



Monitoring report form (Version 03.1)

Monitoring report

Title of the project activity	Catalytic N ₂ O destruction project at the new nitric acid plant PANNA 4 of Enaex S.A.
Reference number of the project activity	5393
Version number of the monitoring report	Version 1
Completion date of the monitoring report	26/07/2013
Registration date of the project activity	30/11/2011
Monitoring period number and duration of this monitoring period	Monitoring period number: 4 Duration: 01/10/2012 – 18/03/2013
Project participant(s)	Enaex S.A. Carbon Climate Protection GmbH Mitsubishi Corporation
Host Party(ies)	Republic of Chile
Sectoral scope(s) and applied methodology(ies)	Sectoral scope 5: Chemical industries ACM0019 "N ₂ O abatement from nitric acid production" (Version 01.0.0)
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	158,581 (169 days)
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	136,221 (169 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 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: **136,221 tCO₂e**

A.2. Location of project activity

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- a) Host Party(ies): Republic of Chile
- b) Province: 2nd 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 "N₂O 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**

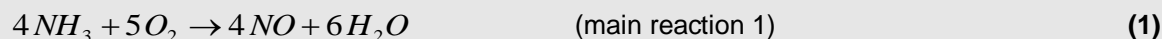
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(a) Information on the implementation of the project activity**General description**

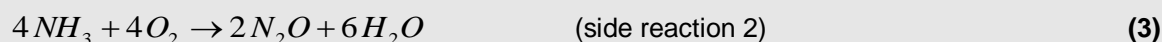
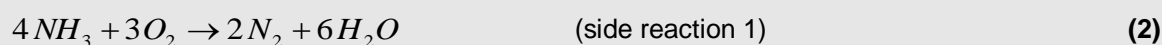
Nitrous oxide (N₂O) is an unwanted, invisible and previously neglected by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide (NO) during the catalytic oxidation of ammonia in air over noble metal gauzes. N₂O is a potent greenhouse gas with a Global 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 (NH₃) 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:

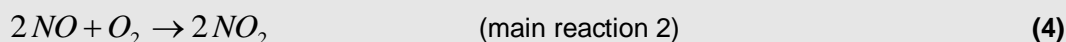


Simultaneously, nitrous oxide (N₂O), nitrogen (N) and water (H₂O) are formed as well, in accordance with the following equations:



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 (NO₂):



3. (According to the technical process) Absorption of NO₂ in water to form nitric acid (HNO₃):



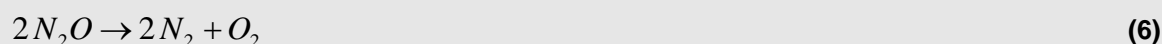
(NO is oxidised to NO₂ according to main reaction 2)

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 (NH₄NO₃), 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 N₂O catalyst was inserted below the primary catalyst (NH₃ catalyst) in the ammonia oxidation reactor. The N₂O catalyst largely results in decomposition of N₂O to nitrogen (N₂) and oxygen (O₂) without any further energy, nor material inputs. Catalytic decomposition of N₂O occurs when the N₂O 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 HNO₃ 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 N₂O abatement, by installing baskets inside the ammonia oxidation reactor and equipping them with the N₂O decomposition catalyst right below the platinum gauze in the high temperature zone of the reactor. The measurement devices for the monitoring of N₂O concentration and tail gas flow are located directly in the stack.

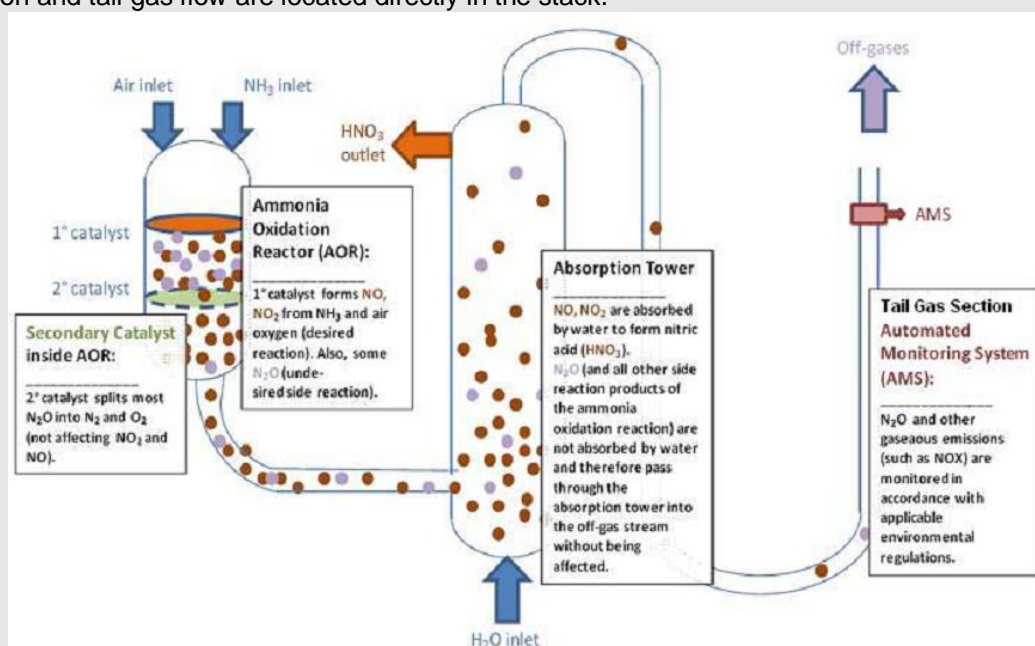


Figure 2: Project boundary

(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: 01/10/2012- 01:00 summarizes the hour from 01/10 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	
26/10/2012	02:00	27/10/2012	02:00	Nitric Acid Plant Shutdown (25 hours)
21/12/2012	10:00	23/12/2012	12:00	Nitric Acid Plant Shutdown (51 hours)
07/02/2013	19:00	13/02/2013	23:00	Nitric Acid Plant Shutdown (149 hours)
25/02/2013	10:00	26/02/2013	02:00	Nitric Acid Plant Shutdown (17 hours)
26/02/2013	04:00	26/02/2013	18:00	Nitric Acid Plant Shutdown (15 hours)
27/02/2013	09:00	27/02/2013	22:00	Nitric Acid Plant Shutdown (14 hours)

Relevant hours of Nitric Acid plant (and consequently secondary N₂O 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	
10/11/2012	19:00	10/11/2012	21:00	Monthly calibration PT-45091 and PT-45095 (3 hours)
08/12/2012	18:00	08/12/2012	18:00	Monthly calibration PT-45091 and PT-45095 (1 hour)
09/01/2013	21:00	09/01/2013	21:00	Monthly calibration PT-45091 and PT-45095 (1 hour)
08/03/2013	18:00	08/03/2013	18:00	Monthly calibration PT-45091 and PT-45095 (1 hour)

During the scheduled DeltaV service, analyzer service and monthly calibrations it has been proven that the nitric acid plant and consequently the secondary N₂O abatement system has been in full operation.

Other issues**Table 3: Other issues**

Start		End		Description
Date	Time	Date	Time	
07/10/2012	01:00	10/11/2012	18:00	Delay in calibration PT-45091 and PT-45095 (809 hours)
27/10/2012	03:00	27/10/2012	16:00	Analyzer out of service (14 hours)
30/10/2012	14:00	30/10/2012	18:00	TT-45030A out of service (5 hours)
26/12/2012	09:00	26/12/2012	15:00	TT-45030A out of service (7 hours)
08/01/2013	01:00	09/01/2013	20:00	Delay in calibration PT-45091 and PT-45095 (44 hours)
09/02/2013	01:00	08/03/2013	17:00	Delay in calibration PT-45091 and PT-45095 (665 hours)
23/02/2013	03:00	23/02/2013	04:00	TT-45030A out of service (2 hours)

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

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 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.

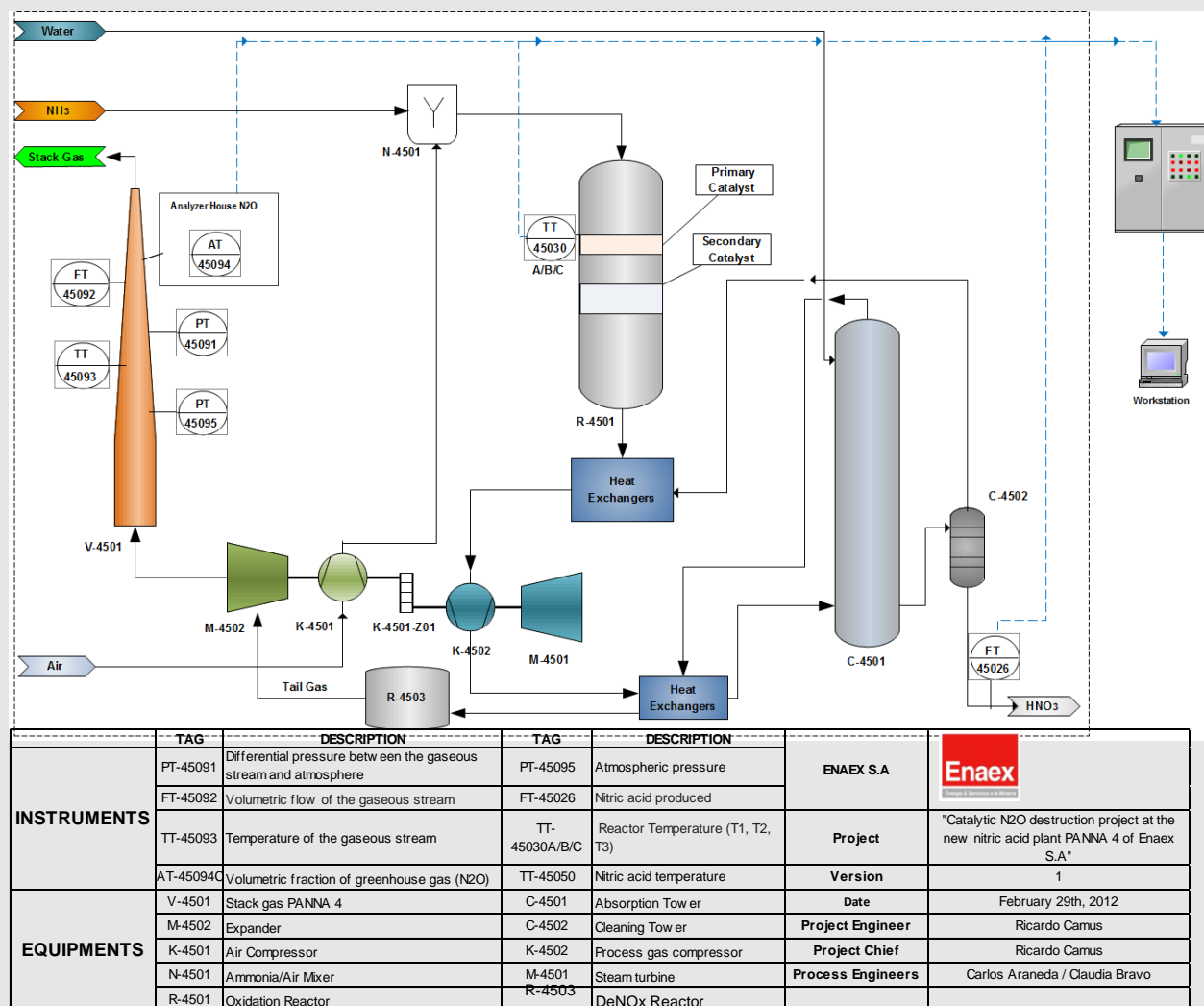


Figure 3: Line diagram showing all relevant monitoring points

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 N₂O 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 / $PE_{N_2O,n}$ / $Q_{N_2O,tail\ gas, n}$), 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*.

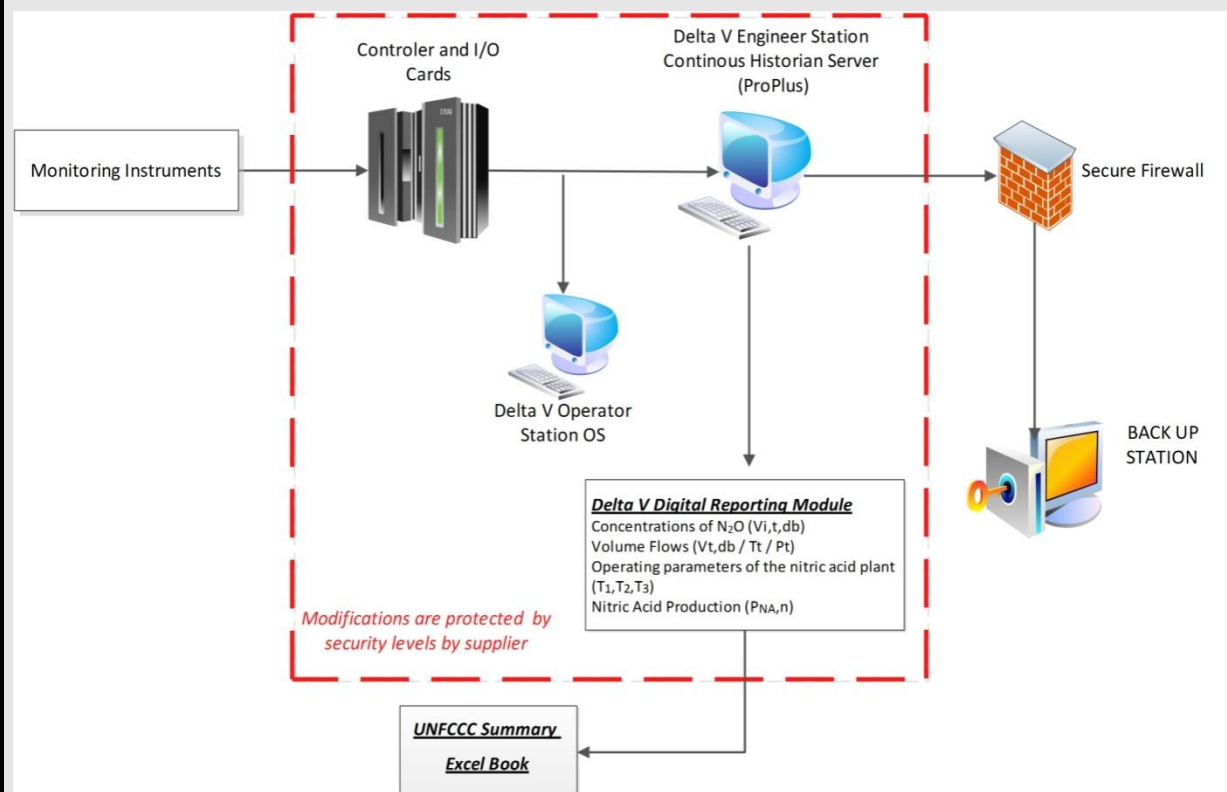


Figure 4: Information flow diagram

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 “N₂O abatement for Nitric Acid production” and the registered project documentation (Monitoring Plan and respective PDD).

(b) Roles and responsibilities of personnel

Project Operator is Enaex S.A. (furthermore called “Enaex”), a privately 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 N₂O 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.

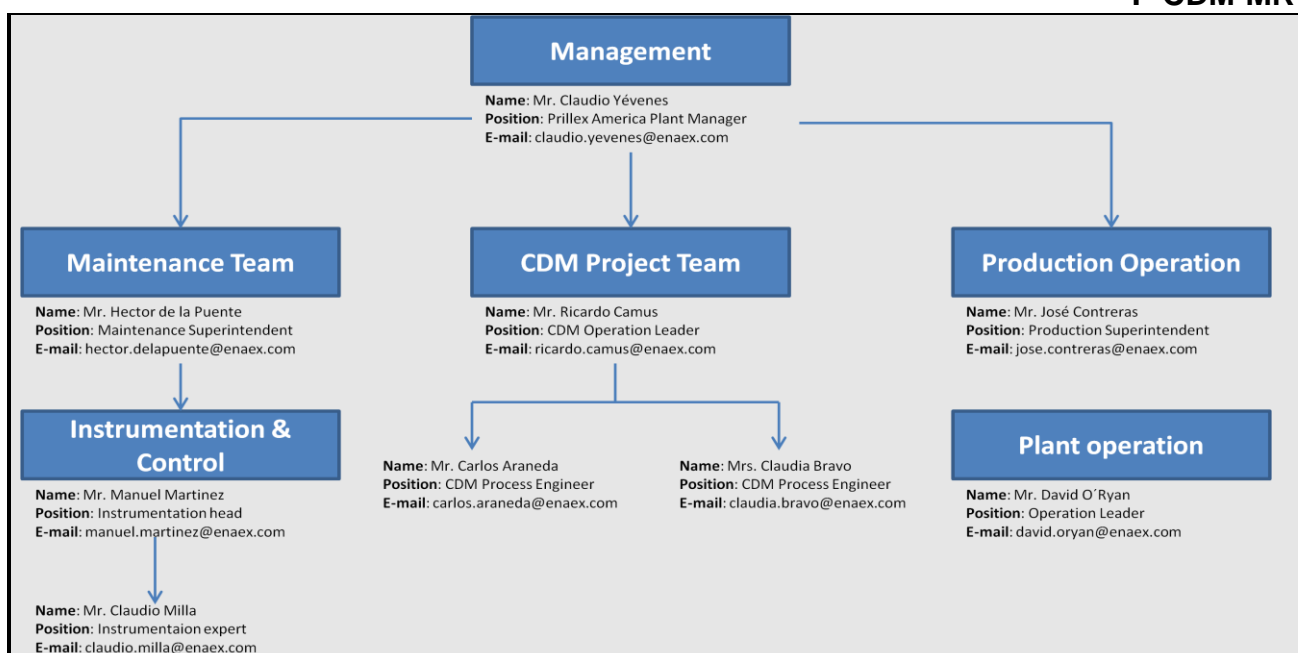


Figure 5: Organizational Chart: Onsite structure at Enaex

(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 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 fixed ex ante or at renewal of crediting period

Data / Parameter:	EF _{default,y}																													
Unit:	kgN ₂ O/tHNO ₃																													
Description:	Default N ₂ O baseline emissions factor in the calendar year y of the monitoring period n																													
Source of data:	According to PDD																													
Value(s) applied):	<table><tr><th>Year</th><th>Emission factor (kgN₂O/HNO₃)</th></tr><tr><td>2011</td><td>4.10</td></tr><tr><td>2012</td><td>3.90</td></tr><tr><td>2013</td><td>3.70</td></tr><tr><td>2014</td><td>3.50</td></tr><tr><td>2015</td><td>3.40</td></tr><tr><td>2016</td><td>3.20</td></tr><tr><td>2017</td><td>3.00</td></tr><tr><td>2018</td><td>2.80</td></tr><tr><td>2019</td><td>2.70</td></tr><tr><td>2020</td><td>2.50</td></tr><tr><td>2021</td><td>2.50</td></tr><tr><td>...</td><td>...</td></tr><tr><td>Year n</td><td>2.50</td></tr></table>		Year	Emission factor (kgN ₂ O/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
Year	Emission factor (kgN ₂ O/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																													
Purpose of data:	Baseline emission calculation																													
Additional comment:	The decrease in the value for the baseline emission factor over time is to reflect the technological development.																													

Data / Parameter:	GWP_{N₂O}
Unit:	tCO₂e/tN₂O
Description:	Global warming potential of N ₂ O valid for the commitment period
Source of data:	According to PDD
Value(s) applied:	310 tCO₂e/tN₂O
Purpose of data:	Baseline and project emission calculation
Additional comment:	Not applicable (NA)

Data / Parameter:	R_u
Unit:	Pa.m³/kmol.K
Description:	Universal ideal gases constant

Source of data:	According to PDD
Value(s) applied:	8,314 Pa.m³/kmol.K
Purpose of data:	Project emission calculation
Additional comment:	NA

Data / Parameter:	MM _i								
Unit:	kg/kmol								
Description:	Molecular mass of greenhouse gas i								
Source of data:	According to PDD								
Value(s) applied):	<table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg/kmol)</th></tr><tr><td>Nitrous oxide</td><td>N₂O</td><td>44.02</td></tr></table>	Compound	Structure	Molecular mass (kg/kmol)	Nitrous oxide	N ₂ O	44.02		
Compound	Structure	Molecular mass (kg/kmol)							
Nitrous oxide	N ₂ O	44.02							
Purpose of data:	Project emission calculation								
Additional comment:	NA								

D.2. Data and parameters monitored

(Copy this table for each piece of data and parameter.)

Data / Parameter:	P_{NA,n}
Unit:	tHNO₃
Description:	Nitric acid produced in the monitoring period n
Measured/ Calculated / Default:	Measured
Source of data:	<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> <p>Please also refer to Section C – (a) (Information Flow / Data collection procedures) of this Monitoring Report.</p>
Value(s) of monitored parameter:	161,877 tHNO₃
Monitoring equipment:	<p>FT-45026 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>TT-45050 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>

Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	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.
QA/QC procedures:	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.
Purpose of data:	Baseline emission calculations
Additional comment:	Not applicable
Data / Parameter:	h_n
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 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.
Value(s) of monitored parameter:	3,785 hours

Monitoring equipment:	<p>TT-45030A 1 Newly calibrated instrument were installed in monitoring period Type: Temperature transmitter Wika TC10 Type K Accuracy class: 0.4% of range Calibration frequency: 2 years</p> <p>Serial number (old instrument): 1102RY6V Date of last calibration: 29/08/2012 Validity: 28/08/2014</p> <p>Serial number (new instrument): 1104NC5G Date of installation: 23/03/2013 Date of last calibration: 07/12/2012 Validity: 06/12/2014</p> <p>TT-45030B 1 Newly calibrated instrument were installed in monitoring period Type: Temperature transmitter Wika TC10 Type K Accuracy class: 0.4% of range Calibration frequency: 2 years</p> <p>Serial number (old instrument): 1102RY6P Date of last calibration: 22/07/2012 Validity: 21/07/2014</p> <p>Serial number (new instrument): 1104NC5H Date of installation: 23/03/2013 Date of last calibration: 07/12/2012 Validity: 06/12/2014</p> <p>TT-45030C 1 Newly calibrated instrument were installed in monitoring period Type: Temperature transmitter Wika TC10 Type K Accuracy class: 0.4% of range Calibration frequency: 2 years</p> <p>Serial number (old instrument): 1102RY6Q Date of last calibration: 31/08/2012 Validity: 30/08/2014</p> <p>Serial number (new instrument): 1104N00N Date of installation: 23/03/2013 Date of last calibration: 05/12/2012 Validity: 04/12/2014</p>
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures:	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.
Purpose of data:	Project emission calculation

Additional comment:	*) The instruments TT-45030A, TT-45030B and TT-45030C were changed on 23/03/2013.
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Data / Parameter:	$V_{t,db}$
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:	175,512 m³ dry gas/h
Monitoring equipment:	FT-45092 Type: Differential pressure transmitter. Durag/ABB 2600T Accuracy class: 2% of range Serial number: 265DS6600071043 Calibration frequency: 3 years (QAL2) Date of last calibration (QAL2): 16/12/2011 Validity: 15/12/2014 Date of AST Test: 24/09/2012-25/09/2012 Validity: 24/09/2013
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures:	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.
Purpose of data:	Project emission calculations
Additional comment:	Not applicable

Data / Parameter:	$V_{i,t,db}$
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 ₂ O (Gas analyzer equipment) Please also refer to Section C – 1 (Information Flow / Data collection procedures) of this Monitoring Report.
Value(s) of monitored parameter:	1.76*10⁻⁴ m³ gas i/m³ dry gas

Monitoring equipment:	AT-45094C Type: Volumetric fraction of N ₂ O in the tail gas analyzer Emerson Process NGA 2000 MLT Accuracy class: 1% of range Serial number: 3709103038248 Calibration frequency: 3 years (QAL2) Date of last calibration (QAL2): 06/06/2012 Validity: 05/06/2015 Date of AST Tests: 24/09/2012-25/09/2012 Validity: 24/09/2013
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures:	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
Purpose of data:	Project emission calculation
Additional comment:	Not applicable

Data / Parameter:	C_{H2O,t,db,n}
Unit:	mg H₂O/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 penultimate determination (QAL2): 14/12/2011 Date of last determination (AST): 25/09/2012 Next determination until: 24/09/2013
Value(s) of monitored parameter:	3.6 mg H₂O/m³ dry gas (Highest measured value) Option A of the tool can be applied, as the moisture content is less than 0.05 kg H ₂ O/m ³ dry gas
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	Measuring / Reading / Recording: Yearly
Calculation method (if applicable):	NA
QA/QC procedures:	NA
Purpose of data:	Project emission calculation
Additional comment:	Not applicable

Data / Parameter:	T_t
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:	386.28 K
Monitoring equipment:	TT-45093 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
Measuring/ Reading/ Recording frequency:	Measuring: Continuously Reading: 1(s) Recording: Hourly
Calculation method (if applicable):	NA
QA/QC procedures:	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.
Purpose of data:	Project emission calculation
Additional comment:	Not applicable

Data / Parameter:	P_t
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:	100,642 Pa

Monitoring equipment:

PT-45091

Type: Capacitive Differential pressure transmitter

Rosemount 2051

Accuracy class: 0.1% of range

Serial number: 58154

Calibration frequency: Monthly

Date of calibration:

Month	Date of Calibration
September	07/09/2012
November	10/11/2012
December	08/12/2012
January	09/01/2013
March	08/03/2013

Validity: 07/04/2013

PT-45095

Type: Capacitive Barometric pressure transmitter

Rosemount 2051

Accuracy class: 0.1% of range

Serial number: 58157

Calibration frequency: Monthly

Date of calibration:

Month	Date of Calibration
September	07/09/2012
November	10/11/2012
December	08/12/2012
January	09/01/2013
March	08/03/2013

Validity: 07/04/2013

Measuring/
Reading/
Recording frequency:

Measuring: Continuously

Reading: 1(s)

Recording: Hourly

Calculation method
(if applicable):

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.

QA/QC procedures:

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.

Purpose of data:

Project emission calculation

Additional comment:

Not applicable

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**

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

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

The baseline N₂O 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 ₂ O emission factor for nitric acid production in the monitoring period n (kgN ₂ O / tHNO ₃)
$EF_{default,y}$	=	Default N ₂ O baseline emissions factor in the calendar year y of the monitoring period n (kgN ₂ O / 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	191,367	tCO ₂ e
$P_{NA,n}$	161,887	tHNO ₃
$EF_{BL,N_2O,2012}$	3.90	kgN ₂ O / tHNO ₃
$EF_{BL,N_2O,2013}$	3.70	kgN ₂ O / tHNO ₃
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 ₂ e)
$PE_{N_2O,n}$	=	Project emissions of N ₂ O from the project plant in monitoring period n (tCO ₂ e)
$PE_{CO_2,tertiary,n}$	=	Project emissions of CO ₂ from the operation of the tertiary N ₂ O abatement facility in monitoring period n (tCO ₂)

Parameter	Value	Unit
PE _n	55,146	tCO ₂ e
PE _{N₂O,n}	55,146	tCO ₂ e
PE _{CO₂,tertiary,n}	0	tCO ₂ e

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

The amount of N₂O emissions from the project activity includes two emission sources:

- The N₂O contained in the tail gas stream of the plant which is released to the atmosphere; and
- In the case of a tertiary N₂O abatement, the N₂O contained in any by-pass streams to the tertiary N₂O abatement facility. As the proposed CDM project activity does not comprise the installation of a tertiary N₂O abatement technology, no emissions need to be considered or monitored.

Accordingly, PE_{N₂O,n} 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 _{N₂O,n}	=	Project emissions of N ₂ O from the project plant in monitoring period n (tCO ₂ e)
Q _{N₂O,tail gas,n}	=	Amount of N ₂ O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN ₂ O)
Q _{N₂O,by-pass,n}	=	Amount of N ₂ O released through the by-pass to a tertiary N ₂ O abatement system to the atmosphere in monitoring period n (tN ₂ O)
GWP _{N₂O}	=	Global Warming Potential of N ₂ O valid for the commitment period

Parameter	Value	Unit
PE _{N₂O,n}	55,146	tCO ₂ e
Q _{N₂O,tail gas,n}	177.89	tN ₂ O
Q _{N₂O,by-pass,n}	0	tN ₂ O
GWP _{N₂O}	310	-

Determination of Q_{N₂O,tailgas,n}

The amount of N₂O 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 N₂O 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 N₂O 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 N₂O 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 N₂O 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 N₂O 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 N₂O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N₂O 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 N₂O 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 kg H_2O/m^3 dry gas; or
- 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, 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 kg/ m^3 dry gas.

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

Measuring Sequence	Date	Moisture content
1	24/09/2012	0.0032 kg H_2O/m^3 dry gas
2	24/09/2012	0.0028 kg H_2O/m^3 dry gas
3	25/09/2012	0.0036 kg H_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

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

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)
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:

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

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

Where:

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

Item	Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO ₂ e) *)
Total	191,367	55,146	0	136,221

*) 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 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 (t CO₂e)	158,581 (169 days)	136,221 (169 days)

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

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The emission reductions in this Monitoring Period are 136,220 tons of CO₂ equivalents. The yearly expected emission reduction according to the registered PDD is 351,773 tons of CO₂ equivalents for 2012 and 331,413 tons of CO₂ equivalents for 2013. This corresponds to emission reductions of 136,220 tons of CO₂ equivalents in 169 days, proportionally to each year; hence the observed emission reduction is lower than expected.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first

commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO ₂ e)	255,006	48,280

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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 4_PANNA 4 (5393)_UNFCCC SUMMARY_v1 (26-07-13)

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
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.

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