



**Project design document form for  
CDM project activities  
(Version 05.0)**

*Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.*

**PROJECT DESIGN DOCUMENT (PDD)**

<b>Title of the project activity</b>	Catalytic N <sub>2</sub> O destruction project in the tail gas of the nitric acid plant PANNA 3 of Enaex S.A.
<b>Version number of the PDD</b>	Version 3.1 (renewal of crediting period)
<b>Completion date of the PDD</b>	09/12/2014
<b>Project participant(s)</b>	Enaex S.A.; Mitsubishi Corporation; RWE Power AG; ThyssenKrupp Industrial Solutions AG; Carbon Climate Protection GmbH Nordic Environment Finance Corporation
<b>Host Party</b>	Republic of Chile
<b>Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)</b>	Sectoral scope 5: Chemical industries  Applied methodology: ACM0019 Version 02.0 "N <sub>2</sub> O abatement from nitric acid production"
<b>Estimated amount of annual average GHG emission reductions</b>	759,716tCO <sub>2</sub> e

## SECTION A. Description of project activity

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

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#### 1. Purpose of project activity

Enaex S.A. has implemented a project for GHG emission reduction by catalytic  $\text{N}_2\text{O}$  destruction in the Prillex® America ammonia nitrate complex, Mejillones, Chile. The project activity consists in development, design, engineering, procurement, finance, construction, operation and maintenance of a system for catalytic reduction of  $\text{N}_2\text{O}$  in the Nitric Acid Plant (PANNA 3) of Enaex S.A.

The EnviNOx® process used in the PANNA 3 nitric acid plant is based on the catalytic reduction of  $\text{NO}_x$  ( $\text{NO}$  and  $\text{NO}_2$ ) with ammonia ( $\text{NH}_3$ ) and of nitrous oxide ( $\text{N}_2\text{O}$ ) with a hydrocarbon. The hydrocarbon used is propane gas of which the main constituent is propane ( $\text{C}_3\text{H}_8$ ). The reactions take place over an iron zeolite catalyst bed. In this project, Enaex S.A. installed one EnviNOx® system for catalytic reduction and decomposition of  $\text{NO}_x$  and  $\text{N}_2\text{O}$  additionally to the equipment at the nitric acid manufacturing plant. The project activity reduces the GHG emissions, which would otherwise be released to the atmosphere, if the project would not have been implemented. The implementation of the  $\text{N}_2\text{O}$  destruction project at PANNA 3 involves that propane is employed as a reducing agent for  $\text{N}_2\text{O}$  removal.

The EnviNOx® system at PANNA 3 was installed in November 2007. Commissioning took place from 02/07/2008 to 04/07/2008 and the catalytic reduction process of  $\text{N}_2\text{O}$  started in the end of June 2008.

#### (a) Scenario existing prior to the implementation of the project activity

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 fertilisers, with smaller quantities going into the manufacture of organic compounds and mining explosives. In the case of PANNA 3, nitric acid is employed as a feed stock to produce ammonium nitrate ( $\text{NH}_4\text{NO}_3$ ), which is used as a raw material for mining and civil explosives in the mining and construction industries. The nitric acid is also used as raw material for other explosives (PETN and Nitroglycerine), which are also used as mining and civil explosives. Enaex has an internal policy of not selling ammonium nitrate for explosives that can be used for military purposes.

Nitrous oxide ( $\text{N}_2\text{O}$ ) 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 ( $\text{NO}$ ) during the catalytic oxidation of ammonia in air over noble metal gauzes. When leaving the ammonia oxidation reactor, there is no relevant loss of  $\text{N}_2\text{O}$  in the tail gas unless an  $\text{N}_2\text{O}$  destruction facility is installed.  $\text{N}_2\text{O}$  that leaves the ammonia oxidation reactor is thus discharged to atmosphere in the tail gas, and has no economic value.

The scenario existing prior to the start of the implementation of the project activity is that the  $\text{N}_2\text{O}$  is emitted to the atmosphere with no  $\text{N}_2\text{O}$  abatement measure being implemented.

#### (b) Baseline scenario

According to the applied methodology ACM0019 "N<sub>2</sub>O abatement from nitric acid production" (Version 02.0) operators of nitric acid plants have no economic incentives to take any  $\text{N}_2\text{O}$  abatement measures in the absence of regulations requiring the abatement of  $\text{N}_2\text{O}$  emissions, because this entails capital and operating costs, but no financial benefits. Therefore, the baseline scenario is that the  $\text{N}_2\text{O}$  is emitted to the atmosphere with no  $\text{N}_2\text{O}$  abatement measure being implemented.

Since no laws or regulations exist at present, which mandate the complete or partial destruction of N<sub>2</sub>O from nitric acid plants in the Republic of Chile, Enaex has no economic incentives to take any N<sub>2</sub>O abatement measures in its nitric acid plant. Hence, the baseline scenario is that the N<sub>2</sub>O is emitted to the atmosphere with no N<sub>2</sub>O abatement measure being implemented.

## **2. GHG emission reductions**

Annual average of GHG emission reductions during 2<sup>nd</sup> crediting period: 759,716tCO<sub>2</sub>e  
Total GHG emission reductions during 2<sup>nd</sup> crediting period: 5,318,009 tCO<sub>2</sub>e

## **3. Projects contribution to sustainable development**

Enaex as the project operator voluntarily invests 3% of the net income from the sale of the CERs in a "Social Fund" to support social projects (additional social benefit). This fund contributes to the social benefit of the people living in the area of the CDM project activity by financing sustainable projects like projects in schools, hospitals and infrastructure.

### **A.2. Location of project activity**

#### **A.2.1. Host Party**

>>  
Republic of Chile

#### **A.2.2. Region/State/Province etc.**

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2<sup>nd</sup> Region (Region of Antofagasta), Province of Antofagasta

#### **A.2.3. City/Town/Community etc.**

>>  
Mejillones

#### **A.2.4. Physical/Geographical location**

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Enaex Prillex® América Plant  
Avenida Costanera Norte N°300  
Mejillones

GPS coordinates: -23.096929, -70.431449



Figure 1: Location of the project (Enaex Prillex® America Plant)

### A.3. Technologies and/or measures

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#### a) Technologies and measures employed by the project activity

The project activity consists in development, design, engineering, procurement, finance, construction, operation and maintenance of a system for catalytic reduction of  $N_2O$  in the Nitric Acid Plant (PANNA 3) at Enaex S.A. The EnviNOx® process used in the PANNA 3 nitric acid plants is based on the catalytic reduction of  $NO_x$  ( $NO$  and  $NO_2$ ) with ammonia ( $NH_3$ ) and of nitrous oxide ( $N_2O$ ) with a hydrocarbon. The hydrocarbon used is propane gas of which the main constituent is propane ( $C_3H_8$ ). The reactions take place over an iron zeolite catalyst bed.

##### a. General Introduction

Nitrous oxide ( $N_2O$ ) is an unwanted, invisible and previously neglected by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide ( $NO$ ) during the catalytic oxidation of ammonia in air over noble metal gauzes. 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)<sup>1</sup>:



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 mainly depends on pressure and temperature in the ammonia oxidation process and is usually in a range of 95% to 97%.

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



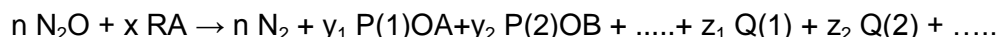
3. (According to the technical process) Absorption of NO<sub>2</sub> in water to form nitric acid (HNO<sub>3</sub>):



(NO is oxidized to NO<sub>2</sub> according to main reaction 2)

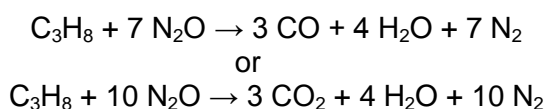
#### Description of catalytic reduction process

Although the term catalytic reduction nowadays has a more general definition in terms of the transfer of electrons, the following definition is sufficient for present purposes: catalytic reduction of N<sub>2</sub>O occurs when reactions take place between N<sub>2</sub>O and other substances in contact with a catalyst, such that the oxygen is removed from the N<sub>2</sub>O molecule and forms one or more compounds with other species. The substance or substances that react with N<sub>2</sub>O to remove oxygen are termed reducing agent. A general reaction equation for the catalytic reduction of N<sub>2</sub>O can be given as:

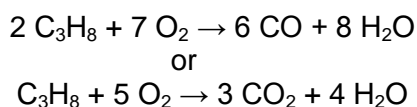


where RA is a molecule of the reducing agent, P(1)OA, P(2)OB are the compound formed by reaction with the oxygen of the N<sub>2</sub>O and Q(1), Q(2) represent further products of the oxidation reaction, n, x, y<sub>1</sub>, y<sub>2</sub>, z<sub>1</sub>, z<sub>2</sub> are the appropriate stoichiometric coefficients.

Equations reduction N<sub>2</sub>O with propane:



The definition does not exclude the possibility of side reactions resulting in consumption of reducing agent without any reduction of N<sub>2</sub>O, for example with propane:



<sup>1</sup> 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 above mentioned main equation.

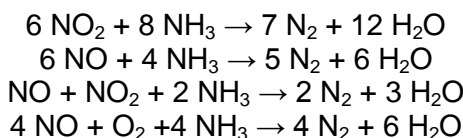
**b. Project Specific Description**Principles of the EnviNOx® process at PANNA 3

In the Prillex® América ammonia nitrate complex of Enaex, PANNA 3 operates as a single pressure nitric acid plant with a design pressure at AOR of 9.85 bar and a design temperature at AOR of 920 °C.

The applied technology, the EnviNOx®-system, is a tertiary measure for the destruction of N<sub>2</sub>O from nitric acid plant tail gas streams based on the catalytic decomposition or catalytic reduction of N<sub>2</sub>O. Enaex S.A. installed an EnviNOx®-system for catalytic reduction and decomposition of NO<sub>x</sub> and N<sub>2</sub>O additionally to the equipment at the nitric acid manufacturing plant. The project activity reduces the GHG emissions, which would otherwise be released to the atmosphere, if the project was not implemented. The implementation of the N<sub>2</sub>O destruction project at PANNA 3 involves that propane is employed as a reducing agent for N<sub>2</sub>O removal.

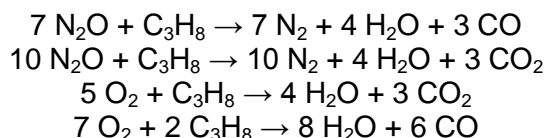
The EnviNOx® process used in the PANNA 3 is based on the catalytic reduction of NO<sub>x</sub> (NO and NO<sub>2</sub>) with ammonia (NH<sub>3</sub>) and of nitrous oxide (N<sub>2</sub>O) with a hydrocarbon. The hydrocarbon used is propane gas of which the main constituent is propane (C<sub>3</sub>H<sub>8</sub>). The reactions take place over an iron zeolite catalyst bed.

Firstly, the NO<sub>x</sub> is reduced with ammonia according to such reactions as:



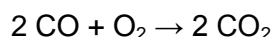
Effectively all the NO<sub>x</sub> is removed. Some destruction of N<sub>2</sub>O also occurs.

Secondly, the nitrous oxide is reduced with hydrocarbons over the iron zeolite according to such reactions as:



Similar reactions take place between nitrous oxide and the small quantities of other hydrocarbons such as butane (C<sub>4</sub>H<sub>10</sub>) that are present in the commercial propane used. N<sub>2</sub>O reduction by these reactions is much more effective when NO<sub>x</sub> is absent.

A large proportion of the carbon monoxide (CO) that is formed is further oxidized to carbon dioxide (CO<sub>2</sub>) over a second EnviCat®-CO / CH catalyst installed in the EnviNOx® reactor downstream of the first catalyst:



All the above reactions are exothermic and cause a temperature rise over the EnviNOx® reactor.

The EnviNOx® reactor contains two catalyst beds, the first an iron zeolite, the second a cordierite monolith coated with a small quantity of platinum. For the efficient reduction of N<sub>2</sub>O, the NO<sub>x</sub> concentration of the tail gas leaving the existing SCR DeNOx reactor must be further lowered to effectively zero. This is achieved simultaneously to the reduction of N<sub>2</sub>O in the first catalyst bed. The reducing agents employed, ammonia and propane, are introduced into the tail gas upstream of the EnviNOx® reactor via the static mixer (tag number N 8103) as superheated vapors.

The commercial propane available at PANNA 3 is HD-5, which consists mainly of propane ( $C_3H_8$ ). The other hydrocarbons behave as reducing agents towards  $N_2O$  just as propane does and are consumed in the EnviNOx® reactor.

The second bed in the EnviNOx® reactor converts carbon monoxide arising from the use of propane in the first bed to carbon dioxide. The amount of this greenhouse gas emission ( $CO_2$ ) is insignificant in comparison to the reduction in greenhouse gas emissions that the process achieves by destroying  $N_2O$ .

#### Ammonia feed

Superheated ammonia from the existing plant ammonia evaporator and superheater is supplied to the EnviNOx® system under flow control. If for any reason the supply of ammonia to the EnviNOx® system must be interrupted, either due to a trip or operator intervention, an automatic double block and bleed system isolates the ammonia system from the tail gas side of the nitric acid plant.

#### Propane feed

Liquid propane is taken from a storage tank, vaporised, superheated and then supplied to the EnviNOx® system under flow control. As with the ammonia supply system, the propane feed is isolated from the tail gas side of the nitric acid plant in case of an interruption of supply caused by operator action or an interlock by means of a double block and bleed arrangement.

#### Mixer

Propane gas and ammonia vapour are supplied to the lances of the tail gas / ammonia / propane gas static mixer. This inline device ensures that the reducing agents ammonia and propane are intimately mixed with the tail gas before the tail gas reaches the EnviNOx® reactor.

#### $N_2O$ and $NO_x$ reduction

At the inlet of the EnviNOx® reactor, the  $NO_x$  concentration is below 100 ppm (due to existing DeNOx unit and voluntary commitment of Enaex) and the  $N_2O$  typically has a concentration of up to 2,000 ppm.

The  $NO_x$  concentration increases with plant load and temperature in the absorption tower while increased absorption tower pressure reduces the  $NO_x$  concentration. Thus the  $NO_x$  concentration is subject to short term fluctuations without any long term trend. While the tail gas  $N_2O$  concentration can also increase with increasing plant load, it additionally depends significantly on the state of the ammonia oxidation Platinum-Palladium-Rhodium gauzes in the ammonia burners. The state of the gauzes deteriorates over the length of a production campaign. So the short term fluctuations in  $N_2O$  concentration are generally – although not in every campaign – overlaid with a long term trend to higher  $N_2O$  concentrations as the campaign advances. The EnviNOx® reactor contains two catalyst beds arranged in series as described above. In the first bed the EnviCat®- $N_2O$ -2 catalyst reduces the concentration of  $NO_x$  and  $N_2O$  to very low levels by reaction with ammonia and hydrocarbons, respectively, while in the second bed carbon monoxide is oxidised to carbon dioxide. Compared with the reduction in greenhouse gas emission achieved by the destruction of  $N_2O$  the additional greenhouse gas emissions ( $CO_2$ ) caused by the use of the hydrocarbon in the process are insignificant but will be determined by the actual propane consumption. Due to the heat released by the exothermic reduction reactions the temperature of the tail gas increases.

	Tag numbers
EnviNOx® reactor	R 8104
Static mixer	N 8103

#### Location of the project activity & location of EnviNOx®-system

The EnviNOx® system is installed at the nitric acid plant PANNA 3 onsite of Enaex S.A. at Enaex Prillex® America Plant.

A catalytic reduction process has been installed in PANNA 3 nitric acid plant. The EnviNOx® reactor (tag number R 8104) is located between the Selective Catalytic Reduction (SCR) DeNOx reactor (tag number R 8103) and the tail gas turbine (tag number M 8102), which is the position with the highest tail gas temperature in the nitric acid production process at PANNA 3. The design temperature at the stage is about 350°C.

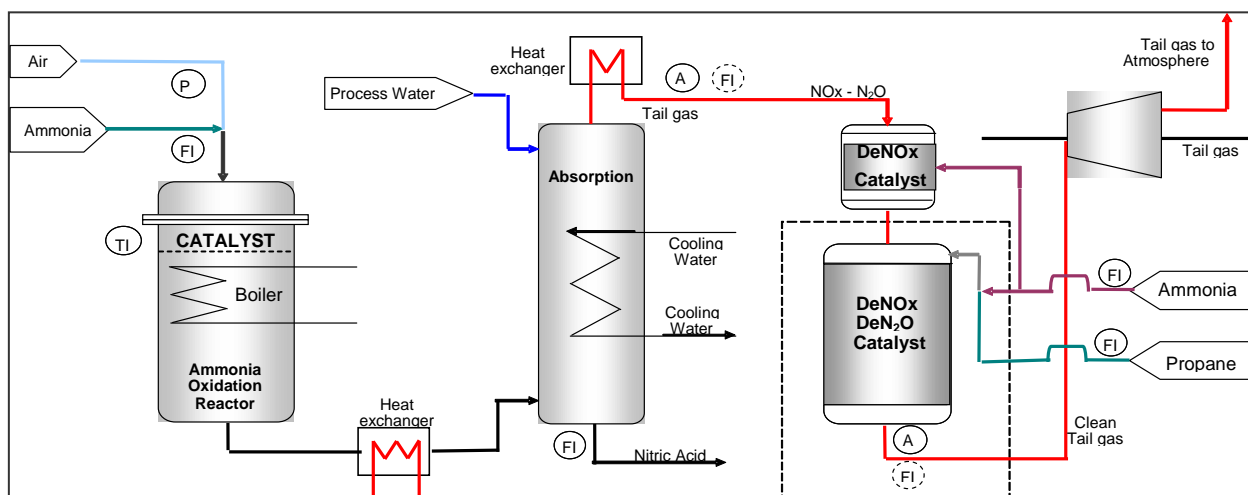


Figure 2: Location of EnviNOx®-system

#### Information on the implementation of the project activity

The EnviNOx® system at PANNA 3 was installed in November 2007. Commissioning took place from 02/07/2008 to 04/07/2008 and the catalytic reduction process of N<sub>2</sub>O started in the end of June 2008.

#### **b) Scenario existing prior to the implementation of the project activity**

When leaving the ammonia oxidation reactor, there is no relevant loss of N<sub>2</sub>O in the tail gas section unless a N<sub>2</sub>O destruction facility is installed. N<sub>2</sub>O that leaves the ammonia oxidation reactor is thus discharged to atmosphere in the tail gas, and has no economic value. According to the applied methodology ACM0019 “N<sub>2</sub>O abatement from nitric acid production” v02.0 operators of nitric acid plants have no economic incentives to take any N<sub>2</sub>O abatement measures in the absence of regulations requiring the abatement of N<sub>2</sub>O emissions, because this entails capital and operating costs, but no financial benefits. Therefore, the baseline scenario is that the N<sub>2</sub>O is emitted to the atmosphere with no N<sub>2</sub>O abatement measure being implemented.

Since no laws or regulations exist at present, which mandate the complete or partial destruction of N<sub>2</sub>O from nitric acid plants in the Republic of Chile, Enaex has no economic incentives to take any N<sub>2</sub>O abatement measures in its nitric acid plant. Hence, the baseline scenario is that the N<sub>2</sub>O is emitted to the atmosphere with no N<sub>2</sub>O abatement measure being implemented.

#### **c) Know-how transfer**

The technology transfer has led to improved understanding of high advanced air cleaning technologies within the Republic of Chile. Furthermore, plant personnel benefits from training courses taking place for operation and maintenance purposes of the tertiary abatement facility.



**A.4. Parties and project participants**

Party involved (host) indicates 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
Japan	Mitsubishi Corporation	No
Federal Republic of Germany	RWE Power AG ThyssenKrupp Industrial Solutions AG	No
Republic of Austria	Carbon Climate Protection GmbH	No
Norway	Nordic Environment Finance Corporation	No

**Host country** is the **Republic of Chile**. Chile ratified the Kyoto Protocol on August 26, 2002.

**Project applicant, sponsor and operator** is **Enaex S.A.** (herein after called Enaex), a private owned entity registered under the laws of the Republic of Chile and an incorporated company listed on the Santiago stock exchange, major shareholder is Sigdo Koppers S.A. Enaex is a leading producer of ammonium nitrate to produce explosive that will be used in the mining industry. Based in Chile, the company's major customer is Enaex Servicios – an associated company of Enaex S.A.

Enaex has well established people, management principles and practices that enable an integral development of its employees. Given the nature of its manufacturing and service operations, Enaex has a strict and high standard of selecting its workers throughout the organisation, which allows to have highly qualified personnel in all of its areas. Enaex's comprehensive people programs include performance management, health, well-being, training and development.

Some of the programs in place:

- Quality Assurance
- Continuous Education and Training
- Consulting on Drug and Alcohol addiction
- Health Plans
- Housing Plans
- Social Technical advising benefits
- Bonus and Equity participation systems
- Creativity Award
- Internal communications
- Sports, Recreation and integration of the family

In 2002, the company received "The Carlos Vial Espantoso Award" for best people management practices. The Prillex® América production facility of Enaex, of which PANNA 3 is one, is certified according to NCh ISO 9001 Of. 2009, ANSI/ASQ Q9001:2000 and BS EN ISO 9001:2008..

The nitric acid plant (including all CDM monitoring equipment) is part of the quality management system.

**Project participant, Mitsubishi Corporation** (herein after called MITSUBISHI), has been involved as a possible buyer of Certified Emissions Reductions of the project. MITSUBISHI is a global

integrated business enterprise that develops and operates businesses across virtually every industry including industrial finance, energy, metals, machinery, chemicals, foods, and environmental business. MITSUBISHI's current activities are expanding far beyond its traditional trading operations as its diverse business ranges from natural resources development to investment in retail business, infrastructure, financial products and manufacturing of industrial goods. With over 200 offices & subsidiaries in approximately 90 countries worldwide and a network of over 600 group companies, MITSUBISHI employs a multinational workforce of over 65,000 people.

**Project participant, RWE Power AG** (herein after called RWE Power), is the continental power generation company within the RWE Group and Germany's biggest power producer. The RWE Group is one of Europe's leading integrated electricity and gas companies. RWE Power has a diverse generation portfolio including lignite, hard coal, nuclear energy, gas and renewable sources such as hydro, wind and biomass. RWE Power invests and participates actively in projects under the Clean Development Mechanism and Joint Implementation. The RWE Power team combines a track record in global commodities and emissions trading as well as risk management with broad experience and a deep understanding of specific risks inherent in CDM and JI projects.

**Project participant, ThyssenKrupp Industrial Solutions AG** (herein after called TKIS), is one of six business areas of the ThyssenKrupp Group and ranks among the world's leading plant technology companies and holds top-three positions in key market segments. The company offers its customers engineering, procurement and construction (EPC) as well as associated services from a single source and has decades of experience gained in building more than 5,000 plants.

**Project participant, Carbon Climate Protection GmbH** (herein after called CARBON), is a limited liability company located and registered in Austria under Austrian law. CARBON is responsible for the project development. The company is an experienced financing and investment company, focussing on the development and implementation of Greenhouse Gas reduction projects according to Article 6 of the Kyoto Protocol (Joint Implementation) and Article 12 of the Kyoto Protocol (Clean Development Mechanism). CARBON has experience with CDM project development in Africa, Latin America and Asia and is specialised in the catalytic N<sub>2</sub>O destruction in the tail gas of nitric acid plants. It has developed the methodology for destruction of N<sub>2</sub>O in the tail gas of nitric acid plants (AM0028) and has implemented the first N<sub>2</sub>O destruction CDM project at nitric acid plants at Abu Qir Fertilizer Company in Egypt as well as similar CDM project at three nitric acid plants at Hu-Chems Fine Chemicals Corporation in Korea and Enaex S.A. in Chile.

**Project participant, Nordic Environment Finance Corporation** (herein after called NEFCO), is an international financial institution established by the five Nordic countries. NEFCO finances green growth investments and projects as well as climate projects across the world. In 2013, NEFCO called in its capacity as the facility manager of the NEFCO Norwegian Carbon Procurement Facility (NorCaP) CDM Project Participants to submit proposals for delivery of CERs in order to prevent the reversal of emission reduction activities by procuring credits from projects, whose survival or continued emission reductions depend on a higher carbon price than achievable under current market conditions. Among others, CDM projects of Enaex were selected by NEFCO in this first call of proposals.

#### **A.5. Public funding of project activity**

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No public funds are available for the financing of the project activity.

## SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

### B.1. Reference of methodology and standardized baseline

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- Selected methodology: Large-scale Consolidated Methodology “N<sub>2</sub>O abatement from nitric acid production” (ACM0019, Version 02.0)<sup>2</sup>
- Tools and other methodologies to which the selected methodology refers:
  - a) Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion (Version 02)<sup>3</sup>
  - b) Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)<sup>4</sup>

### B.2. Applicability of methodology and standardized baseline

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According to the used methodology, the project activity is applicable under following conditions:

Applicability criteria #1: The methodology applies to project activities that introduce N<sub>2</sub>O abatement measures in nitric acid plants.

Justification #1: The proposed project activity destroys N<sub>2</sub>O emissions by the reduction of N<sub>2</sub>O in the tail gas stream of the nitric acid plant PANNA 3 of Enaex S.A. (tertiary abatement technology).

Applicability criteria #2: In the case that the nitric acid plant started commercial operation before the implementation of the CDM project activity, the project participants shall demonstrate that there was no secondary or tertiary abatement technology installed in the respective nitric acid plant.

Justification #2: Since the start of the commercial operation no secondary or tertiary abatement technology was installed in the nitric acid plant PANNA 3 of Enaex S.A. prior to the implementation of the CDM project in 2007 (first crediting period). Evidence for this was already demonstrated during first crediting period.

Applicability criteria #3: Continuous real-time measurements of the N<sub>2</sub>O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N<sub>2</sub>O emissions throughout the crediting period of the project activity;

Justification #3: Continuous real-time measurements of the N<sub>2</sub>O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N<sub>2</sub>O emissions throughout the crediting period of the project activity. A dedicated Automated Monitoring System (AMS) was already installed in the plant prior to the beginning of the first crediting period of the project activity. This AMS will be adapted – if needed – in order to meet the requirements of the applied monitoring methodology.

Applicability criteria #4: No law or regulation, which mandates the complete or partial destruction of N<sub>2</sub>O from nitric acid plants exists in the host country, where the CDM project activity is implemented.

Justification #4: At present no laws or regulations exist, which mandate the complete or partial destruction of N<sub>2</sub>O from nitric acid plants in the host country, the Republic of Chile.

<sup>2</sup> <http://cdm.unfccc.int/methodologies/DB/MNMFNF10VUEOJACEIRX3EHYC9QXGDC>

<sup>3</sup> <http://cdm.unfccc.int/Reference/tools/index.html>

<sup>4</sup> <http://cdm.unfccc.int/Reference/tools/index.html>

### B.3. Project boundary

The spatial extent of the project boundary encompasses the facility and equipment for the nitric acid production process from the inlet of the ammonia burner (i.e. the ammonia oxidation reactor) to the outlet of the tail gas section (i.e. the stack).

The following figure demonstrates the project boundary of the project activity (simplified standard nitric acid plant layout displaying the location of the  $N_2O$  abatement catalyst, process sources of  $N_2O$  and the sampling point location for the Automated Monitoring System (AMS)).

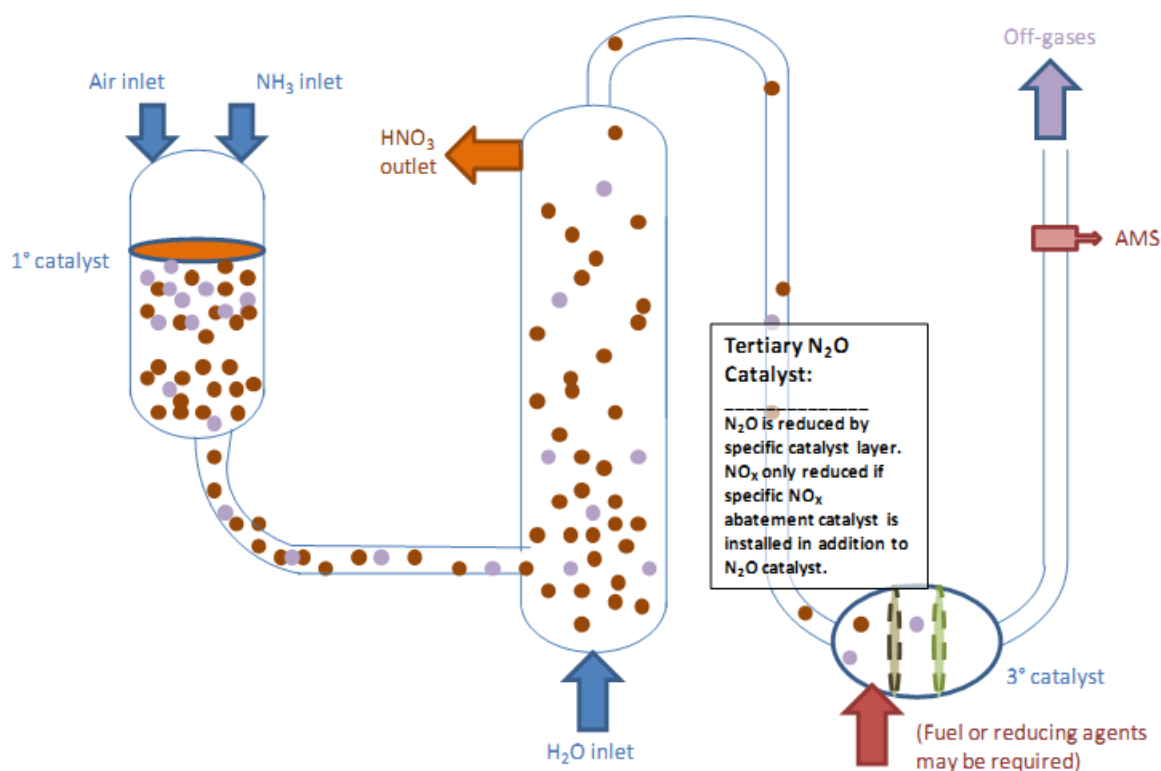


Figure 3: Project boundary of the project activity as tertiary  $N_2O$  abatement measure (simplified standard nitric acid plant layout displaying the location of the  $N_2O$  abatement catalyst, process sources of  $N_2O$  and the sampling point location for the Automated Monitoring System (AMS))

As shown in the figure above, the only baseline emissions considered are the  $N_2O$  emissions formed in the Ammonia Oxidation Reactor, a part of the nitric acid plant.

The project activity includes a tertiary  $N_2O$  abatement facility, physically located in the tail gas stream of the nitric acid plant. It is expected that the tertiary abatement facility will destroy  $N_2O$  emissions to a high extent. The remaining  $N_2O$ , which is not destroyed and still present after the abatement facility, is considered as project emissions. Fossil fuels will be used as reducing agent when operating the tertiary abatement facility, for this reason emissions from this source are to be considered as well.

The following table illustrates in detail, which emissions sources are included and which are excluded from the project boundary for determination of both baseline and project emissions:

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	NH <sub>3</sub> oxidation at primary catalyst gauze	CO <sub>2</sub>	No	The project activity has no influence on these types of emissions, if present (as per methodology)
		CH <sub>4</sub>	No	
		N <sub>2</sub> O	Yes	Included, main emission source
Project scenario	NH <sub>3</sub> oxidation at primary catalyst gauze	CO <sub>2</sub>	No	The project activity has no influence on these types of emissions, if present (as per methodology)
		CH <sub>4</sub>	No	
		N <sub>2</sub> O	Yes	Included, main emission source
	Operation of a tertiary N <sub>2</sub> O Abatement facility	CO <sub>2</sub>	Yes	In some cases, fossil fuels are used as reducing agent and/or for decomposing the tail gas as part of a tertiary N <sub>2</sub> O abatement facility. In this case the fossil fuels are mainly converted to CO <sub>2</sub> . CO <sub>2</sub> emissions arising from the production of ammonia are assumed to be small and <b>not</b> taken into account.
		CH <sub>4</sub>	No	Not applicable, as per the methodology
		N <sub>2</sub> O	Yes	Included

#### B.4. Establishment and description of baseline scenario

>>

At present no laws or regulations exist, which mandate the complete or partial destruction of N<sub>2</sub>O from nitric acid plants in the host country, the Republic of Chile. This was attested by a letter of the Chilean DNA.

In accordance with the methodology, Enaex S.A. has no economic incentives to take any N<sub>2</sub>O abatement measures in its nitric acid plant in the absence of regulations requiring such measures, as this would entail capital and operating costs, but no financial benefits. Therefore, the proposed CDM project is considered additional and the baseline scenario is that the N<sub>2</sub>O emitted to the atmosphere with no N<sub>2</sub>O abatement measure being implemented.

#### B.5. Demonstration of additionality

>>

According to the applied methodology ACM0019 v02.0 the CDM project activity is considered additional in case of the absence of regulations requiring the abatement of N<sub>2</sub>O emissions, as the operator of the nitric acid plant has no economic incentives to take any N<sub>2</sub>O abatement measures.

Since it was clearly demonstrated in section B.4 above that no regulations exist in Chile, which require the abatement of N<sub>2</sub>O emissions in nitric acid plants, the proposed project activity "Catalytic N<sub>2</sub>O destruction project in the tail gas of the nitric acid plant PANNA 3 of Enaex S.A." is considered additional.

## B.6. Emission reductions

### B.6.1. Explanation of methodological choices

&gt;&gt;

#### Baseline Emissions

*Case 1: For nitric acid plants that have used AM0028 or AM0034 in the first crediting period*

PANNA 3 nitric acid plant used AM0028, version 04 in the first crediting period. Then on May 31<sup>st</sup>, 2013, the methodology ACM0019 v02.0 came into effect, substituting the methodologies AM0028 and AM0034 for their use in N<sub>2</sub>O reduction projects in nitric acid plants. Hence, the methodology ACM0019 is applied for the second crediting period of the proposed project activity and the baseline emissions are calculated as follows:

$$BE_y = \left( \min\{P_{production,y}; P_{product,max}\} \times EF_{existing,y} + \max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y} \right) \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N2O} \times 10^{-3} \quad \text{Equation (1)}$$

Where:

- $BE_y$  = Baseline emissions in year  $y$  (t CO<sub>2</sub>e)
- $P_{product,max}$  = Design capacity (t HNO<sub>3</sub>)
- $P_{production,y}$  = Production of nitric acid in year  $y$  (t HNO<sub>3</sub>)
- $EF_{existing,y}$  = N<sub>2</sub>O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $EF_{new,y}$  = Baseline N<sub>2</sub>O emission factor for nitric acid production in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $GWP_{N2O}$  = Global Warming Potential of N<sub>2</sub>O valid for the commitment period
- $h_y$  = Number of hours in year  $y$  during which the plant was in operation ( $h$ )
- $h_{r,y}$  = Number of hours ( $h$ ) in year  $y$  where:
  - (a) For secondary N<sub>2</sub>O abatement: the abatement system was not installed, underperforming or failed;
  - (b) For tertiary N<sub>2</sub>O abatement: the abatement system is by-passed, underperforming or failed

The N<sub>2</sub>O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period ( $EF_{existing,y}$ ) will be calculated as follows:

$$EF_{existing,y} = \min\{EF_{historical}; EF_{default,y}\} \quad \text{Equation (2)}$$

Where:

- $EF_{existing,y}$  = N<sub>2</sub>O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $EF_{historical}$  = Historical baseline emission factor of the nitric acid plant (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $EF_{default,y}$  = Default emission factor according to the operating pressure of the ammonia burner in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)

Since the proposed project activity used AM0028 in its first crediting period, Case 1 applies and Case 2 has not to be considered.

**Calculation of  $h_{r,y}$** 

An abatement system is deemed to be bypassed, not working, underperform or failed in the hour  $h$  in year  $y$  if:

*Case 1: For nitric acid plants that have used AM0028 or AM0034 in the first crediting period*

$$F_{N_2O, tail gas, h} > EF_{existing, y} \times P_{NA, h} \quad \text{Equation (3)}$$

Where:

- $P_{NA, h}$  = Nitric acid produced in the hour  $h$  (t HNO<sub>3</sub>)
- $EF_{existing, y}$  = Default N<sub>2</sub>O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $F_{N_2O, tail gas, h}$  = Mass flow of N<sub>2</sub>O in the gaseous stream of the tail gas in the hour  $h$  (kg N<sub>2</sub>O/h)

Since the proposed project activity used AM0028 in its first crediting period, Case 1 applies and Case 2 has not to be considered.

**Project emissions**

Project emissions include N<sub>2</sub>O emissions, which have not been destroyed by the project activity and, in case of the installation of a tertiary N<sub>2</sub>O abatement facility, CO<sub>2</sub> emissions resulting from the operation of the N<sub>2</sub>O abatement facility. Project emissions are calculated as follows:

$$PE_y = PE_{N_2O, y} + PE_{CO_2, tertiary, y} \quad \text{Equation (4)}$$

Where:

- $PE_y$  = Project emissions in year  $y$  (t CO<sub>2</sub>e)
- $PE_{N_2O, y}$  = Project emissions of N<sub>2</sub>O from the project plant in year  $y$  (t CO<sub>2</sub>e)
- $PE_{CO_2, tertiary, y}$  = Project emissions of CO<sub>2</sub> from the operation of the tertiary N<sub>2</sub>O abatement facility in year  $y$  (t CO<sub>2</sub>)

**Project emissions of N<sub>2</sub>O from the project plant ( $PE_{N_2O, y}$ )**

The amount of N<sub>2</sub>O emissions from the project activity are the emissions from the N<sub>2</sub>O contained in the tail gas stream of the plant which is released to the atmosphere. Accordingly,  $PE_{N_2O, y}$  is determined as follows:

$$PE_{N_2O, y} = \sum_{h=1}^{h_y - h_{r, y}} F_{N_2O, tail gas, h} \times GWP_{N_2O} \times 10^{-3} \quad \text{Equation (5)}$$

Where:

- $PE_{N_2O, y}$  = Project emissions of N<sub>2</sub>O from the project plant in year  $y$  (t CO<sub>2</sub>e)
- $GWP_{N_2O}$  = Global warming potential of N<sub>2</sub>O valid for the commitment period
- $F_{N_2O, tail gas, h}$  = Mass flow of N<sub>2</sub>O in the gaseous stream of the tail gas in the hour  $h$  (kg N<sub>2</sub>O/h)
- $h_y$  = Number of hours in year  $y$  during which the plant was in operation ( $h$ )

- $h_{r,y}$  = Number of hours ( $h$ ) in year  $y$  where:
- (a) For secondary N<sub>2</sub>O abatement. Abatement system was not installed, underperforming or failed;
  - (b) For tertiary N<sub>2</sub>O abatement. The abatement system is by-passed, underperforming or failed

### Determination of $F_{N_2O, tail\ gas, h}$

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:

- (a) 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;
- (b) 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 two 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;
- (c) 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;
- (d) 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;
- (e) In the case that the N<sub>2</sub>O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters  $P_t$  and  $T_t$  do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream.

According to the applied tool 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).

Option A of the tool states two ways how to demonstrate that the gaseous stream is dry:



- 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<sub>2</sub>O/m<sup>3</sup> 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.

The mass flow of greenhouse gas i ( $F_{i,t}$ )<sup>5</sup> is determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \quad \text{Equation (6)}$$

With

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad \text{Equation (7)}$$

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 <sup>3</sup> 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 <sup>3</sup> gas i/m <sup>3</sup> dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m <sup>3</sup> gas i)
$P_t$	=	Absolute pressure of the gaseous stream in time interval t (Pa)
$MM_i$	=	Molecular mass of greenhouse gas i (kg/kmol)
$R_u$	=	Universal ideal gases constant (Pa.m <sup>3</sup> /kmol.K)
$T_t$	=	Temperature of the gaseous stream in time interval t (K)

Option A of the tool (measurement options: volume flow of gaseous stream on dry basis, volumetric fraction on dry or wet basis) will be applied, since it was demonstrated by the latest QAL2 Report, which was performed by AIRTEC in October 2013, that the gaseous stream is dry according to USEPA CF42 method 4. The measured moisture content ( $C_{H_2O,t,db,n}$ ) in the stack gas is less than 0.05 kg/m<sup>3</sup> dry gas.

Measuring Sequence	Date	Moisture content
1	21/10/2013	0.0039 kgH <sub>2</sub> O/m <sup>3</sup> dry gas
2	22/10/2013	0.0042 kgH <sub>2</sub> O/m <sup>3</sup> dry gas
3	22/10/2013	0.0040 kgH <sub>2</sub> O/m <sup>3</sup> dry gas

### Project emissions from the operation of the tertiary N<sub>2</sub>O abatement facility ( $PE_{CO_2,tertiary,y}$ )

This emission source only needs to be estimated if a tertiary N<sub>2</sub>O abatement facility is installed under the project activity and if fossil fuels are used to operate the facility or re-heat the gas after the facility. This applies to the project activity as a tertiary N<sub>2</sub>O abatement facility will be installed.

The emissions related to the operation of the N<sub>2</sub>O destruction facility include only on-site emissions due to the fossil fuel use as input to the N<sub>2</sub>O destruction facility:

$$PE_{CO_2,tertiary,y} = PE_{FF,y} \quad \text{Equation (8)}$$

Where:

<sup>5</sup>  $F_{i,t}$  corresponds to the parameter  $F_{N_2O,tail\ gas,h}$  of the methodology ACM0019.

- $PE_{CO_2, tertiary, y}$  = Project emissions of CO<sub>2</sub> from the operation of the tertiary N<sub>2</sub>O abatement facility in year y (t CO<sub>2</sub>)
- $PE_{FF, y}$  = Project emissions related to fossil fuel input to the destruction facility and/or re-heater in year y (t CO<sub>2</sub>)

Project proponents shall use the latest version of the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” to calculate the project emissions related to fossil fuels used in year y. Specific guidance on the use of the tool:

- The parameter  $PE_{FC, j, y}$  used in the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” corresponds to the parameter  $PE_{FF, y}$  in this methodology; and
- The element process  $j$  in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N<sub>2</sub>O abatement facility and/or the re-heating of the tail gas.

It shall be considered that for synchronizing the applied tool with the methodology “yr” and “y” are understood to cover the same time period unless otherwise explained.

According to the applied tool CO<sub>2</sub> emissions from fossil fuel combustion in process  $j$  are calculated based on the quantity of fuels combusted and the CO<sub>2</sub> emission coefficient of those fuels.

$$PE_{FC, j, y} = \sum FC_{i, j, y} \times COEF_{i, y} \quad \text{Equation (9)}$$

Where:

- $PE_{FC, j, y}$  = Are the CO<sub>2</sub> emissions from fossil fuel combustion in process  $j$  during the year y (tCO<sub>2</sub>/yr)
- $FC_{i, j, y}$  = Is the quantity of fuel type  $i$  combusted in process  $j$  during the year y (mass or volume unit/yr)
- $COEF_{i, y}$  = Is the CO<sub>2</sub> emission coefficient of fuel type  $i$  in year y (tCO<sub>2</sub>/mass or volume unit)
- $i$  = Are the fuel types combusted in process  $j$  during the year y

According to the applied tool the CO<sub>2</sub> emission coefficient  $COEF_{i, y}$  can be calculated using one out of two options, depending on the availability of data on the fossil fuel type  $i$ . Option A should be the preferred approach, if the necessary data is available.

Based on currently available information Option A of the applied tool can be applied as the necessary data such as chemical composition of the used fossil fuel (i.e. propane gas) will be provided by the gas supplier. According to Option A the CO<sub>2</sub> emission coefficient  $COEF_{i, y}$  is calculated based on the chemical composition of the fossil fuel type  $i$ , using the following approach:

If  $FC_{i, j, y}$  is measured in a mass unit:  $COEF_{i, y} = w_{C, i, y} \times 44/12$  Equation (10)

If  $FC_{i, j, y}$  is measured in a volume unit:  $COEF_{i, y} = w_{C, i, y} \times \rho_{i, y} \times 44/12$  Equation (11)

Where:

- $COEF_{i, y}$  = Is the CO<sub>2</sub> emission coefficient of fuel type  $i$  (t CO<sub>2</sub>/mass or volume unit)
- $w_{C, i, y}$  = Is the weighted average mass fraction of carbon in fuel type  $i$  in year y (t C/mass unit of the fuel)
- $\rho_{i, y}$  = Is the weighted average density of fuel type  $i$  in year y (mass unit/volume unit of the fuel)
- $i$  = Are the fuel types combusted in process  $j$  during the year y

Since the amount of used fossil fuel will be measured in volume unit, Equation (11) will be applied.

**Leakage**

Any leakage emissions sources are deemed to be negligible as per applied methodology.

**Emission reductions**

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Equation (12)}$$

Where:

$ER_y$	=	Emission reductions in year y (t CO <sub>2</sub> e)
$BE_y$	=	Baseline emissions in year y (t CO <sub>2</sub> e)
$PE_y$	=	Project emissions in year y (t CO <sub>2</sub> e)

**B.6.2. Data and parameters fixed ex ante**

**Data / Parameter table 1.**

<b>Data / Parameter</b>	<b>Operating pressure</b>
<b>Unit</b>	kPa
<b>Description</b>	Operating pressure of the ammonia burner
<b>Source of data</b>	Manufacturer specifications
<b>Value(s) applied</b>	<b>985</b> (equivalent to 9.85 bar)
<b>Choice of data or Measurement methods and procedures</b>	NA
<b>Purpose of data</b>	The parameter is used to determine whether the nitric acid plant operates at a low, medium or high pressure.
<b>Additional comment</b>	NA

**Data / Parameter table 2.**

<b>Data / Parameter</b>	<b>EF<sub>historical</sub></b>
<b>Unit</b>	kg N <sub>2</sub> O/t HNO <sub>3</sub>
<b>Description</b>	Historical baseline emission factor of the nitric acid plant
<b>Source of data</b>	Historical information from issuance reports of CDM-PDD documents
<b>Value(s) applied</b>	<b>8.63</b>
<b>Choice of data or Measurement methods and procedures</b>	<p>Plants that used AM0028 in the first crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period;</p> <p>Enaex Panna 3 plant used AM0028 in the first crediting period accordingly the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period is used.</p> <p>Calculation of EF<sub>historical</sub> is based on actual data of overall historical baseline emission factor obtained in one calendar year of the nitric acid plant of the first crediting period from issuance reports of CDM-PDD.</p>

<b>Purpose of data</b>	Calculation of baseline emissions
<b>Additional comment</b>	This value will remain constant over the 2 <sup>nd</sup> and 3 <sup>rd</sup> crediting period.

Data / Parameter table 3.

Data / Parameter	EF <sub>default,y</sub>			
Unit	kg N <sub>2</sub> O/t HNO <sub>3</sub>			
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid)			
Source of data	This default N <sub>2</sub> O baseline emission factor will vary every year. In the year 2013 the emission factors will be 5.5; 8.4; and 12.6 kg N <sub>2</sub> O/t HNO <sub>3</sub> for low, medium and high pressure ammonia burners. For each subsequent year, the emission factors will decrease by 0.2 kg N <sub>2</sub> O/t HNO <sub>3</sub> until they reach a value of 2.5 or 2.4. After reaching the values of 2.5 or 2.4 the emission factor will remain constant over time:			
	Year	Low pressure (0 – 200 kPa)	Medium pressure (200 – 600 kPa)	High pressure (Over 600 kPa)
	2013	5.5	8.4	12.6
	2014	5.3	8.2	12.4
	2015	5.1	8.0	12.2
	2016	4.9	7.8	12.0
	2017	4.7	7.6	11.8
	2018	4.5	7.4	11.6
	2019	4.3	7.2	11.4
	2020	4.1	7.0	11.2
	2021	3.9	6.8	11.0
	2022	3.7	6.6	10.8
	2023	3.5	6.4	10.6
	2024	3.3	6.2	10.4
	2025	3.1	6.0	10.2
	2026	2.9	5.8	10.0
	2027	2.7	5.6	9.8
	2028	2.5	5.4	9.6
	2029	2.5	5.2	9.4
	2030	2.5	5.0	9.2
Value(s) applied		Year	High pressure (Over 600 kPa)	
		2015	12.2	
		2016	12.0	
		2017	11.8	
		2018	11.6	
		2019	11.4	
		2020	11.2	
		2021	11.0	
		2022	10.8	
Choice of data or Measurement methods and procedures	NA			
Purpose of data	Calculation of baseline emissions			

<b>Additional comment</b>	The decrease in the value for the baseline emission factor over time is to reflect the technological development
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Data / Parameter table 4.

<b>Data / Parameter</b>	<b>EF<sub>new,y</sub></b>																																												
<b>Unit</b>	kg N <sub>2</sub> O/t HNO <sub>3</sub>																																												
<b>Description</b>	Baseline N <sub>2</sub> O emission factor for nitric acid production in year y (related to 100 per cent pure acid)																																												
<b>Source of data</b>	<p>The baseline N<sub>2</sub>O emission factor for nitric acid production will vary every year. In year 2005 the emission factor will be 5.1 and then it will decrease every year until it reaches a final value of 2.5 in the year 2020. The value of 2.5 will remain constant after 2020, as provided in the following table:</p> <table> <tr> <th>Year</th><th>Emission factor (kg N<sub>2</sub>O/t HNO<sub>3</sub>)</th></tr> <tr><td>2005</td><td>5.10</td></tr> <tr><td>2006</td><td>4.90</td></tr> <tr><td>2007</td><td>4.70</td></tr> <tr><td>2008</td><td>4.60</td></tr> <tr><td>2009</td><td>4.40</td></tr> <tr><td>2010</td><td>4.20</td></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>2022</td><td>2.50</td></tr> <tr><td>2023</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 (kg N <sub>2</sub> O/t HNO <sub>3</sub> )	2005	5.10	2006	4.90	2007	4.70	2008	4.60	2009	4.40	2010	4.20	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	2022	2.50	2023	2.50	...	...	Year n	2.50
Year	Emission factor (kg N <sub>2</sub> O/t HNO <sub>3</sub> )																																												
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Year n	2.50																																												
<b>Value(s) applied</b>	<table> <tr> <th>Year</th><th>Emission factor (kg N<sub>2</sub>O/t HNO<sub>3</sub>)</th></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>2022</td><td>2.50</td></tr> </table>	Year	Emission factor (kg N <sub>2</sub> O/t HNO <sub>3</sub> )	2015	3.40	2016	3.20	2017	3.00	2018	2.80	2019	2.70	2020	2.50	2021	2.50	2022	2.50																										
Year	Emission factor (kg N <sub>2</sub> O/t HNO <sub>3</sub> )																																												
2015	3.40																																												
2016	3.20																																												
2017	3.00																																												
2018	2.80																																												
2019	2.70																																												
2020	2.50																																												
2021	2.50																																												
2022	2.50																																												

Choice of data or Measurement methods and procedures	NA
Purpose of data	Calculation of baseline emissions
Additional comment	The decrease in the value for the baseline emission factor over time is to reflect the technological development.

Data / Parameter table 5.

Data / Parameter	$P_{\text{product,max}}$
Unit	t Product (t HNO <sub>3</sub> )
Description	Design capacity of nitric acid production during the first crediting period
Source of data	Manufacture's specifications
Value(s) applied	337,625
Choice of data or Measurement methods and procedures	NA
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is only for project activities applying case 1. According to the technology supplier it is common engineering practice that the design capacity contains a safety margin of up to 20%.

Data / Parameter table 6.

Data / Parameter	$GWP_{N_2O}$
Unit	t CO <sub>2</sub> e/t N <sub>2</sub> O
Description	Global warming potential of N <sub>2</sub> O valid for the commitment period
Source of data	Relevant decisions by the CMP
Value(s) applied	298
Choice of data or Measurement methods and procedures	None
Purpose of data	Calculation of baseline and project emissions
Additional comment	NA

Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data / Parameter table 7.

Data / Parameter	$R_u$
Unit	Pa.m <sup>3</sup> /kmol.K
Description	Universal ideal gases constant
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied	8,314
Choice of data or Measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comment	NA

Data / Parameter table 8.

Data / Parameter	MM <sub>i</sub>									
Unit	kg/kmol									
Description	Molecular mass of greenhouse gas i									
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0)									
Value(s) applied		<table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg/kmol)</th></tr><tr><td>Nitrous oxide</td><td>N<sub>2</sub>O</td><td>44.02</td></tr></table>	Compound	Structure	Molecular mass (kg/kmol)	Nitrous oxide	N <sub>2</sub> O	44.02		
Compound	Structure	Molecular mass (kg/kmol)								
Nitrous oxide	N <sub>2</sub> O	44.02								
Choice of data or Measurement methods and procedures	Specified in the tool									
Purpose of data	Calculation of project emissions									
Additional comment	NA									

Data / Parameter table 9.

Data / Parameter	<b>P<sub>n</sub></b>
Unit	Pa
Description	Total pressure at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied	<b>101,325</b>
Choice of data or Measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comment	Will be used to determine the mass flow of the N <sub>2</sub> O in the tail gas.

Data / Parameter table 10.

Data / Parameter	<b>T<sub>n</sub></b>
Unit	K
Description	Temperature at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied	<b>273.15</b>
Choice of data or Measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comment	Will be used to determine the mass flow of the N <sub>2</sub> O in the tail gas.

### B.6.3. Ex ante calculation of emission reductions

>>

Please note that ex-ante estimation of emission reductions is for reference purposes only, actual project and baseline emissions will be determined on measurement results on an ex-post basis.

The following data are applied for the ex-ante calculation of emission reduction:

- Nitric acid production of 337,625 tHNO<sub>3</sub>/y<sup>6</sup>;
- Tail gas volume flow rate of 124,500 Nm<sup>3</sup> dry gas/h (normal conditions)<sup>7</sup>;
- Concentration of N<sub>2</sub>O prior to the N<sub>2</sub>O abatement catalyst of about 1,474 ppmv<sup>8</sup>;
- Removal rate of 94 %<sup>9</sup> of N<sub>2</sub>O emissions;
- Yearly operation is assumed to be 342 days<sup>10</sup>.

## **BASELINE EMISSIONS**

Since the proposed project activity used AM0028 in the first crediting period, Case 1 was applied and therefore baseline emissions are given by the following equation:

$$BE_y = \left( \frac{\min\{P_{production,y}; P_{product,max}\} \times EF_{existing,y} + \max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y}}{h_y} \right) \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N_2O} \times 10^{-3}$$

Where:

- $BE_y$  = Baseline emissions in year  $y$  (t CO<sub>2</sub>e)
- $P_{product,max}$  = Design capacity (t HNO<sub>3</sub>)
- $P_{production,y}$  = Production of nitric acid in year  $y$  (t HNO<sub>3</sub>)
- $EF_{existing,y}$  = N<sub>2</sub>O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $EF_{new,y}$  = Baseline N<sub>2</sub>O emission factor for nitric acid production in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $GWP_{N_2O}$  = Global Warming Potential of N<sub>2</sub>O valid for the commitment period
- $h_y$  = Number of hours in year  $y$  during which the plant was in operation ( $h$ )
- $h_{r,y}$  = Number of hours ( $h$ ) in year  $y$  where:
- For secondary N<sub>2</sub>O abatement: the abatement system was not installed, underperforming or failed;
  - For tertiary N<sub>2</sub>O abatement: the abatement system is by-passed, underperforming or failed

Year	BE <sub>y</sub>	EF <sub>existing,y</sub>	EF <sub>new,y</sub>	P <sub>production,y</sub>	P <sub>product,max</sub>	h <sub>y</sub>	h <sub>r,y</sub>	GWP <sub>N<sub>2</sub>O</sub>
	tCO <sub>2</sub> e	kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>	tHNO <sub>3</sub>	tHNO <sub>3</sub>	h	h	-
26/06 - 31/12/2015	393,387	8.63	3.40	163,809	174,825	4,250	0	298
2016	759,716	8.63	3.20	316,350	337,625	8,208	0	298
2017	759,716	8.63	3.00	316,350	337,625	8,208	0	298
2018	759,716	8.63	2.80	316,350	337,625	8,208	0	298
2019	759,716	8.63	2.70	316,350	337,625	8,208	0	298
2020	759,716	8.63	2.50	316,350	337,625	8,208	0	298
2021	759,716	8.63	2.50	316,350	337,625	8,208	0	298
01/01 - 25/06/2022	366,329	8.63	2.50	152,541	162,800	3,958	0	298

<sup>6</sup> Manufacture's specifications

<sup>7</sup> The average hourly volume flow rate at the exit of the destruction facility over the 1<sup>st</sup> Crediting Period was 124,585 Nm<sup>3</sup>/h. The value was slightly rounded to 124,500 Nm<sup>3</sup>/h.

<sup>8</sup> The average daily N<sub>2</sub>O concentration over the historic period was 1,474 ppmv.

<sup>9</sup> Manufacture's specifications (minimum efficiency of EnviNOx)

<sup>10</sup> Production plan for the year 2015



Please note that the operating hours ( $h_y$ ) were calculated on the basis of 342 operating days per full year of operation: (1 h x 24 h / day x 342 days (number of intervals) = 8,208 h / year)

$$EF_{existing,y} = \min\{EF_{historical}; EF_{default,y}\}$$

Where:

- $EF_{existing,y}$  = N<sub>2</sub>O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $EF_{historical}$  = Historical baseline emission factor of the nitric acid plant (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- $EF_{default,y}$  = Default emission factor according to the operating pressure of the ammonia burner in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)

Year	EF <sub>existing,y</sub>	EF <sub>historical</sub>	EF <sub>default,y</sub> (high pressure)
	kgN <sub>2</sub> O/tHNO <sub>3</sub>	kgN <sub>2</sub> O/tHNO <sub>3</sub>	kgN <sub>2</sub> O/tHNO <sub>3</sub>
26/06 - 31/12/2015	8.63	8.63	12.2
2016	8.63	8.63	12.0
2017	8.63	8.63	11.8
2018	8.63	8.63	11.6
2019	8.63	8.63	11.4
2020	8.63	8.63	11.2
2021	8.63	8.63	11.0
01/01 - 25/06/2022	8.63	8.63	10.8

## PROJECT EMISSIONS

Project emissions are defined by the following equation:

$$PE_y = PE_{N_2O,y} + PE_{CO_2,tertiary,y}$$

Where:

- $PE_y$  = Project emissions in year  $y$  (t CO<sub>2</sub>e)
- $PE_{N_2O,y}$  = Project emissions of N<sub>2</sub>O from the project plant in year  $y$  (t CO<sub>2</sub>e)
- $PE_{CO_2,tertiary,y}$  = Project emissions of CO<sub>2</sub> from the operation of the tertiary N<sub>2</sub>O abatement facility in year  $y$  (t CO<sub>2</sub>)

Year	PE <sub>y</sub>	PE <sub>N<sub>2</sub>O,y</sub>	PE <sub>CO<sub>2</sub>,tertiary,y</sub>
	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub>
26/06 - 31/12/2015	28,091	27,390	701
2016	54,250	52,897	1,354
2017	54,250	52,897	1,354
2018	54,250	52,897	1,354
2019	54,250	52,897	1,354
2020	54,250	52,897	1,354
2021	54,250	52,897	1,354
01/01 - 25/06/2022	26,159	25,506	653

Project emissions of N<sub>2</sub>O from the project plant ( $PE_{N_2O,y}$ )

$$PE_{N_2O,y} = \sum_1^{h_y - h_{r,y}} F_{N_2O,tail\ gas,h} \times GWP_{N_2O} \times 10^{-3}$$

Where:

- $PE_{N_2O,y}$  = Project emissions of N<sub>2</sub>O from the project plant in year  $y$  (t CO<sub>2</sub>e)
- $GWP_{N_2O}$  = Global warming potential of N<sub>2</sub>O valid for the commitment period
- $F_{N_2O,tail\ gas,h}$  = Mass flow of N<sub>2</sub>O in the gaseous stream of the tail gas in the hour  $h$  (kg N<sub>2</sub>O/h)
- $h_y$  = Number of hours in year  $y$  during which the plant was in operation ( $h$ )
- $h_{r,y}$  = Number of hours ( $h$ ) in year  $y$  where:
- (a) For secondary N<sub>2</sub>O abatement: the abatement system was not installed, underperforming or failed;
  - (b) For tertiary N<sub>2</sub>O abatement: the abatement system is by-passed, underperforming or failed

Year	$PE_{N_2O,y}$	$F_{N_2O,tail\ gas,h}$	$h_y$	$h_{r,y}$	$GWP_{N_2O}$
	tCO <sub>2</sub> e	kgN <sub>2</sub> O/h	h	h	-
26/06 - 31/12/2015	27,390	21.63	4,250	0	298
2016	52,897	21.63	8,208	0	298
2017	52,897	21.63	8,208	0	298
2018	52,897	21.63	8,208	0	298
2019	52,897	21.63	8,208	0	298
2020	52,897	21.63	8,208	0	298
2021	52,897	21.63	8,208	0	298
01/01 - 25/06/2022	25,506	21.63	3,958	0	298

Please note that the operating hours ( $h_y$ ) were calculated on the basis of 342 operating days per full year of operation: (1 h x 24 h / day x 342 days (number of intervals) = 8,208 h / year)

According to currently available information  $F_{N_2O,tail\ gas,h}$  was determined to 21.63 kg N<sub>2</sub>O/h and was used for ex-ante determination.

Since the N<sub>2</sub>O concentration and the volume flow of the tail gas are automatically converted to normal conditions,  $P_t$  and  $T_t$  need not to be monitored. Therefore, Equation 5, 6 and 11 of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” were derived in order to determine a fixed value for N<sub>2</sub>O density at normal conditions ( $P_t = P_n = 101,325$  Pa;  $T_t = T_n = 273.15$  K). Accordingly, N<sub>2</sub>O density at normal conditions was determined to be 1.96 kg/m<sup>3</sup>.

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

With

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

and

$$V_{t,db,n} = V_{t,db} \times \frac{T_n \times P_t}{P_n \times T_t}$$

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 <sup>3</sup> 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 <sup>3</sup> gas i/m <sup>3</sup> dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m <sup>3</sup> gas i)
$P_t$	=	Absolute pressure of the gaseous stream in time interval t (Pa)
$MM_i$	=	Molecular mass of greenhouse gas i (kg/kmol)
$R_u$	=	Universal ideal gases constant (Pa.m <sup>3</sup> /kmol.K)
$T_t$	=	Temperature of the gaseous stream in time interval t (K)

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”; *→ Tool is used, exclusively formulae therein are applied.*

In the case that the N<sub>2</sub>O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters  $P_t$  and  $T_t$  need not to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream. *→ Reached through transformation of formulae →  $P_t$  and  $T_t$  need not to be monitored, since the N<sub>2</sub>O concentration and the volume flow of the tail gas are automatically converted to normal conditions.*

Year	$F_{N_2O, tail\ gas, h} = F_{i,t}$	$\rho_{i,t}$	$V_{t,db,n}$	$v_{i,t,db}$
	kg N <sub>2</sub> O/h	kg gas i/m <sup>3</sup> gas i	m <sup>3</sup> dry gas/h	m <sup>3</sup> gas i/ m <sup>3</sup> dry gas
26/06 - 31/12/2015	21.63	1.96	124,500	8.84E-05
2016	21.63	1.96	124,500	8.84E-05
2017	21.63	1.96	124,500	8.84E-05
2018	21.63	1.96	124,500	8.84E-05
2019	21.63	1.96	124,500	8.84E-05
2020	21.63	1.96	124,500	8.84E-05
2021	21.63	1.96	124,500	8.84E-05
01/01 - 25/06/2022	21.63	1.96	124,500	8.84E-05

Year	$\rho_{i,t}$	$P_n$	$MM_i$	$R_u$	$T_n$
	kg gas i/m <sup>3</sup> gas i	Pa	kg/kmol	Pa.m <sup>3</sup> /kmol.K	K
26/06 - 31/12/2015	1.96	101,325	44.02	8,314	273.15
2016	1.96	101,325	44.02	8,314	273.15
2017	1.96	101,325	44.02	8,314	273.15
2018	1.96	101,325	44.02	8,314	273.15
2019	1.96	101,325	44.02	8,314	273.15
2020	1.96	101,325	44.02	8,314	273.15
2021	1.96	101,325	44.02	8,314	273.15
01/01 - 25/06/2022	1.96	101,325	44.02	8,314	273.15

Project emissions from the operation of the tertiary N<sub>2</sub>O abatement facility ( $PE_{CO_2,tertiary,y}$ )

$$PE_{CO_2,tertiary,y} = PE_{FF,y}$$

Where:

$PE_{CO_2,tertiary,y}$  = Project emissions of CO<sub>2</sub> from the operation of the tertiary N<sub>2</sub>O abatement facility in year y (t CO<sub>2</sub>)

$PE_{FF,y}$  = Project emissions related to fossil fuel input to the destruction facility and/or re-heater in year y (t CO<sub>2</sub>)

- The parameter  $PE_{FC,j,y}$  used in the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” corresponds to the parameter  $PE_{FF,y}$  in this methodology, and
- The element process  $j$  in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N<sub>2</sub>O abatement facility and/or the re-heating of the tail gas.

Year	$PE_{CO_2,tertiary,y} = PE_{FF,y} = PE_{FC,j,y}$
	tCO <sub>2</sub> /yr
26/06 - 31/12/2015	701
2016	1,354
2017	1,354
2018	1,354
2019	1,354
2020	1,354
2021	1,354
01/01 - 25/06/2022	653

$$PE_{FC,j,y} = \sum FC_{i,j,y} \times COEF_{i,y}$$

Where:

$PE_{FC,j,y}$  = Are the CO<sub>2</sub> emissions from fossil fuel combustion in process  $j$  during the year  $y$  (tCO<sub>2</sub>/yr)

$FC_{i,j,y}$  = Is the quantity of fuel type  $i$  combusted in process  $j$  during the year  $y$  (mass or volume unit/yr)

$COEF_{i,y}$  = Is the CO<sub>2</sub> emission coefficient of fuel type  $i$  in year  $y$  (tCO<sub>2</sub>/mass or volume unit)

$i$  = Are the fuel types combusted in process  $j$  during the year  $y$

Year	$PE_{FC,j,y}$	$FC_{i,j,y}$	$COEF_{i,y}$
	tCO <sub>2</sub> /yr	Nm <sup>3</sup> /y	tCO <sub>2</sub> /Nm <sup>3</sup>
26/06 - 31/12/2015	701	119,096	5.89E-03
2016	1,354	230,000	5.89E-03
2017	1,354	230,000	5.89E-03
2018	1,354	230,000	5.89E-03
2019	1,354	230,000	5.89E-03
2020	1,354	230,000	5.89E-03
2021	1,354	230,000	5.89E-03
01/01 - 25/06/2022	653	110,904	5.89E-03

Based on the currently available information **Option A** of the tool will be applied, as the chemical composition of the used fossil fuel (i.e. propane gas) will be provided by the gas supplier.

The CO<sub>2</sub> emission coefficient  $COEF_{i,y}$  is calculated based on the chemical composition of the fossil fuel type  $i$ , using the following approach:

$$COEF_{i,y} = w_{C,i,y} \times \rho_{i,y} \times 44/12$$

$FC_{i,j,y}$  is measured in a volume unit

Where:

- $COEF_{i,y}$  = Is the CO<sub>2</sub> emission coefficient of fuel type  $i$  (t CO<sub>2</sub>/mass or volume unit)  
 $w_{C,i,y}$  = Is the weighted average mass fraction of carbon in fuel type  $i$  in year  $y$  (t C/mass unit of the fuel)  
 $\rho_{i,y}$  = Is the weighted average density of fuel type  $i$  in year  $y$  (mass unit/volume unit of the fuel)  
 $i$  = Are the fuel types combusted in process  $j$  during the year  $y$

Year	$COEF_{i,y}$	$\rho_{i,y}$	$w_{C,i,y}$
	tCO <sub>2</sub> /Nm <sup>3</sup>	t/Nm <sup>3</sup>	tC/t
26/06 - 31/12/2015	5.89E-03	1.96E-03	0.82
2016	5.89E-03	1.96E-03	0.82
2017	5.89E-03	1.96E-03	0.82
2018	5.89E-03	1.96E-03	0.82
2019	5.89E-03	1.96E-03	0.82
2020	5.89E-03	1.96E-03	0.82
2021	5.89E-03	1.96E-03	0.82
01/01 - 25/06/2022	5.89E-03	1.96E-03	0.82

## LEAKAGE

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

## EMISSION REDUCTIONS

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

- $ER_y$  = Emission reductions in year  $y$  (t CO<sub>2</sub>e)  
 $BE_y$  = Baseline emissions in year  $y$  (t CO<sub>2</sub>e)  
 $PE_y$  = Project emissions in year  $y$  (t CO<sub>2</sub>e)

Year	$ER_y$	$BE_y$	$PE_y$
	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e
26/06 - 31/12/2015	393,387	421,478	28,091
2016	759,716	813,966	54,250

2017	759,716	813,966	54,250
2018	759,716	813,966	54,250
2019	759,716	813,966	54,250
2020	759,716	813,966	54,250
2021	759,716	813,966	54,250
01/01 - 25/06/2022	366,329	392,488	26,159

#### B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO <sub>2</sub> e)	Project emissions (t CO <sub>2</sub> e)	Leakage (t CO <sub>2</sub> e)	Emission reductions (t CO <sub>2</sub> e)
26/06 – 31/12/2015	421,478	28,091	0	393,387
2016	813,966	54,250	0	759,716
2017	813,966	54,250	0	759,716
2018	813,966	54,250	0	759,716
2019	813,966	54,250	0	759,716
2020	813,966	54,250	0	759,716
2021	813,966	54,250	0	759,716
01/01 – 25/06/2022	392,488	26,159	0	366,329
<b>Total</b>	<b>5,697,761</b>	<b>379,751</b>	<b>0</b>	<b>5,318,009</b>
<b>Total number of crediting years</b>	<b>7 years</b>			
<b>Annual average over the crediting period</b>	<b>813,966</b>	<b>54,250</b>	<b>0</b>	<b>759,716</b>

#### B.7. Monitoring plan

##### B.7.1. Data and parameters to be monitored

All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data will be monitored if not indicated otherwise in the tables below. All measurements will be conducted with calibrated measurement equipment according to relevant industry standards.

The accuracy of the N<sub>2</sub>O emissions monitoring results will be ensured by installing a monitoring system that has been certified to meet the requirements of the prevailing best industry practice or monitoring standards in terms of operation, maintenance and calibration. The latest applicable European standards and norms (EN 14181) will be used as the basis for selecting and operating the monitoring system.

The value(s) applied in the parameter tables below are an estimate of the data/parameters that will be monitored during the crediting period, but are used for the purpose of determining estimated emission reductions above. The value(s) applied are generally based on design parameters and/or historic values from the 1<sup>st</sup> crediting period, taking into consideration future trends and consideration.

Data / Parameter table 11.

<b>Data / Parameter</b>	<b>P<sub>production,y</sub></b>
<b>Unit</b>	t HNO <sub>3</sub>
<b>Description</b>	Nitric acid produced in year y
<b>Source of data</b>	Production reports
<b>Value(s) applied</b>	<b>316,350</b> (Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)
<b>Measurement methods and procedures</b>	<p>The actual nitric acid production is measured according to the installed Coriolis flowmeter, which measures the flow, density and concentration. The instrument signals are recorded in the control room and sent to the Delta V system.</p> <p>Meter Location: located in the nitric acid line, downstream of the absorption tower</p> <p>FT – 8131 Type: Panna3 Acid Production Flow Transmitter Accuracy class: ± 0.1% in accordance to instrument range</p>
<b>Monitoring frequency</b>	Recording frequency: Hourly
<b>QA/QC procedures</b>	<p>As part of the QA/QC procedures of PANNA3, the nitric acid production measured by the Coriolis is compared with the production report and a theoretical value for cross-check purposes.</p> <p>Additionally the nitric acid production is cross-checked by the laboratory. According to internal procedures the laboratory takes samples twice a day (once during each shift) to analyse the density and concentration of the nitric acid. In case there is a difference of more than 20 % between the theoretical and real values, the instrumentation department checks the Coriolis calibration, makes corresponding changes and revalidate the values.</p> <p>Please note that for CDM project purposes the used source of data is the one obtained by Delta V system.</p>
<b>Purpose of data</b>	Calculation of baseline emissions
<b>Additional comment</b>	The parameter P <sub>NA,h</sub> (Nitric acid produced in the hour h) represents the hourly value of P <sub>production,y</sub> and is used for determining h <sub>r,y</sub> as described in section 5.3.3 of the applied methodology (Equation 4).

Data / Parameter table 12.

<b>Data / Parameter</b>	<b>h<sub>y</sub></b>
<b>Unit</b>	h
<b>Description</b>	Number of hours of operation in year y
<b>Source of data</b>	Measured
<b>Value(s) applied</b>	<b>8,208</b> (Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)

<b>Measurement methods and procedures</b>	<p>The operation temperature of the ammonia oxidation reactor (AOR) ranges from 860 – 940°C (as defined by the technology supplier) and this range corresponds to the real operation hours of the reactor. Therefore, the plant is considered to be in operation when the temperature is within this range. The temperature is monitored by three thermocouples. The operating temperatures in the AOR are automatically collected by the distributed control system (DCS) and then automatically transferred to the Delta-V distributed control system (Delta-V system) serving the CDM project.</p> <p>Meter Location: located in the ammonia oxidation reactor</p> <p>(1) TT-8122 Type: PANNA 3 AOR Temperature Transmitter Accuracy class: ± 0.1% according to thermocouple type S</p> <p>(2) TT-8123 Type: PANNA 3 AOR Temperature Transmitter Accuracy class: ± 0.1% according to thermocouple type S</p> <p>(3) TT-8124 Type: PANNA 3 AOR Temperature Transmitter Accuracy class: ± 0.1% according to thermocouple type S</p> <p>The instrument with the TAG number TT-8122 was selected as main signal for monitoring the operation temperature; TT-8123 and TT-8124 will be used as back-up signals in case of malfunction of the main signal.</p>
<b>Monitoring frequency</b>	Every monitoring period
<b>QA/QC procedures</b>	<p>Periodic calibration of relevant temperature transmitter as above mentioned will be performed according to supplier's recommendations.</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>	Calculation of baseline and project emissions
<b>Additional comment</b>	Records to be maintained during project's lifetime

Data / Parameter table 13.

<b>Data / Parameter</b>	<b><math>h_{r,y}</math></b>
<b>Unit</b>	h
<b>Description</b>	For tertiary N <sub>2</sub> O abatement, Number of hours (h) in year y where the abatement system is by-passed, underperforming or failed
<b>Source of data</b>	Measured
<b>Value(s) applied</b>	<p><b>0</b></p> <p>(Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)</p>



<b>Measurement methods and procedures</b>	<p>Panna 3 nitric acid plant has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour h in year y, if:</p> <p>a) Abatement system is by-passed: Signal from by-pass valve (HV-8156) &lt; 100 %</p> <p>b) Abatement system is not working or failed:</p> $F_{N2O,tailgas,h} > EF_{existing,y} \times P_{NA,h}$ <p>The functioning of HV-8156 is monitored by the control room. The other parameters mentioned above will be determined and monitored as explained in the respective sections of this PDD.</p>
<b>Monitoring frequency</b>	Every monitoring period
<b>QA/QC procedures</b>	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>	Calculation of baseline and project emissions
<b>Additional comment</b>	<p>Records to be maintained during project's lifetime.</p> <p>The parameter <math>P_{NA,h}</math> (Nitric acid produced in the hour h) represents the hourly value of <math>P_{production,y}</math> and is used for determining <math>h_{r,y}</math> as described in section 5.3.3 of the applied methodology (Equation 4).</p>

Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data / Parameter table 14.

<b>Data / Parameter</b>	$V_{t,db,n}$
<b>Unit</b>	m <sup>3</sup> dry gas/h
<b>Description</b>	Volumetric flow of the gaseous stream in time interval t on a dry basis
<b>Source of data</b>	Measured
<b>Value(s) applied</b>	<p><b>124,500</b></p> <p>(Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)</p>
<b>Measurement methods and procedures</b>	<p>Volumetric flow measurement will refer to normal conditions (as per applied methodology).</p> <p>Calculated based on the dry basis flow measurement plus water concentration measurement (according to Option A of the tool).</p>
<b>Monitoring frequency</b>	Continuous monitoring
<b>QA/QC procedures</b>	<p>According to European Norm 14181.</p> <p>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.</p>
<b>Purpose of data</b>	Calculation of project emissions
<b>Additional comment</b>	<p>This parameter will be monitored in Options A.</p> <p>The volume flow is expressed at normal conditions. Therefore, the respective parameters were determined at normal conditions (<math>P_t = P_n = 101,325</math> Pa; <math>T_t = T_n = 273.15</math> K) and monitoring of actual conditions (<math>P_t</math>, <math>T_t</math>) is not necessary according to the applied methodology.</p> <p>Dry basis flow measurement since gaseous stream is considered to be dry.</p>

Data / Parameter table 15.

<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>Source of data</b>	Measured
<b>Value(s) applied</b>	<b>8.84E-05</b> (Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)
<b>Measurement methods and procedures</b>	<p>Continuous gas analyser operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature.</p> <p>Non-dispersive infrared photometry for N<sub>2</sub>O</p> <p>Meter Location: Sample take-off is located in the tail gas line, downstream of the EnviNOx system and goes along the sample gas line to the locked analyzer house (located closely to the EnviNOx® reactor), where analyzers and standard gases for calibrations are installed.</p> <p>AI – 8136  Type: R8104 Outlet Tail Gas Analyzer (NDIR)  Accuracy class: ± 1% in accordance to instrument range</p>
<b>Monitoring frequency</b>	Continuous monitoring
<b>QA/QC procedures</b>	<p>According to European Norm 14181.</p> <p>Calibration should include zero verification with an inert gas (e.g. N<sub>2</sub>) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period. Hence, certified standard gases (certificates confirming stability of standard gas) are used.</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>	Calculation of project emissions
<b>Additional comment</b>	<p>Option A parameter according to the applied tool.</p> <p>The volumetric fraction is expressed at normal conditions according to the applied methodology (<math>P_n = 101,325 \text{ Pa}</math>; <math>T_n = 273.15 \text{ K}</math>).</p> <p>Dry basis flow measurement since gaseous stream is considered to be dry.</p>

Data / Parameter table 16.

<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>Source of data</b>	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content

<b>Value(s) applied</b>	<b>4,200</b> (= 0.0042 kgH <sub>2</sub> O/m <sup>3</sup> dry gas) (Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)
<b>Measurement methods and procedures</b>	Discrete measurement procedure
<b>Monitoring frequency</b>	The mean value among three consecutive measurements performed in the same day (at least 2 hours each) shall be considered. Measurements will coincide with the Annual Surveillance Test (associated with requirements of the EN 14181 standard).
<b>QA/QC procedures</b>	According to the USEPA CF42 method 4
<b>Purpose of data</b>	Calculation of project emissions
<b>Additional comment</b>	Option A parameter for proving that the gaseous stream is dry.

The volume flow is expressed at normal conditions. Therefore, the respective parameters were determined at normal conditions ( $P_t = P_n = 101,325 \text{ Pa}$ ;  $T_t = T_n = 273.15 \text{ K}$ ) and monitoring of actual conditions ( $P_t, T_t$ ) is not necessary according to the applied methodology.

Parameters from the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion”

**Data / Parameter table 17.**

<b>Data / Parameter</b>	<b>FC<sub>i,j,y</sub></b>
<b>Unit</b>	Nm <sup>3</sup> /y
<b>Description</b>	Quantity of fuel type i combusted in process j during the year y
<b>Source of data</b>	Onsite measurements
<b>Value(s) applied</b>	<b>230,000</b> (Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)
<b>Measurement methods and procedures</b>	<p>The propane used as reducing agent is measured by standard flow meters. Flow is converted to standard conditions based on temperature and pressure measurement.</p> <p>Meter Location: located in the propane gas line, upstream of the EnviNOx system</p> <p>FT – 8193 Type: Propane Flow variable area Flow Transmitter Accuracy class: ± 1.6% in accordance with VDI/VDE 3513</p> <p>TT – 8166 Type: Propane Temperature Transmitter Accuracy class: ± 0.1% in accordance to instrument range</p> <p>PT – 8121 Type: Propane Pressure Transmitter Accuracy class: ± 0.1% in accordance to instrument range</p>
<b>Monitoring frequency</b>	Continuous monitoring

<b>QA/QC procedures</b>	<p>Devices will be subject to a regular maintenance and testing regime according to manufacturer instruction. As far as feasible consistency of metered fuel consumption quantities shall be cross-checked.</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>	Calculation of project emissions
<b>Additional comment</b>	NA

Data / Parameter table 18.

<b>Data / Parameter</b>	$W_{C,i,y}$						
<b>Unit</b>	tC/mass unit of the fuel						
<b>Description</b>	Weighted average mass fraction of carbon in fuel type i in year y						
<b>Source of data</b>	Hydrocarbon supplier or measurements (if certificate is not available)						
<b>Value(s) applied</b>	<p><b>0.82</b></p> <p>(Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)</p>						
<b>Measurement methods and procedures</b>	<p>The following data sources may be used if the relevant conditions apply:</p> <table border="1"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <tr> <td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr> <tr> <td>b) Measurements by the project participants</td><td>If a) is not available</td></tr> </tbody> </table> <p>Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates (option a).</p>	Data source	Conditions for using the data source	a) Values provided by the fuel supplier in invoices	This is the preferred source	b) Measurements by the project participants	If a) is not available
Data source	Conditions for using the data source						
a) Values provided by the fuel supplier in invoices	This is the preferred source						
b) Measurements by the project participants	If a) is not available						
<b>Monitoring frequency</b>	Measuring; In order to assure conservativeness a certificate from the fuel supplier is requested at least on a yearly basis. The mass fraction of carbon should be obtained regularly (if feasible for each fuel delivery), from which weighted average annual values should be calculated.						
<b>QA/QC procedures</b>	<p>All propane loads to propane tank are certified.</p> <p>Verify if the values under a) and b) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.</p>						
<b>Purpose of data</b>	Calculation of project emissions						
<b>Additional comment</b>	Applicable where Option A is used.						

Data / Parameter table 19.

<b>Data / Parameter</b>	$\rho_{i,y}$
<b>Unit</b>	t/Nm <sup>3</sup>
<b>Description</b>	Weighted average density of fuel type i in year y
<b>Source of data</b>	Hydrocarbon supplier or measurements (if certificate is not available)
<b>Value(s) applied</b>	<p><b>1.96E-03</b></p> <p>(Assumption according to Emission Reductions calculation, see also in respective section B.6.1 and B.6.3.)</p>

<b>Measurement methods and procedures</b>	<p>The following data sources may be used if the relevant conditions apply:</p> <table border="1" data-bbox="563 219 1377 427"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <tr> <td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr> <tr> <td>b) Measurements by the project participants</td><td>If a) is not available</td></tr> </tbody> </table> <p>Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates (option a).</p>	Data source	Conditions for using the data source	a) Values provided by the fuel supplier in invoices	This is the preferred source	b) Measurements by the project participants	If a) is not available
Data source	Conditions for using the data source						
a) Values provided by the fuel supplier in invoices	This is the preferred source						
b) Measurements by the project participants	If a) is not available						
<b>Monitoring frequency</b>	Measuring; In order to assure conservativeness a certificate from the fuel supplier is requested at least on a yearly basis. The density of the fuel should be obtained for each fuel delivery, from which weighted average annual values should be calculated.						
<b>QA/QC procedures</b>	All propane loads to propane tank are certified.						
<b>Purpose of data</b>	Calculation of project emissions						
<b>Additional comment</b>	Applicable where Option A is used and where $FC_{i,j,y}$ is measured in a volume unit. Preferably the same data source should be used for $w_{C,i,y}$ and $\rho_{i,y}$ .						

**B.7.2. Sampling plan**

&gt;&gt;

Not applicable for the project activity.

**B.7.3. Other elements of monitoring plan**

&gt;&gt;

**Operational and Management structure**

Project Operator is Enaex S.A. Enaex operates 1 production unit (Nitric Acid Facility) which produce fine chemical products. Enaex is ISO 9001:2008 certified and received the safety and health management awards. The Prillex® America production facility of Enaex, of which PANNA 3 is part, has received the certifications NCh ISO 9001 Of. 2009, ANSI/ASQ Q9001:2000 and BS EN ISO 9001:2008.

The operating and maintenance personal of the EnviNOx® system have been trained by the technology provider UHDE and the supplier of the digital process control system (Delta V, Emerson). Enaex S.A. is responsible for reporting of data under the CDM Project.

Find below the responsibilities and corresponding tasks for the CDM Project:

Responsibility	Tasks	Company
CDM Project Management	Needs to report to the Enaex Board and communicates with the UNFCCC to achieve project goals	Enaex
CDM Project Administration & Communication	Ensures that the project proceeds according to the schedule and budget; Provides the DOE with all required information for the validation and verification process	Enaex
CDM Project Operation & Maintenance	Ensures that the onsite operative activities of the project runs according to the project plan; Provides support to the Project Operation and ensures that all quality procedures are accomplished	Enaex
CDM Project Review: Monitoring Reports	Review and approval of monitoring reports before they are sent to DOE/UNFCCC	Carbon

CDM Project Monitoring (data collection)	Collects all relevant parameters required for monitoring the project	Enaex
------------------------------------------	----------------------------------------------------------------------	-------

### Measurement of the N<sub>2</sub>O concentration and the total gas volume flow

The project will employ the latest state of the art monitoring and control equipment that measures, records and reports all key parameters to determine the GHG emission reductions. The plant will be equipped with an Automated Monitoring System (AMS) in order to allow continuous real-time measurements of the N<sub>2</sub>O concentration and the total gas volume flow, which is required by the methodology.

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:

- (a) 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;
- (b) 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 two 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;
- (c) 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;
- (d) 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;
- (e) In the case that the N<sub>2</sub>O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters  $P_t$  and  $T_t$  do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream.

The European Norm EN 14181 stipulates three levels of quality assurance tests and one annual functional test for AMS, which are recommended to be used as guidance regarding the selection, installation and operation of the AMS under the applied monitoring methodology. The three quality assurance levels (QAL) are as follows:

1. Quality assurance of tested AMS. AMS will have performance certificate with calculation of uncertainty before installation. The specific performance characteristics of the monitoring system chosen by the project will be listed in the Monitoring Reports.

2. Quality assurance of installation and calibration of the Automated Measuring System according to the Standard Reference Measurement Method (SRM) for concentration measurements, determination of the measurement uncertainty/variability of the AMS and inspection of the compliance with the prescribed measurement uncertainties. Such tests will be carried out by organisations that have an accredited quality assurance system.
3. Continuous quality assurance through the local operator/manager.
  - i) Permanent quality assurance during the plant operation by the operating staff;
  - ii) Assurance of reliable and correct operation of the monitoring equipment (maintenance evidence);
  - iii) Regular controls as scheduled by the manufacturer (maintenance intervals);

In addition, annual functionality tests including SRM measurements to check for uncertainties in the data measured by the AMS are planned. Such tests will be carried out by organisations that have an accredited quality assurance system.

### Data collection

The emission reductions achieved by the project activity will be monitored using the requirements of the approved consolidated baseline and monitoring methodology ACM0019 "N<sub>2</sub>O abatement from nitric acid production" (Version 02.0.0), of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) and of the "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion" (Version 02).

Regarding how the data associated with the N<sub>2</sub>O destruction is obtained and also how these data are processed in order to calculate the final Emission Reduction, the description is as follows:

- The instruments transmitters convert the primary sensing signals (resistance, voltage, infrared light, etc.) in a 4 – 20 mA analogue signal according to range and units configured in it.
- This signal is hardwired transmitted to I/O cards (Analogue Input Cards) where are sampled by a special system called DeltaV Processor. This digital value is assigned to a software block of the variable (with the same range of the field transmitter) and made available in the fiber optics network for use, among others, in controller blocks, other variables calculations and DeltaV Continuous Historian Server (CHS).
- The CHS is installed in a station called Pro Plus and there stores continually the information of field process variables, calculated variables or normalized variables. It's from the CHS database where the Excel Macros (described hereunder) get the data for the internal reports.
- The reporting module of the Delta V system automatically generates aggregated daily reports based on the stored raw data from the continuous historian server.
- In addition, to ensure the fidelity of the data collection of CHS, no device can be introduced to extract information. The reports are exported to the processor called "Back Up". From the "Back Up", using a large storage device, the reports are extracted and used in the Excel Macros to generate the internal reports.

### B.7.4. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>

Date of completion of study on application of the selected methodology: 09/12/2014

#### Contact information:

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Mejillones

Tel: + 56 55 353 536  
 Cel: + 56 9 63339187  
 E mail: [carlos.araneda@enaex.com](mailto:carlos.araneda@enaex.com)

Enaex S.A. is a project participant. For further information please see Appendix 1.

## **SECTION C. Duration and crediting period**

### **C.1. Duration of project activity**

#### **C.1.1. Start date of project activity**

>>  
 03/11/2006 (according to the PDD of 1<sup>st</sup> crediting period)

#### **C.1.2. Expected operational lifetime of project activity**

>>  
 25 years, 0 months

### **C.2. Crediting period of project activity**

#### **C.2.1. Type of crediting period**

>>  
 Renewable (2<sup>nd</sup> crediting period)

#### **C.2.2. Start date of crediting period**

>>  
 26/06/2015

#### **C.2.3. Length of crediting period**

>>  
 7 years, 0 months

## **SECTION D. Environmental impacts**

### **D.1. Analysis of environmental impacts**

>>  
 The catalytic N<sub>2</sub>O destruction project in the tail gas of the PANNA 3 Nitric Acid Plant is a sustainable project that contributes to the environmental, economic and social benefits in the Republic of Chile.

#### **Environmental Impacts**

From June 26<sup>th</sup>, 2008 (start of 1<sup>st</sup> crediting period) until December 31<sup>st</sup>, 2013, the CDM project activity reduced almost 4 million tonnes of CO<sub>2</sub>e. The ex-ante GHG emission reduction over the 2<sup>nd</sup> crediting period is estimated to amount over 5 million tonnes of CO<sub>2</sub>e. Additionally, the EnviNOx<sup>®</sup> system reduces NO<sub>x</sub> emissions (additional environmental benefit in expected).

On December 6<sup>th</sup>, 2006 Enaex and CARBON presented the project to the National Commission of Environment of 2<sup>nd</sup> Region of Antofagasta (CONAMA). On January 25<sup>th</sup>, 2007 Enaex presented an



Environmental Impact Declaration to CONAMA organism which is in charge of technical evaluation of the project. Once this project was approved by CONAMA, the following step was the voting from COREMA (Regional Commission of Environment). Based on information submitted to COREMA the final resolution/approval was issued on March 26<sup>th</sup>, 2007. COREMA certified that all the applicable environmental requirements are fulfilled, and that the project fulfils with the regulations of environmental character, included the requisites of environmental character contained in the environmental sectoral permission contained in the article 94 of the "Regulation of the System of Evaluation of Environmental Impacts". COREMA certified that all applicable environmental requirements of the Republic of Chile are fulfilled and the project is in compliance with all relevant Chilean law.

COREMA approval: 26/03/2007  
COREMA Resolution No.: 0090/2007

No transboundary impacts are expected.

## **D.2. Environmental impact assessment**

>>

Not applicable, as no negative environmental impacts are expected.

## **SECTION E. Local stakeholder consultation**

### **E.1. Solicitation of comments from local stakeholders**

>>

A local stakeholder conference was held by Enaex and CARBON in the public auditorium of Mutual de Seguridad CCHC in Antofagasta on December 6<sup>th</sup>, 2006 addressing stakeholders and residents living near the CDM project as well as local companies, organisations and the Chilean DNA. Invitation was done by public announcement (e.g. three times in five local newspapers respectively, public blackboards) and by more than 100 personal invitation letters. Finally, 68 participants attended the stakeholder conference and were asked to fill in the questionnaire about the CDM project activity.

Some pictures of the stakeholder meeting:





#### Agenda:

- Introduction note from the CEO of Enaex S.A., Mr. Camilo Sandoval
- Presentation on climate change (Jorge Saffie, Enaex)
- Presentation on the technical and economic decision for the CDM project (Oscar Jadue, Enaex)
- Presentation on description of Kyoto process for CDM project (Ferdinand Heilig, CARBON)
- Questions and answers from the audience
- Fill in questionnaires

Enaex and CARBON have carried out investigation on the local stakeholder comments on the proposed project activity in form of issuing questionnaires to introduce the aims and characteristics of the project and addressing in particular its potential environmental impacts.

#### **E.2. Summary of comments received**

>>

#### Details of attendants who returned questionnaires:

Organisation / company	Attendants	Additional information
Codelco	1	Mining company
Conama	1	Designated National Authority (DNA)
El Mercurio	2	Official newspaper of the Region
Enaex	23	
Inhabitants of Mejillones	5	
Inmobiliaria Miguel Vergara SCH	1	Construction company
Minera El Tesoro	1	Mining company
Minera Escondida	1	Mining company
Minera Meridian	1	Mining company
Natural persons (public)	2	
Quantum Consultores	1	Consulting company
SAG II Region	1	Environmental and health authorities
Sernageomin	1	Mining authorities
University of Antofagasta	1	
University Católica del Norte	2	
<b>Total</b>	<b>44</b>	

#### Questions of the questionnaire and answers received:

Questions	yes	no	not answered
Do you think that the region and the Chilean people living in the	44	0	0

region will benefit from this CDM project?			
Is your company or the organization you are working for / you are presenting influenced by this CDM project?	27	17	0
Will your company or the organization you are working for / you are presenting play a role in the implementation of this CDM project?	26	15	3
Do you think that the Chilean government shall support this project?	43	1	0
Do you think that the Republic of Chile shall take efforts towards reducing greenhouse gas emissions within Chile?	40	1	3
Do you consider that this CDM project will contribute to the sustainable development of Chile?	42	0	2
Do you consider this CDM project as being "additional"?	27	15	2

### E.3. Report on consideration of comments received

>>

All remarks and questions were discussed. The project owner paid attention to the comments and questions of stakeholders and made all conceivable effort to achieve environmental, social and economic benefits.

#### Questions from stakeholders:

The discussion with the local stakeholders was very positive and the local community overwhelmingly supported the development and implementation of the CDM project at PANNA 3.

Translation of the main questions and answers of the stakeholder conference:

<b>Q: Questions from stakeholders</b>
<b>A: Answers</b>
<p><b>Q:</b> Will there be a measurement system to verify the amount of gases that will be released to the atmosphere at the Mejillones community?</p> <p><b>A:</b> Yes, Enaex will invest in modern, best available infrared measurement systems to monitor real-time and continuously the ammonia and propane flow, the tail gas volume flow and the inlet and outlet N<sub>2</sub>O and NO<sub>x</sub> concentration. Data from the monitoring system will be stored for the duration of the CDM project and will be made public in form of the verification reports of the independent verifier.</p>
<p><b>Q:</b> In terms of transparency, it would be highly appreciated if the company would keep the community informed about the implementation of the project.</p> <p><b>A:</b> The process to develop and implement a CDM project is an extraordinary transparent process. The project design document (PDD) has to be independently validated by a Designated Operational Entity (DOE) accredited with the CDM EB, the public will have a period of 30 days for comments before the validation report can be finalized. Public comments have to be considered by the validator. For the registration of the project with the CDM EB the project documents will be made public for a period of 60 days again. During the operation of the CDM project all data will be monitored, stored and reported. An independent verifier will verify the monitored data before CERs will be issued.</p>
<p><b>Q:</b> Do you consider a similar project for PANNA I and PANNA II?</p> <p><b>A:</b> PANNA I and PANNA II are small plants with a total production of only 100 metric tonnes of nitric acid per day. A tertiary measure cannot be implemented at PANNA I and PANNA II as some technical parameter do not allow the installation of a tertiary measure. In addition, the investment costs could never be paid back with the income from the sale of CERs. Enaex would be in favor to use a tertiary measure, as Enaex would not accept any interference in the production process and up to now no long-term reference project exists for primary and secondary measures. Nevertheless, Enaex will</p>

*investigate whether to make use of a primary or secondary measure at PANNA I and PANNA II. But it cannot be expected that primary or secondary measures would be that efficient in terms of N<sub>2</sub>O destruction. Besides, no positive impact on the NO<sub>x</sub> emissions will arise from primary or secondary measure.*

**Q:** Will current emissions be back again after 2012?

**A:** *Up to now, those countries which ratified the Kyoto Protocol have not established a common strategy for a Post-Kyoto period beyond 2012. However, the crediting period for emission reductions generated by the PANNA 3 CDM project is until 2014 and the project lifetime is expected to be at least 25 years.*

## **SECTION F. Approval and authorization**

>>

The letters of approval of the following Parties are available at the time of submitting the PDD to the validating DOE for renewal of crediting period:

- Chile (Host)
- Japan
- Germany
- Austria
- Norway

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## Appendix 1. Contact information of project participants and responsible persons/ entities

<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input checked="" type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
<b>Organization name</b>	Enaex S.A.
<b>Street/P.O. Box</b>	El Trovador 4253 piso 5, Las Condes
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<b>Fax</b>	-
<b>E-mail</b>	-
<b>Website</b>	<a href="http://www.enaex.com">www.enaex.com</a>
<b>Contact person</b>	Mr. Carlos Araneda
<b>Title</b>	Project Manager
<b>Salutation</b>	-
<b>Last name</b>	Araneda
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<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
<b>Organization name</b>	Mitsubishi Corporation
<b>Street/P.O. Box</b>	3-1 Marunouchi 2-Chome, Chiyoda-Ku
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<b>City</b>	Tokyo
<b>State/Region</b>	Tokyo
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<b>Country</b>	Japan
<b>Telephone</b>	+81-3-3210-8759
<b>Fax</b>	-
<b>E-mail</b>	mc-focal-point@mitsubishicorp.com
<b>Website</b>	<a href="http://www.mitsubishi.com">www.mitsubishi.com</a>
<b>Contact person</b>	Yousuke Kuroda
<b>Title</b>	Project Team North & Latin Americas
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<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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<b>Middle name</b>	-
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<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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<b>E-mail</b>	-
<b>Website</b>	<a href="http://www.thyssenkrupp-industrial-solutions.com">www.thyssenkrupp-industrial-solutions.com</a>
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<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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<b>Website</b>	<a href="http://www.carbon-austria.com">www.carbon-austria.com</a>
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<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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## Appendix 2. Affirmation regarding public funding

No public funds are available for the financing of the project activity.

## Appendix 3. Applicability of methodology and standardized baseline

No additional information on the applicability of the methodology is to be mentioned.

## Appendix 4. Further background information on ex ante calculation of emission reductions

No additional information on the ex-ante calculation of emission reductions is to be mentioned.



## Appendix 5. Further background information on monitoring plan

Please refer to chapter B.7.3 (Other elements of monitoring plan).

## Appendix 6. Summary of post registration changes

The start date of crediting period has been changed from 13/10/2007 to 26/06/2008.

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### Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
05.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> <li>• Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0));</li> <li>• Include provisions related to standardized baselines;</li> <li>• Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1;</li> <li>• Change the reference number from <i>F-CDM-PDD</i> to <i>CDM-PDD-FORM</i>;</li> <li>• Editorial improvement.</li> </ul>
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b
04.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: Registration Keywords: project activities, project design document		