O}$  to nitrogen ( $\text{N}_2$ ) and oxygen ( $\text{O}_2$ ) without any further energy, nor material inputs. Catalytic decomposition of  $\text{N}_2\text{O}$  occurs when the  $\text{N}_2\text{O}$  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  $\text{N}_2\text{O}$  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: **50,763 tCO<sub>2</sub>e**

### A.2. Location of project activity

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- a) Host Party(ies): Republic of Chile
- b) Province: 2<sup>nd</sup> Region (Region of Antofagasta), Province of Antofagasta
- c) Town: Mejillones
- d) GPS coordinates: -23.097400 , -70.430153



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

**A.3. Parties and project participant(s)**

Party involved (host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Chile (Host)	Enaex S.A.	No
Republic of Austria	Carbon Climate Protection GmbH	No
Japan	Mitsubishi Corporation	No

**A.4. Reference of applied methodology**

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- (a) Approved consolidated baseline and monitoring methodology ACM0019 “N<sub>2</sub>O abatement from nitric acid production” (Version 01.0.0)
- (b) “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0)

**A.5. Crediting period of project activity**

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Type of the crediting period: Fixed  
Starting date of the first crediting period: 19/12/2011  
End date of the first crediting period: 18/12/2021  
Length of the first crediting period: 10 years (Fixed)

**SECTION B. Implementation of project activity****B.1. Description of implemented registered project activity**

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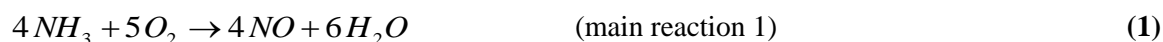
- (a) Information on the implementation of the project activity

**General description**

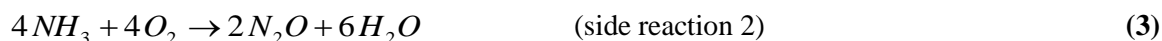
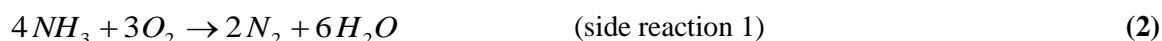
Nitrous oxide (N<sub>2</sub>O) is an unwanted, invisible and previously neglected by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide (NO) during the catalytic oxidation of ammonia in air over noble metal gauzes. N<sub>2</sub>O is a potent greenhouse 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<sub>3</sub>) 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:

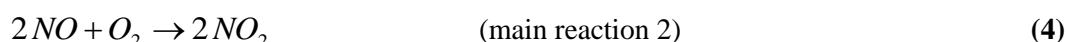


Simultaneously, nitrous oxide (N<sub>2</sub>O), nitrogen (N) and water (H<sub>2</sub>O) are formed as well, in accordance with the following equations:

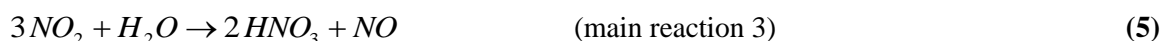


NO yield depends mainly on pressure and temperature in the ammonia oxidation process and usually is in a range of 95% to 97%.

2. NO is oxidised to nitrogen dioxide (NO<sub>2</sub>):



3. (According to the technical process) Absorption of NO<sub>2</sub> in water to form nitric acid (HNO<sub>3</sub>):



(NO is oxidised to NO<sub>2</sub> 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<sub>4</sub>NO<sub>3</sub>), 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<sub>2</sub>O catalyst was inserted below the primary catalyst (NH<sub>3</sub> catalyst) in the ammonia oxidation reactor. The N<sub>2</sub>O catalyst largely results in decomposition of N<sub>2</sub>O to nitrogen (N<sub>2</sub>) and oxygen (O<sub>2</sub>) without any further energy, nor material inputs. Catalytic decomposition of N<sub>2</sub>O occurs when the N<sub>2</sub>O 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:



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<sub>3</sub> 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<sub>2</sub>O abatement, by installing baskets inside the ammonia oxidation reactor and equipping them with the N<sub>2</sub>O decomposition catalyst right below the platinum gauze in the high temperature zone of the reactor. The measurement devices for the monitoring of N<sub>2</sub>O concentration and tail gas flow are located directly in the stack.

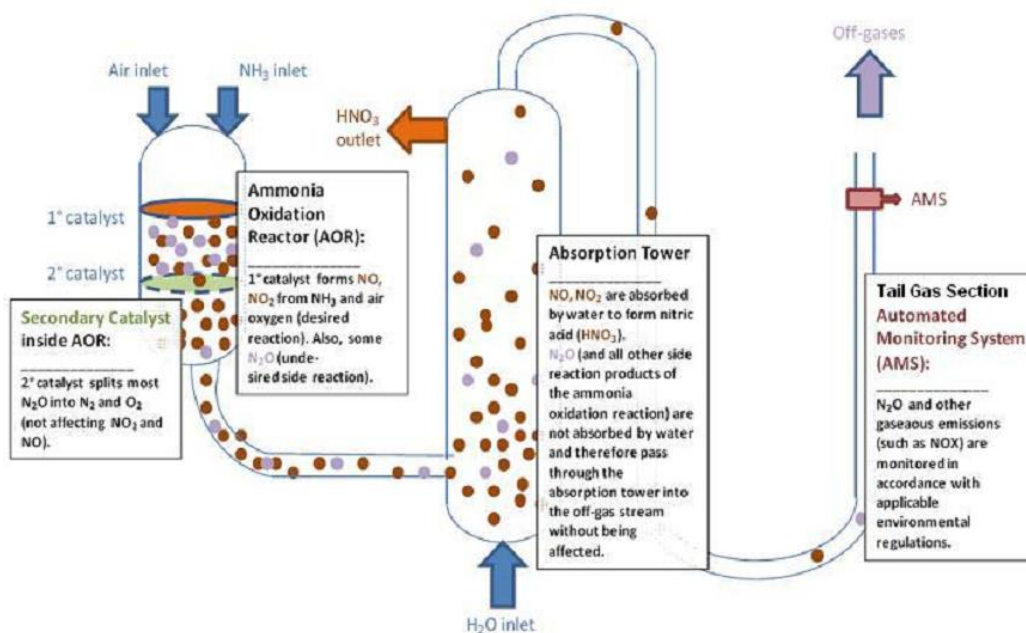


Figure 2: Project boundary

(b) **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.

(c) **Actual operation of the Project Activity during the covered monitoring period**

It should be noted that actual hours as given in the Excel book as per Annex 1 are to be read as follows. Example: 01/07/2012- 01:00 summarizes the hour from 01/07 00:00 am to 01:00 am. The time as given in the tables below are expressed in this regard.

#### Shutdown periods of the nitric acid plant

Table 1: Shutdown periods of Nitric Acid plant

Start		End		Description
Date	Time	Date	Time	
18/07/2012	14:00	19/07/2012	03:00	Nitric Acid Plant Shutdown (14 hours)
22/07/2012	21:00	29/07/2012	20:00	Nitric Acid Plant Shutdown (168 hours)*
07/08/2012	06:00	08/08/2012	11:00	Nitric Acid Plant Shutdown (30 hours)
09/08/2012	18:00	10/08/2012	12:00	Nitric Acid Plant Shutdown (19 hours)
26/08/2012	17:00	08/09/2012	22:00	Nitric Acid Plant Shutdown (318 hours)

\*) During the scheduled shutdown on 25/07/2012, a support ring was installed and the reactor was refilled with approximately 1520 kg. of secondary catalyst, due to a loss of secondary catalyst for a catchment basket broken (after plant shutdown on 15-16/02/2012).

Relevant hours of Nitric Acid plant (and consequently secondary N<sub>2</sub>O 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.

Service works (calibration & maintenance)

**Table 2:** Service works (calibration & maintenance)

Start		End		Description
Date	Time	Date	Time	
09/07/2012	22:00	09/07/2012	22:00	Monthly calibration PT-45091 and PT-45095 (1 hour)
08/08/2012	19:00	08/08/2012	19:00	Monthly calibration PT-45091 and PT-45095 (1 hour)
07/09/2012	18:00	07/09/2012	18:00	Monthly calibration PT-45091 and PT-45095 (1 hour)

During the scheduled DeltaV service, analyser service and monthly calibrations it has been proven that the nitric acid plant and consequently the secondary N<sub>2</sub>O abatement system has been in full operation.

Other issues

**Table 3:** Other issues

Start		End		Description
Date	Time	Date	Time	
19/07/2012	04:00	19/07/2012	19:00	Analyzer out of service (blockage) (16 hours)
22/08/2012	21:00	23/08/2012	00:00	Instrument problem (TT-45093) (4 hours)
08/09/2012	23:00	10/09/2012	08:00	Analyzer out of service (blockage) (34 hours)
24/09/2012	14:00	24/09/2012	15:00	Analyzer out of service (AIRTEC AST tests) (2 hours)

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

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

## **B.2. Post registration changes**

### **B.2.1. Temporary deviations from registered monitoring plan or applied methodology**

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No temporary deviations from registered monitoring plan or applied methodology have been applied during this monitoring period.

**B.2.2. Corrections**

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No corrections have been applied during this monitoring period, neither to any previous monitoring periods.

**B.2.3. Permanent changes from registered monitoring plan or applied methodology**

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No permanent changes from the registered monitoring plan or applied methodology have been applied during this monitoring period, neither to any previous monitoring periods.

**B.2.4. Changes to project design of registered project activity**

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No changes from the project design have been done during this monitoring period.

**B.2.5. Changes to start date of crediting period**

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No such changes have been applied to this monitoring period.

**B.2.6. Types of changes specific to afforestation or reforestation project activity**

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Not applicable.

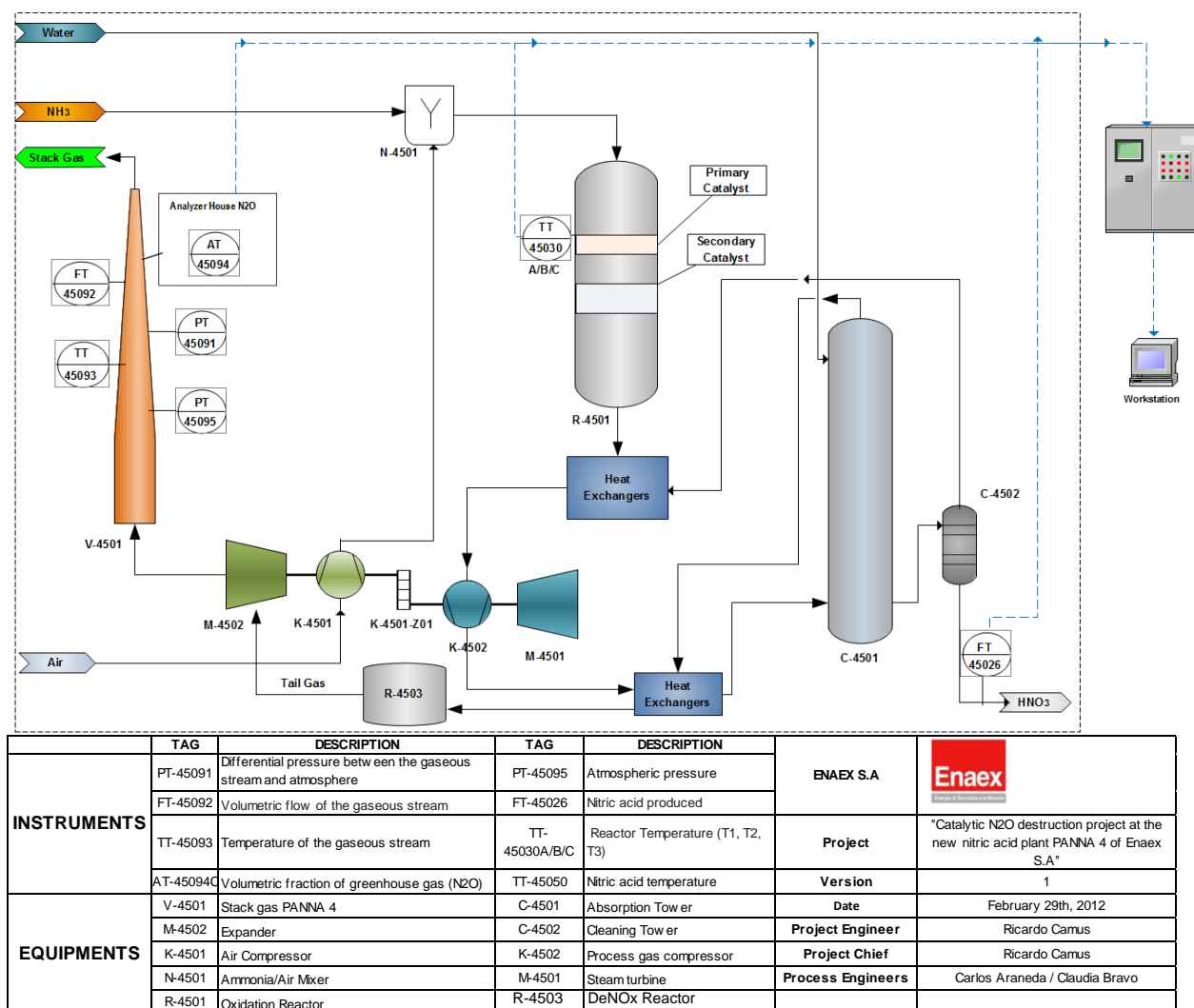
**SECTION C. Description of monitoring system**

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**(a) 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 1second 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.



**Figure 3:** Line diagram showing all relevant monitoring points

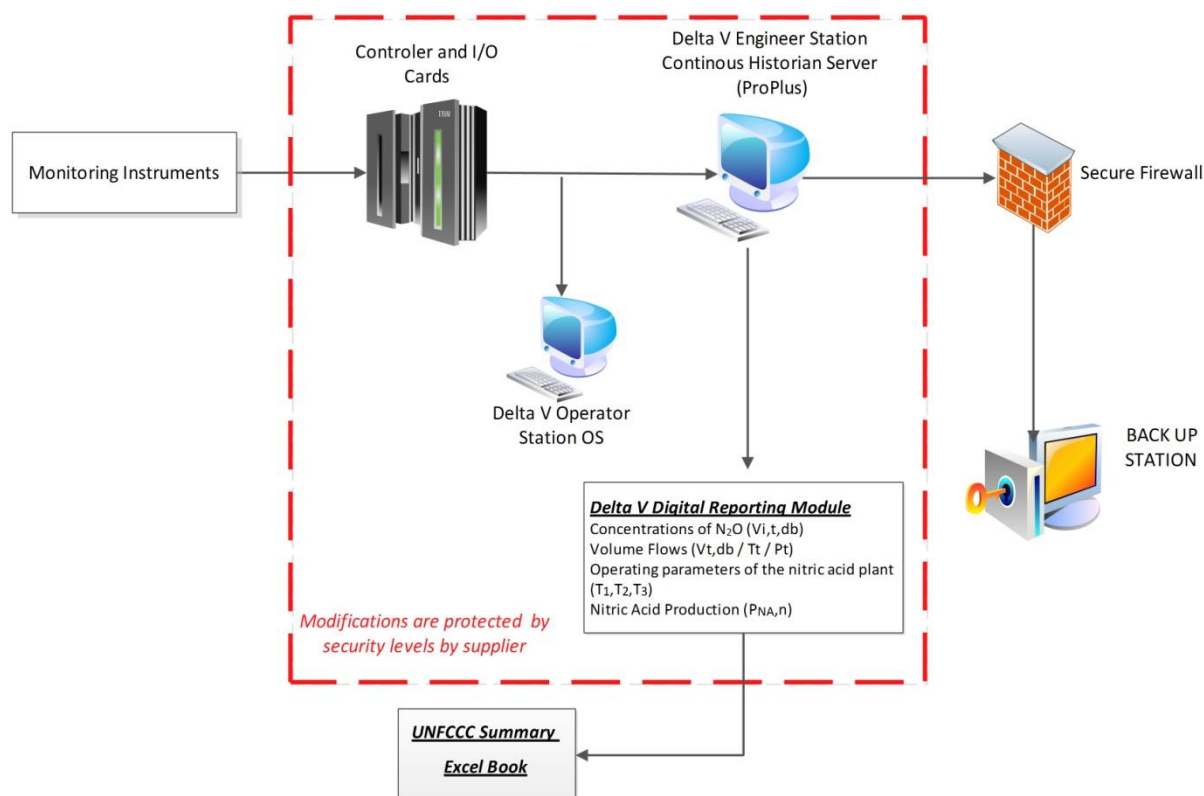
The reporting module of the Delta V system automatically generates aggregated daily reports based on the stored raw data from the continuous historian server. Daily reports contain following kinds of data relevant for calculation of claimed emission reductions:

- Concentrations of  $N_2O$  at stack gas of PANNA 4 system ( $V_{i,t,db}$ )
- Volume Flow ( $V_{i,t,db} / T_i / P_i$ )
- 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 ( $PE_n / PE_{N_2O,n} / Q_{N_2O,tail\ gas, n}$ ), 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<sub>2</sub>O abatement for Nitric Acid production” and the registered project documentation (Monitoring Plan and respective PDD).

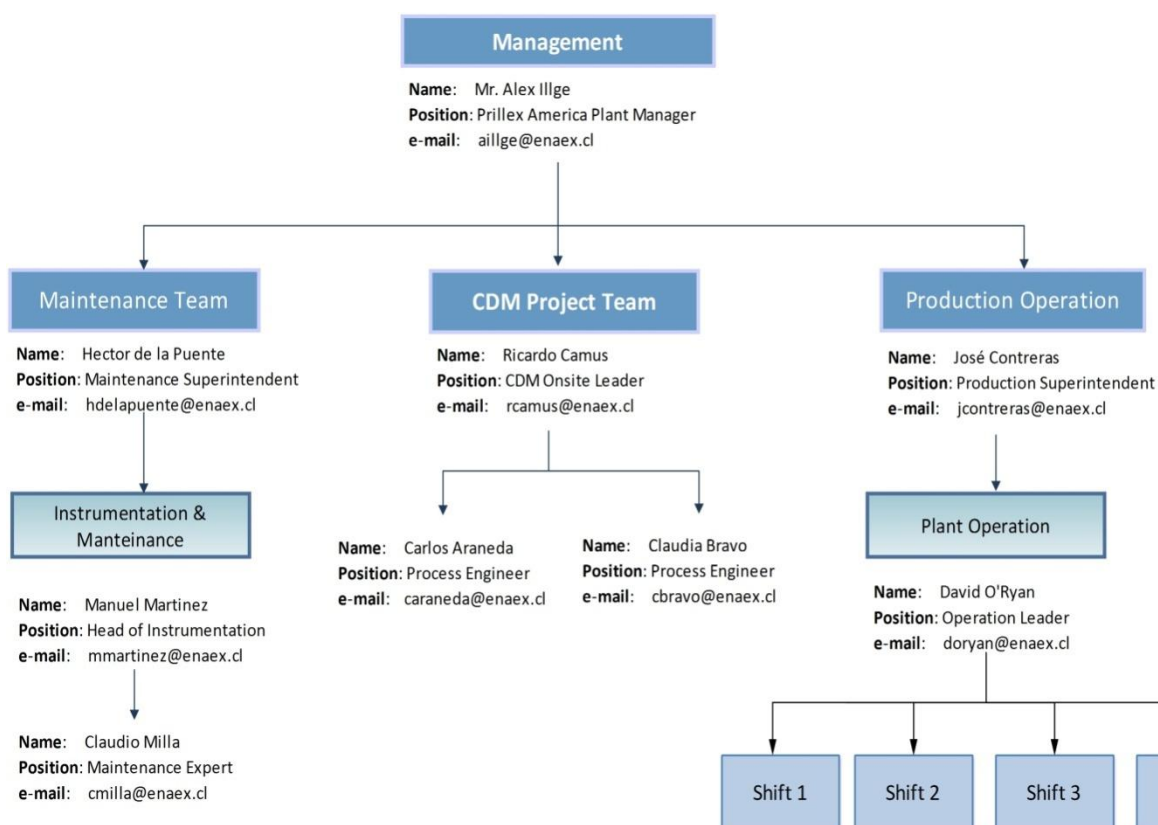
### (b) Roles and responsibilities of personnel

Project Operators 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 SigdoKoppers 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<sub>2</sub>O 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 Climate Protection GmbH supports Enaex, also giving 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

### (c) 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 4:** 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 analysed 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 fixed ex ante or at renewal of crediting period

Data/Parameter	EF <sub>default,y</sub>	
Unit	kgN <sub>2</sub> O/tHNO <sub>3</sub>	
Description	Default N <sub>2</sub> O baseline emissions factor in the calendar year y of the monitoring period n	
Source of data	According to PDD	
Value(s) applied	Year	Emission factor (kgN <sub>2</sub> O/HNO <sub>3</sub> )
	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



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...	...				
Year n	2.50				
<b>Purpose of data</b>	Baseline emission calculation				
<b>Additional comment</b>	The decrease in the value for the baseline emission factor over time is to reflect the technological development.				

<b>Data/Parameter</b>	<b>GWP<sub>N2O</sub></b>
<b>Unit</b>	<b>tCO<sub>2</sub>e/tN<sub>2</sub>O</b>
<b>Description</b>	Global warming potential of N2O valid for the commitment period
<b>Source of data</b>	According to PDD
<b>Value(s) applied</b>	<b>310 tCO<sub>2</sub>e/tN<sub>2</sub>O</b>
<b>Purpose of data</b>	Baseline and project emission calculation
<b>Additional comment</b>	Not applicable (NA)

<b>Data/Parameter</b>	<b>R<sub>u</sub></b>
<b>Unit</b>	<b>Pa.m<sup>3</sup>/kmol.K</b>
<b>Description</b>	Universal ideal gases constant
<b>Source of data</b>	According to PDD
<b>Value(s) applied</b>	<b>8,314 Pa.m<sup>3</sup>/kmol.K</b>
<b>Purpose of data</b>	Project emission calculation
<b>Additional comment</b>	NA

Data/Parameter	MM <sub>i</sub>		
Unit	kg/kmol		
Description	Molecular mass of greenhouse gas i		
Source of data	According to PDD		
Value(s) applied	Compound	Structure	Molecular mass (kg/kmol)
	Nitrous oxide	N <sub>2</sub> O	44.02
Purpose of data	Project emission calculation		
Additional comment	NA		

## D.2. Data and parameters monitored

<b>Data/Parameter</b>	<b>P<sub>NA,n</sub></b>
<b>Unit</b>	<b>tHNO<sub>3</sub></b>
<b>Description</b>	Nitric acid produced in the monitoring period n
<b>Measured/Calculated/Default</b>	Measured
<b>Source of data</b>	<p>Production Logs</p> <p>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.</p>



	Please also refer to Section C – 1 (Information Flow / Data collection procedures) of this Monitoring Report.
<b>Value(s) of monitored parameter</b>	<b>68,476 tHNO<sub>3</sub></b>
<b>Monitoring equipment</b>	<p><b>FT-45026</b>  Type: Coriolis flow and density transmitter  Endress Hauser Promass 80 F 3''  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</p> <p><b>TT-45050</b>  Type: Temperature transmitter  Inor MESO H  Accuracy class: 0.1% of range  Serial number: N0809.842183/VO336261  Calibration frequency: 2 years  Date of last calibration: 30/11/2011  Validity: 29/11/2013</p>
<b>Measuring/Reading/Recording frequency</b>	Measuring: Continuously Reading: 1(s) Recording: Hourly
<b>Calculation method (if applicable)</b>	The nitric acid at 100% is calculated by multiplying the mass flow with the concentration. The concentration is calculated at DCS using the density measurement of the coriolis flowmeter and the temperature instrument TT-45050.
<b>QA/QC procedures</b>	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 9001:2008.
<b>Purpose of data</b>	Baseline emission calculations
<b>Additional comment</b>	Not applicable

<b>Data/Parameter</b>	<b>h<sub>n</sub></b>
<b>Unit</b>	<b>NA</b>
<b>Description</b>	Number of hours of operation in a monitoring period n
<b>Measured/Calculated/Default</b>	Measured
<b>Source of data</b>	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 TT-45030A, 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.
<b>Value(s) of monitored parameter</b>	<b>1,659 hours</b>
<b>Monitoring equipment</b>	<p><b>TT-45030A</b>  <b>2 Newly calibrated instrument were installed in monitoring period</b>  Type: Temperature transmitter  Wika TC10 Type K  Accuracy class: 0.4% of range  Calibration frequency: 2 years</p> <p>Serial number (old instrument): 3F0AF4X  Date of last calibration: 30/06/2011  Validity: 29/06/2013</p> <p>Serial number (new instrument N°1): 1102RY6R *)  Date of installation: 28/07/2012  Date of last calibration: 21/07/2012  Validity: 20/07/2014</p> <p>Serial number (new instrument N°2): 1102RY6V  Date of installation: 10/08/2012  Date of penultimate calibration: 26/10/2011  Date of last calibration: 29/08/2012  Validity: 28/08/2014</p> <p><b>TT-45030B</b>  <b>Newly calibrated instrument was installed in monitoring period</b>  Type: Temperature transmitter  Wika TC10 Type K  Accuracy class: 0.4% of range  Calibration frequency: 2 years</p> <p>Serial number (old instrument): 3F0AF4Y  Date of last calibration (old instrument): 30/06/2011  Validity (old instrument): 29/06/2013</p> <p>Serial number (new instrument): 1102RY6P  Date of installation: 28/07/2012  Date of last calibration (new instrument): 22/07/2012  Validity (new instrument): 21/07/2014</p> <p><b>TT-45030C</b>  <b>2 Newly calibrated instrument were installed in monitoring period (10/08/2012)</b>  Type: Temperature transmitter  Wika TC10 Type K  Accuracy class: 0.4% of range  Calibration frequency: 2 years</p> <p>Serial number (old instrument): 3F0AF4W  Date of last calibration (old instrument): 30/06/2011</p>



	<p>Validity (old instrument): 29/06/2013</p> <p>Serial number (new instrument N°1): 1102RY6S *)</p> <p>Date of installation: 28/07/2012</p> <p>Date of last calibration: 22/07/2012</p> <p>Validity: 21/07/2014</p> <p>Serial number (new instrument N°2): 1102RY6Q</p> <p>Date of installation: 10/08/2012</p> <p>Date of penultimate calibration: 26/10/2011</p> <p>Date of last calibration: 31/08/2012</p> <p>Validity: 30/08/2014</p>
<b>Measuring/Reading/Recording frequency</b>	<p>Measuring: Continuously</p> <p>Reading: 1(s)</p> <p>Recording: Hourly</p>
<b>Calculation method (if applicable)</b>	NA
<b>QA/QC procedures</b>	<p>Periodic calibration is performed according to manufacturer's recommendation.</p> <p>The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2008.</p>
<b>Purpose of data</b>	Project emission calculation
<b>Additional comment</b>	*) The instruments TT-45030A and TT-45030C were changed on 28/07/2012. Due to failure during a shutdown, were replaced again for new transmitters on 10/08/2012.

<b>Data/Parameter</b>	$V_{t,db }$
<b>Unit</b>	<b>m<sup>3</sup> dry gas/h</b>
<b>Description</b>	Volumetric flow of the gaseous stream in time interval t on a dry basis
<b>Measured/Calculated/Default</b>	Measured
<b>Source of data</b>	<p>Flow meter / Field instruments/Monitoring system (Delta V)</p> <p>Please also refer to Section C – 1 (Information Flow / Data collection procedures) of this Monitoring Report.</p>
<b>Value(s) of monitored parameter</b>	<b>138,126 m<sup>3</sup> dry gas/h</b>
<b>Monitoring equipment</b>	<p><b>FT-45092</b></p> <p>Type: Differential pressure transmitter.</p> <p>Durag/ABB 2600T</p> <p>Accuracy class: 2% of range</p> <p>Serial number: 265DS6600071043</p> <p>Calibration frequency: 3 years (QAL2)</p> <p>Date of last calibration (QAL2): 16/12/2011</p> <p>Validity: 15/12/2015</p> <p>Date of AST Test: 24/09/2012-25/09/2012</p>
<b>Measuring/Reading/Recording frequency</b>	<p>Measuring: Continuously</p> <p>Reading: 1(s)</p>



	Recording: Hourly
<b>Calculation method (if applicable)</b>	NA
<b>QA/QC procedures</b>	Periodic calibration (QAL2) against a primary device by an independent accredited laboratory. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2008.
<b>Purpose of data</b>	Project emission calculations
<b>Additional comment</b>	Not applicable

<b>Data/Parameter</b>	$V_{i,t,db}$
<b>Unit</b>	m <sup>3</sup> gas i/m <sup>3</sup> dry gas
<b>Description</b>	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
<b>Measured/Calculated /Default</b>	Measured
<b>Source of data</b>	Non-dispersive infrared photometry (NDIR) for N <sub>2</sub> O (Gas analyzer equipment) Please also refer to <i>Section C – 1 (Information Flow / Data collection procedures)</i> of this Monitoring Report.
<b>Value(s) of monitored parameter</b>	$1.86 \cdot 10^{-4}$ m <sup>3</sup> gas i/m <sup>3</sup> dry gas
<b>Monitoring equipment</b>	<b>AT-45094C</b> Type: Volumetric fraction of N <sub>2</sub> O in the tail gas analyzer Emerson Process NGA 2000 MLT Accuracy class: 1% of range Serial number: 3709103038248 Calibration frequency: 3 years (QAL2) Validity: 05/06/2015 Date of AST Tests: 24/09/2012-25/09/2012
<b>Measuring/Reading/Recording frequency</b>	Measuring: Continuously Reading: 1(s) Recording: Hourly
<b>Calculation method (if applicable)</b>	NA
<b>QA/QC procedures</b>	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 9001:2008





<b>Purpose of data</b>	Project emission calculation
<b>Additional comment</b>	Not applicable

<b>Data/Parameter</b>	$C_{H_2O,t,db,n}$
<b>Unit</b>	mg H <sub>2</sub> O/m <sup>3</sup> dry gas
<b>Description</b>	Moisture content of the gaseous stream at normal conditions, in time interval t
<b>Measured/Calculated/Default</b>	Measured
<b>Source of data</b>	Measurements according to USEPA CF 42 method 4 – Gravimetric determination of water content (QAL2 Report)  Date of penultimate determination (QAL2): 14/12/2011 Date of last determination (AST): 25/09/2012 Next determination until: 24/09/2013
<b>Value(s) of monitored parameter</b>	<b>3.6 mg H<sub>2</sub>O/m<sup>3</sup> dry gas (Highest measured value)</b>  Option A of the tool can be applied, as the moisture content is less than 0.05 kg H <sub>2</sub> O/m <sup>3</sup> dry gas.
<b>Monitoring equipment</b>	
<b>Measuring/Reading/Recording frequency</b>	Measuring / Reading / Recording: Yearly
<b>Calculation method (if applicable)</b>	NA
<b>QA/QC procedures</b>	NA
<b>Purpose of data</b>	Project emission calculation
<b>Additional comment</b>	Not applicable

<b>Data/Parameter</b>	$T_t$
<b>Unit</b>	K
<b>Description</b>	Temperature of the gaseous stream in time interval t
<b>Measured/Calculated/Default</b>	Measured
<b>Source of data</b>	Temperature Transmitter Please also refer to Section C – 1 (Information Flow / Data collection procedures) of this Monitoring Report.
<b>Value(s) of monitored parameter</b>	<b>366.17 K</b>
<b>Monitoring equipment</b>	<b>TT-45093</b> Type: Tail gas temperature transmitter Rosemount 3144P Accuracy class: 0.4 °C Serial number: 706088 Calibration frequency: 2 years



	Date of last calibration: 16/11/2011 Validity: 15/11/2013
<b>Measuring/Reading/Recording frequency</b>	Measuring: Continuously Reading: 1(s) Recording: Hourly
<b>Calculation method (if applicable)</b>	NA
<b>QA/QC procedures</b>	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 9001:2008.
<b>Purpose of data</b>	Project emission calculation
<b>Additional comment</b>	The monitored parameter average includes all values of the monitoring period

<b>Data/Parameter</b>	<b>P<sub>t</sub></b>										
<b>Unit</b>	<b>Pa</b>										
<b>Description</b>	Pressure of the gaseous stream in time interval t										
<b>Measured/Calculated/Default</b>	Measured										
<b>Source of data</b>	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.										
<b>Value(s) of monitored parameter</b>	<b>100,911 Pa</b>										
<b>Monitoring equipment</b>	<p><b>PT-45091</b> Type: Capacitive Differential pressure transmitter Rosemount 2051 Accuracy class: 0.1% of range Serial number: 58154 Calibration frequency: Monthly Date of calibration:</p> <table border="1"> <thead> <tr> <th>Month</th><th>Date of Calibration</th></tr> </thead> <tbody> <tr> <td>June</td><td>10/06/2012</td></tr> <tr> <td>July</td><td>09/07/2012</td></tr> <tr> <td>August</td><td>08/08/2012</td></tr> <tr> <td>September</td><td>07/09/2012</td></tr> </tbody> </table> <p>Validity: 06/10/2012</p> <p><b>PT-45095</b> Type: Capacitive Barometric pressure transmitter Rosemount 2051 Accuracy class: 0.1% of range Serial number: 58157</p>	Month	Date of Calibration	June	10/06/2012	July	09/07/2012	August	08/08/2012	September	07/09/2012
Month	Date of Calibration										
June	10/06/2012										
July	09/07/2012										
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	Calibration frequency: Monthly Date of calibration: <table border="1"> <thead> <tr> <th>Month</th><th>Date of Calibration</th></tr> </thead> <tbody> <tr> <td>June</td><td>10/06/2012</td></tr> <tr> <td>July</td><td>09/07/2012</td></tr> <tr> <td>August</td><td>08/08/2012</td></tr> <tr> <td>September</td><td>07/09/2012</td></tr> </tbody> </table> Validity: 06/10/2012	Month	Date of Calibration	June	10/06/2012	July	09/07/2012	August	08/08/2012	September	07/09/2012
Month	Date of Calibration										
June	10/06/2012										
July	09/07/2012										
August	08/08/2012										
September	07/09/2012										
<b>Measuring/Reading/Recording frequency</b>	Measuring: Continuously Reading: 1(s) Recording: Hourly										
<b>Calculation method (if applicable)</b>	The static pressure inside the stack and the barometric pressure are measured continuously. The hourly averages of these parameters are added in the attached excel book in order to obtain the pressure of the gaseous stream.										
<b>QA/QC procedures</b>	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 9001:2008.										
<b>Purpose of data</b>	Project emission calculation										
<b>Additional comment</b>	The monitored parameter average includes all values of the monitoring period										

### D.3. Implementation of sampling plan

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Not applicable for the project activity.

## SECTION E. Calculation of emission reductions or GHG removals by sinks

### E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

&gt;&gt;

Baseline emissions are given by the following equation:

$$BE_n = P_{NA,n} * EF_{BL,N_2O,n} * GWP_{N_2O} * 10^{-3}$$

Where:

$BE_n$	=	Baseline emissions in monitoring period n (tCO <sub>2</sub> e)
$P_{NA,n}$	=	Nitric acid produced in the monitoring period n (tHNO <sub>3</sub> )
$EF_{BL,N_2O,n}$	=	Baseline N <sub>2</sub> O emission factor for nitric acid production in the monitoring period n (kgN <sub>2</sub> O / tHNO <sub>3</sub> )
$GWP_{N_2O}$	=	Global Warming Potential of N <sub>2</sub> O valid for the commitment period

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

The baseline  $N_2O$  emission factor in the monitoring period  $n$  ( $EF_{BL,N_2O,n}$ ) 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:

$$EF_{BL,N_2O,n} = EF_{default,y}$$

Where:

$EF_{BL,N_2O,n}$	=	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  $EF_{BL,N_2O,n}$  and then applying this to the nitric acid production of that calendar year.

The values for the present period are:

Parameter	Value	Unit
$BE_n$	82,788	tCO <sub>2</sub> e
$P_{NA,n}$	68,476	tHNO <sub>3</sub>
$EF_{BL,N_2O,2012}$	3.90	kgN <sub>2</sub> O / tHNO <sub>3</sub>
$GWP_{N_2O}$	310	-

## **E.2. Calculation of project emissions or actual net GHG removals by sinks**

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Project emissions are calculated as follows:

$$PE_n = PE_{N_2O,n} + PE_{CO_2,tertiary,n}$$

Where:

$PE_n$	=	Project emissions in monitoring period $n$ (tCO <sub>2</sub> e)
$PE_{N_2O,n}$	=	Project emissions of $N_2O$ from the project plant in monitoring period $n$ (tCO <sub>2</sub> e)
$PE_{CO_2,tertiary,n}$	=	Project emissions of CO <sub>2</sub> from the operation of the tertiary $N_2O$ abatement facility in monitoring period $n$ (tCO <sub>2</sub> )

Parameter	Value	Unit
$PE_n$	32,024	tCO <sub>2</sub> e
$PE_{N_2O,n}$	32,024	tCO <sub>2</sub> e
$PE_{CO_2,tertiary,n}$	0	tCO <sub>2</sub> e

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

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

- 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<sub>2</sub>O abatement, the N<sub>2</sub>O contained in any by-pass streams to the tertiary N<sub>2</sub>O abatement facility. As the proposed CDM project activity does not comprise the installation of a tertiary N<sub>2</sub>O abatement technology, no emissions need to be considered or monitored.

Accordingly, PE<sub>N<sub>2</sub>O,n</sub> is determined as follows:

$$PE_{N_2O,n} = (Q_{N_2O,tail\ gas,n} + Q_{N_2O,by-pass,n}) * GWP_{N_2O}$$

Where:

PE <sub>N<sub>2</sub>O,n</sub>	=	Project emissions of N <sub>2</sub> O from the project plant in monitoring period n (tCO <sub>2</sub> e)
Q <sub>N<sub>2</sub>O,tail gas,n</sub>	=	Amount of N <sub>2</sub> O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN <sub>2</sub> O)
Q <sub>N<sub>2</sub>O,by-pass,n</sub>	=	Amount of N <sub>2</sub> O released through the by-pass to a tertiary N <sub>2</sub> O abatement system to the atmosphere in monitoring period n (tN <sub>2</sub> O)
GWP <sub>N<sub>2</sub>O</sub>	=	Global Warming Potential of N <sub>2</sub> O valid for the commitment period

Parameter	Value	Unit
PE <sub>N<sub>2</sub>O,n</sub>	32,024	tCO <sub>2</sub> e
Q <sub>N<sub>2</sub>O,tail gas,n</sub>	103.30	tN <sub>2</sub> O
Q <sub>N<sub>2</sub>O,by-pass,n</sub>	0	tN <sub>2</sub> O
GWP <sub>N<sub>2</sub>O</sub>	310	-

#### Determination of Q<sub>N<sub>2</sub>O,tail gas,n</sub>

The amount of N<sub>2</sub>O 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<sub>2</sub>O 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<sub>2</sub>O 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<sub>2</sub>O 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<sub>2</sub>O 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<sub>2</sub>O 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<sub>2</sub>O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N<sub>2</sub>O 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<sub>2</sub>O 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:

- Measure the moisture content of the gaseous stream ( $C_{H_2O,t,db,n}$ ) and demonstrate that this is less or equal to  $0.05 \text{ kg H}_2\text{O}/\text{m}^3 \text{ dry gas}$ ; or
- Demonstrate that the temperature of the gaseous stream ( $T_t$ ) is less than  $60^\circ\text{C}$  ( $333.15 \text{ K}$ ) 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, which was confirmed by AST Report 2012 by AIRTEC, according to USEPA CF42 method 4.. The measured moisture content in the stack gas is less than  $0.05 \text{ kg}/\text{m}^3 \text{ dry gas}$ .

**Table 4:** Moisture content measurements (according to AST report)

Measuring Sequence	Date	Moisture content
1	24/09/2012	$0.0032 \text{ kgH}_2\text{O}/\text{m}^3 \text{ dry gas}$
2	24/09/2012	$0.0028 \text{ kgH}_2\text{O}/\text{m}^3 \text{ dry gas}$
3	25/09/2012	$0.0036 \text{ kgH}_2\text{O}/\text{m}^3 \text{ dry gas}$

The mass flow of greenhouse gas  $i$  ( $F_{i,t}$ )<sup>1</sup> is calculated as follows:

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

With

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

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 ( $\text{m}^3 \text{ dry gas}/\text{h}$ )
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas $i$ in the gaseous stream in a time interval $t$ on a dry basis ( $\text{m}^3 \text{ gas } i/\text{m}^3 \text{ dry gas}$ )
$\rho_{i,t}$	=	Density of greenhouse gas $i$ in the gaseous stream in time interval $t$ ( $\text{kg gas } i/\text{m}^3 \text{ gas}$ )
$P_t$	=	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 ( $\text{Pa} \cdot \text{m}^3/\text{kmol} \cdot \text{K}$ )
$T_t$	=	Temperature of the gaseous stream in time interval $t$ (K)

<sup>1</sup> $F_{i,t}$  corresponds to the parameter  $F_{N_2O,tail \text{ gas},h}$  of the methodology ACM0019 Version 01.0.0.

*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:

$$Q_{N_2O, tail gas, n} = \sum_{h=1}^{h=h_n} F_{N_2O, tail gas, h} * 10^{-3}$$

Where:

$Q_{N_2O, tail gas, n}$	=	Amount of N <sub>2</sub> O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN <sub>2</sub> O)
$F_{N_2O, tail gas, h}$	=	Mass flow of N <sub>2</sub> O in the gaseous stream of the tail gas in the hour h (kgN <sub>2</sub> O/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. Calculation of leakage

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

### E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO <sub>2</sub> e)	Project emissions or actual net GHG removals by sinks (tCO <sub>2</sub> e)	Leakage (tCO <sub>2</sub> e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO <sub>2</sub> e) *)
Total	82,788	32,024	0	50,763

*\*) 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<sub>n</sub> calculation only. This can be traced in the excel book attached to this monitoring report.*

### E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks(tCO <sub>2</sub> e)	88,666 (92 days)	50,763 (92 days)

### E.6. Remarks on difference from estimated value in registered PDD

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The emission reductions in this Monitoring Period are 50,763 tons of CO<sub>2</sub> equivalents. The yearly expected emission reduction according to the registered PDD is 351,773 tons of CO<sub>2</sub> equivalents. This corresponds to emission reductions of 88,666 tons of CO<sub>2</sub> equivalents in 92 days; hence the observed emission reduction is lower than expected.

## 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 3\_PANNA 4 (5393)\_UNFCCC SUMMARY\_v2 18-12-12

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### History of the document

Version	Date	Nature of revision
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	EB 54, Annex 34 28 May 2010	Initial adoption.
<b>Decision Class:</b> Regulatory <b>Document Type:</b> Form <b>Business Function:</b> Issuance		