



**CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006**

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**SECTION A. General description of project activity****A.1 Title of the project activity:**

“Catalytic N₂O destruction project in the tail gas of the nitric acid plant PANNA 3 of Enaex S.A.”

Version 1

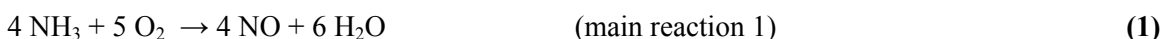
Date of Completion: 21/Dec/2006

A.2. Description of the project activity:**General Introduction:**

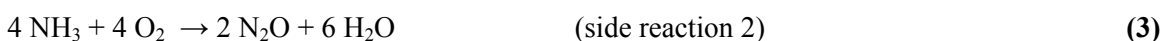
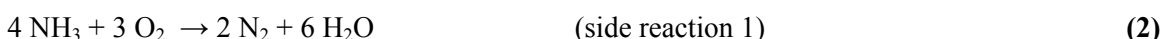
Nitrous oxide (N₂O) is an unwanted, invisible and previously neglected by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide (NO) during the catalytic oxidation of ammonia in air over noble metal gauzes. The production of nitric acid takes place in three main process steps as indicated by the following reactions:

1. Ammonia (NH₃) combustion to form nitric oxide (NO):

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

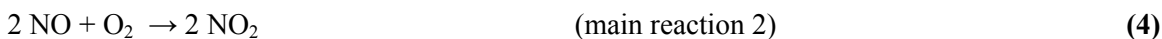


Simultaneously, nitrous oxide (N₂O), nitrogen (N) and water (H₂O) are formed as well, in accordance with the following equations:

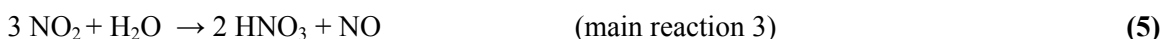


NO yield depends mainly on pressure and temperature in the ammonia oxidation process and usually is in a range of 95% to 97%.

2. NO is oxidised to nitrogen dioxide (NO₂):



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



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



Nitric acid plants are, in the vast majority of cases, part of a chemical complex and are built and operated to supply acid for consumption in downstream process units. The most common use for nitric acid is for 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 (NH_4NO_3), which is used as a raw material for mining and civil explosives used in the mining and construction industries. Ammonium nitrate produced at Enaex is used for civil services only.

On leaving the ammonia oxidation reactor some of the N_2O may be destroyed in the part of the plant upstream of the absorption tower by high temperature homogeneous gas phase decomposition and by catalytic decomposition on platinum deposits formed from metal lost from the ammonia oxidation catalyst. Since platinum dust carryover into the tail gas section of the plant is prevented by the absorption tower, which acts as a very efficient scrubber, and the temperatures encountered in the tail gas section of the plant are lower than those leading to homogeneous gas phase N_2O decomposition there is no relevant loss of N_2O in the tail gas section unless a N_2O destruction facility is installed. N_2O that has reached the tail gas section is thus discharged to atmosphere in the tail gas, and has no economic value.

Depending on technical parameters (e.g. tail gas temperature) the project applicant has to decide either to install a catalytic decomposition process or catalytic reduction process for the proposed project activity.

Description of catalytic decomposition process:

Catalytic decomposition of N_2O occurs when the N_2O is split into its constituent elements by contact with a catalyst. A catalyst is a material which accelerates the speed of the reaction without itself being transformed or consumed by the reaction.

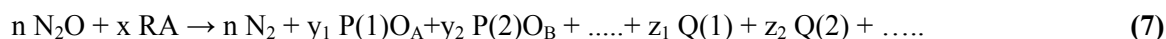
Overall reaction:



The products of N_2O decomposition are the substances that result from decomposition reaction (N_2 and O_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_2O occurs when reactions take place between N_2O and other substances in contact with a catalyst, such that the oxygen is removed from the N_2O molecule and forms one or more compounds with other species. The substance or substances that react with N_2O to remove oxygen are termed reducing agent. A general reaction equation for the catalytic reduction of N_2O can be given as:



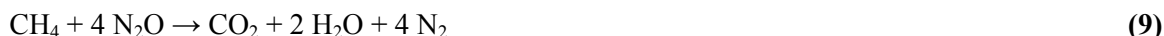
where RA is a molecule of the reducing agent, $\text{P}(1)\text{O}_A$, $\text{P}(2)\text{O}_B$ are the compound formed by reaction with the oxygen of the N_2O and Q(1), Q(2) represents further products of the oxidation reaction, n, x, y_1 , y_2 , z_1 , z_2 are the appropriate stoichiometric coefficients.

Equations for N₂O reduction with hydrocarbons:

e.g.

Reducing agent is **methane**:

or



e.g.

Reducing agent is **ethane**, overall reaction is:

or



e.g.:

Reducing agent is **propane**, overall reaction is:

or



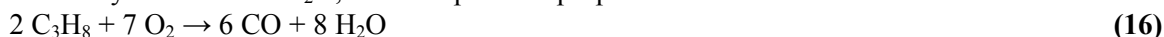
e.g.

Reducing agent is **butane**, overall reaction is:

or



The definition does not exclude the possibility of side reactions resulting in consumption of reducing agent without any reduction of N₂O, for example with propane:



or



The world's nitric acid plants represent the single greatest industrial process source of N₂O emissions. Currently, approx. 700 nitric acid plants are operated globally with an estimated amount of N₂O emissions of 400,000 t N₂O p.a. (corresponding to 125 Mio t CO₂e p.a.).

In response to this, UHDE GmbH, a leading company in the field of nitric acid technology, has undertaken the task of developing processes for removing N₂O from nitric acid plant tail gas streams based on the catalytic decomposition or catalytic reduction of N₂O. Efforts have been concentrated on treating the tail gas, as this end-of-pipe approach offers the general advantage, compared with other possible measures (called primary and secondary measures, see section A.4.3.), that minimum interference with the nitric acid production process is caused. In particular, any possibility of nitric acid product contamination, or loss of NO that could otherwise influence nitric acid production, is eliminated.

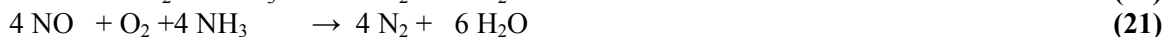
Project Specific description:Principles of the EnviNOx® process at PANNA 3:

In the Prillex América ammonia nitrate complex of Enaex, PANNA 3 operates as a single pressure nitric acid plant. The EnviNOx® process to be used is based on the catalytic reduction of NO_x (NO and NO₂) with ammonia (NH₃) and of nitrous oxide (N₂O) with a hydrocarbon. The hydrocarbon used will be



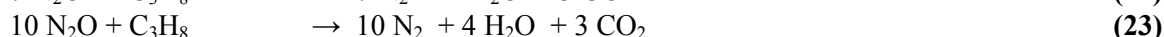
propane type HD-5 gas of which the main constituent is propane (C₃H₈). The reactions take place over an iron zeolite catalyst bed.

First the NO_x is reduced with ammonia according to such reactions as:



Effectively, all the NO_x is removed. Some destruction of N₂O also occurs.

Secondly the nitrous oxide (N₂O) 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 (C₄H₁₀) that are present in the commercial propane used. N₂O reduction by these reactions is much more effective when NO_x is absent.

A large proportion of the carbon monoxide (CO) that is formed is further oxidised to carbon dioxide (CO₂) 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.

Compared with the reduction in greenhouse gas emission achieved by the destruction of N₂O the additional greenhouse gas emissions (CO₂) caused by the use of hydrocarbons in the process are insignificant but will be determined.

The proposed project activity will reduce the N₂O emissions from PANNA 3 nitric acid plant by more than 98% by installing the EnviNOx® process. The project will use propane as reducing agent.

It is important to emphasise that the hydrocarbon and ammonia are not employed as fuels, to increase the temperature of the tail gas to a level at which high rates of N₂O decomposition can take place, but that they are used as genuine chemical reagents that take part in reactions with N₂O and NO_x respectively on specific sites on the surface of catalysts specially developed for the purpose by UHDE.

The proposed project activity will consume about 120 kg propane per hour. The precise specific consumption figures of the reducing agent (propane) will be fine-tuned during commissioning of the EnviNOx® system.

Enaex. S.A. (see section A.3.) will invest in the most efficient catalytic destruction technology for N₂O emission reductions in the tail gas of nitric acid plants (furthermore called “EnviNOx® system”) provided by the manufacturer UHDE GmbH. Enaex will install and operate the EnviNOx® system at its PANNA 3 nitric acid plant, which was commissioned by UHDE in 1999 and which is in full commercial operation.



The **project's aim** is to destruct (almost eliminate) N₂O emissions at the nitric acid plant PANNA 3 with potential additional environmental and secure social benefits. The project activity will not result in any revenues except the income from the sale of CERs. The catalytic N₂O destruction project activity is expected to reduce more than 98% of the N₂O emissions that would be emitted without the project activity. Under related project circumstances at the nitric acid of AMI in Austria, UHDE's EnviNOx[®] system reduces more than 98% of all N₂O emissions of the nitric acid plant. A similar CDM project in Egypt (Abu Qir Fertilizer Company, Alexandria), which went into operation in October 2006, showed a N₂O destruction rate of about 99%. Enaex as the project applicant and project operator will voluntarily invest 3% of the net income from the sale of the CERs in a "Social Fund" to support social projects (additional social benefit).

A.3. Project participants:

Name of Party involved (* (host) indicates a host Party)	Private and/or public entity(ies) project participants (* (as applicable)	Kindly 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
Republic of Austria	CARBON Projektentwicklung GmbH	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

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 Sidgo Koppers S.A.. Enaex is a leading producer of explosives and raw materials for rock fragmentation. Based in Chile, the company also supplies operational and technical support for its explosives to the mining industry. Enaex's range of products covers open pit and underground mine blasting, as well as boosters and accessories. Major customers are the most important mining companies of South America, such as CODELCO, BHP Billiton, Anglo American, Antofagasta Minerals, Southern Perú Copper, Phelps Dodge and Placer Dome. Enaex sells explosives for mining and civil purposes only.

In 1996, Enaex launched its quality management system by adopting the model of the "Premio Nacional a la Calidad", which includes ISO 9000 and ISO 14001, OHSAS 18001 (Occupational Health and Safety



Assessment Series) as well as Human Resources strategies. The Prillex América production facility of Enaex, of which PANNA 3 is one of three nitric acid plants, has received the following certification: NCh ISO 9001. Of. 2001; ANSI/ASQ Q9001:2000; and BS EN ISO 9001:2000 (see Annex 5).

Enaex operates the Prillex América ammonium nitrate plant in Mejillones in Northern Chile with an annual production capacity of 450,000 tonnes. Part of the Prillex América complex are three nitric acid plants, of which PANNA 3 is the biggest (production of 925 metric tonnes of nitric acid per day) and where the proposed CDM project activity will be implemented.

Major buyer of Emission Reductions from the project is **Mitsubishi Corporation**, Japan's largest general trading company with over 200 bases of operations in approximately 80 countries worldwide. Together with its over 500 group companies, Mitsubishi Corporation employs a multinational workforce of approximately 48,000 people. Mitsubishi Corporation has long been engaged in business with customers around the world in virtually every industry, including energy, metals, machinery, chemicals, food and general merchandise.

Project developer is **CARBON Projektentwicklung GmbH** (herein after called **CARBON**), a limited liability company located and registered in Austria under Austrian law. The company is an experienced financing and investment company specialized in 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 N₂O destruction in the tail gas of nitric acid plants. It has developed the methodology for destruction of N₂O in the tail gas of nitric acid plants (AM0028) and has implemented the first N₂O 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.

**A.4. Technical description of the project activity:****A.4.1. Location of the project activity:****A.4.1.1. Host Party(ies):**

Republic of Chile

A.4.1.2. Region/State/Province etc.:

2nd Region (Region of Antofagasta), Province of Antofagasta

A.4.1.3. City/Town/Community etc:

Mejillones

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

Chile is endowed with many natural resources – it is the world's major copper producer. In the medium-term, production levels are expected to reach nearly 40% of the world's total. The copper industry is by far the most important industrial energy consumer. It is also Chile's main export commodity, accounting for 40% of total export earnings.

Chile is generally recognized as a model for the successful implementation of market-oriented economic reforms. There is a political consensus on maintaining a liberal market economy and prudent fiscal and monetary policies. The government has demonstrated its commitment to an open economy by reducing its uniform import tariff over several years, from 11% to a current level of 6%, beginning in January 2003. Chile's foreign trade is diversified among many partners including Asia, the European Union and Latin America, in addition to the US, which was the market for about 20% of Chile's exports and the origin of almost 15% of its imports. As part of its export growth strategy, Chile has pursued free trade negotiations with several countries, in addition to that concluded with the US in December 2002, and is an active participant in negotiations for a Free Trade Area of the Americas (FTAA). In 1996, Chile signed bilateral free trade agreements with both Canada and Mexico. In 2002, it concluded negotiations for free trade agreements with South Korea and the European Union. In 1996, Chile signed an association agreement with the four-nation Common Market of the South (Mercosur). In 1994, Chile became a full member of the Asia-Pacific Economic Cooperation (Apec) group and is working to expand trade in the Asia-Pacific region. In 2006, negotiations with China have been concluded and it was agreed to start a trade agreement with Japan in 2007.

Enaex operates three nitric acid facilities at its Prillex América ammonia nitrate complex in Mejillones in Northern Chile (Province of Antofagasta, 2nd Region). Mejillones is located 65 km to the north of Antofagasta, the region's capital city and is surrounded by the Pacific Ocean to the west and by one of the most arid deserts in the world (Desierto de Atacama) to the east. Since the past two centuries, the port of Antofagasta has been playing an important role for the export of raw materials extracted in the area, shifting from guano to potassium nitrate (saltpetre) to copper over the years. The port of Mejillones has also playing an important role. Currently, the population of Mejillones is 8,500 and main economic activities are linked to the mining industry.



Figure 1: Location of the project

**A.4.2. Category(ies) of project activity:**

Sectoral scope: 5 Chemical Industry

A.4.3. Technology to be employed by the project activity:

The possible ways to destroy or reduce N₂O emissions at nitric acid plants can be categorized into three groups:

- **Primary:** Part of the N₂O is prevented from forming. This requires modifications to the precious metal ammonia oxidation gauzes to reduce N₂O formation. Alternative materials can also be employed as the ammonia oxidation catalyst. Cobalt oxide, for example, does not generate any N₂O by-product, but suffers from being less selective for the production of NO.
- **Secondary:** N₂O, once formed, is removed anywhere between the outlet of the ammonia oxidation gauzes and the inlet of the absorption tower. The preferred position of choice for secondary methods is directly after the gauzes. A real-time continuous measurement of baseline and project emissions is not possible.
- **Tertiary:** N₂O is removed from the tail gas downstream of the absorption tower by catalytic destruction (either by catalytic decomposition or by catalytic reduction). In general the optimum position for a tertiary N₂O destruction facility is at the hottest position in the tail gas stream. In tertiary catalytic N₂O destruction processes a hydrocarbon input may be necessary to achieve the highest available N₂O destruction rate. Thus hydrocarbons may be used to increase the tail gas temperature for catalytic decomposition processes (considered as leakage emissions) or as a reducing agent in catalytic reduction processes of N₂O (considered as project emissions).

A tertiary approach offers a number of advantages:

- A tertiary measure is the most efficient for N₂O destruction at nitric acid plants compared to primary and secondary measures.
- The tertiary approach, as an end-of-pipe technology, is analogous to the various well-established catalytic NO_x reduction processes. Therefore, high acceptance of this technology by plant operators is to be expected.
- There is no interference with the nitric acid production process itself. The tertiary N₂O destruction technology will not cause a nitric acid production increase and therefore no financial incentive for the implementation of the proposed project activity exists.
- A tertiary process incorporates a selective catalyst suitable for destroying N₂O and also NO_x, which can lead to additional environmental benefit.
- No technical possibility that relevant N₂O will be destroyed downstream the tertiary N₂O destruction facility. Consequently, an overestimation of N₂O baseline emissions is not possible whenever tertiary N₂O destruction facility will be installed.
- A real-time continuous measurement of baseline and project emissions can be verified easily.

The **project technology provider** is **UHDE GmbH**, a German company and 100% subsidiary of Thyssen-Krupp. UHDE GmbH is the world market leader in the field of fertilizer technology engineering



and construction and has constructed several nitric acid plants all over the world. Among these plants is PANNA 3.

In response to climate change, UHDE has developed and tested different processes for abating and removing N₂O from nitric acid plants. In this context, UHDE invented a process for the combined removal of N₂O and NO_x from the tail gas of nitric acid plants. The EnviNOx[®] system, a tertiary abatement technology for combined N₂O and NO_x emission removal in the tail gas of nitric acid plants, has been patented by UHDE world-wide. UHDE has developed a tertiary measure for the reduction of N₂O to avoid a direct interference in the production process of nitric acid. In particular, any possibility of nitric acid product contamination, or loss of the valuable intermediate product nitric oxide (NO) that could otherwise influence nitric acid production, is eliminated.

The N₂O and NO_x destruction efficiency of the EnviNOx[®] system can be measured and monitored easily and independently from the production process (these are the main differences to primary and secondary technologies, which are treating N₂O emissions directly in the ammonia oxidation reactor at the same time the N₂O is produced). The EnviNOx[®] system is currently the best available technology for N₂O (more than 98% removal) and NO_x (down to 0-3 ppmv) destruction.

The EnviNOx[®] system is an example of a tertiary measure for the destruction of N₂O from nitric acid plant tail gas streams based on the catalytic decomposition or catalytic reduction of N₂O. Therefore, the EnviNOx[®] system is located between the existing SCR DeNO_x system and the tails gas turbine. The reactor in an EnviNOx[®] system houses one or two catalyst beds through which the tail gas flows.

A hydrocarbon input may be necessary to achieve the best N₂O destruction rate. Thus hydrocarbons may be used to increase the tail gas temperature for catalytic decomposition processes or hydrocarbons may be used as a reducing agent to increase the efficiency of the catalytic reduction process.

Technology to be used at PANNA 3:

A catalytic reduction process will be installed in PANNA 3 nitric acid plant. The new EnviNOx[®] reactor (tag number 12 R004) will be located between the existing Selective Catalytic Reduction (SCR) DeNO_x reactor (tag number 12 R 003) and the tail gas turbine (tag number 12 MT 02), 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 and sufficient to permit very high rates of N₂O destruction by virtue of the use of propane and ammonia as reducing agents for N₂O and NO_x respectively. Due to modifications the actual tail gas temperature at this part is approximately 335°C and will be increased back to about 350°C by installing a process gas side bypass. The existing SCR DeNO_x unit will stay in operation.

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 nitrous oxide, the NO_x concentration of the tail gas leaving the existing SCR DeNO_x reactor must be further lowered to effectively zero. This is achieved simultaneously to the reduction of nitrous oxide 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 12 N003) as superheated vapours. PANNA 3 will use about 120 kg propane per hour. Currently, a DeNO_x unit is already in place at PANNA 3 to fulfil the voluntary commitment of Enaex to limit NO_x emissions (a mixture of NO and NO₂) to a maximum of 100



ppmv and to comply with local Chilean regulations for air emissions (reference: Swiss Confederation Federal Law, October 7, 1983). This DeNO_x unit will stay in operation and will complement the EnviNO_x® system.

The commercial propane available at PANNA 3 is HD-5 which consists mainly of propane (C₃H₈). The other hydrocarbons behave as reducing agents towards N₂O just as propane does and are consumed in the EnviNO_x® reactor.

The second bed in the EnviNO_x® reactor converts carbon monoxide arising from the use of propane in the first bed to carbon dioxide. The amount of this greenhouse gas emission (CO₂) is insignificant in comparison to the reduction in greenhouse gas emissions that the process achieves by destroying nitrous oxide but will be determined by measuring the flow of propane to the EnviNO_x® system. Emissions of propane itself will be effectively zero.

All the reactions taking place in the EnviNO_x® reactor are exothermic. The resulting higher temperature at the inlet of the tail gas turbine increases the amount of energy recovered and compensates for the slight reduction in energy recovery caused by the additional pressure drop of the new equipment.

Location of EnviNO_x® system:

The EnviNO_x® system requires the highest temperature available in the tail gas heat recovery train and is therefore installed between the existing SCR DeNO_x system and the tails gas turbine.

Ammonia feed:

Superheated ammonia from the existing plant ammonia evaporator and superheater is supplied to the EnviNO_x® system under flow control. If for any reason the supply of ammonia to the EnviNO_x® 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 EnviNO_x® 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 EnviNO_x® reactor.

Tail gas flow measurement:

According to the methodology AM0028 (vers. 4), the tail gas flow should be monitored at the inlet and the outlet of the EnviNO_x® system. However, the installation of venturi tubes for tail gas flow measurements requires sufficient space on the site of the plant (in compliance with ISO 5167-4:2003). In the case that only one venturi tube can be installed due to the space available at PANNA 3 nitric acid plant, the other flow parameter can easily be determined by taking into account the NH₃ and propane volume flows which are added into the EnviNO_x® process.

N₂O and NO_x reduction:

At the inlet of the EnviNO_x® reactor, the NO_x concentration is below 100 ppm (due to existing DeNO_x unit and voluntary commitment of Enaex) and the N₂O typically has a concentration of up to 2000 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 N₂O concentration can also increase with increasing plant load it additionally depends significantly on the state of the ammonia oxidation platinum-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 N₂O concentration are generally – although not in every campaign – overlaid with a long term trend to higher N₂O concentrations as the campaign advances.

The EnviNO_x® reactor contains two catalyst beds arranged in series as described above. In the first bed the EnviCat®-N₂O-2 catalyst reduces the concentration of NO_x and N₂O 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 N₂O the additional greenhouse gas emissions (CO₂) 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
EnviNO _x ® reactor	12 R004
Static mixer	12 N003

**A.4.4 Estimated amount of emission reductions over the chosen crediting period:**

The implementation of the project activity will result in an ex-ante estimation of GHG emission reductions conservatively calculated at 5.76 million t CO₂e over the first seven-year crediting period. Please note - that estimates of GHG emission reductions are made for reference purposes only - actual baseline and project emissions and emission reductions will be determined based on measurement results on ex-post basis. The global warming potential of N₂O is set at 310 according to the Kyoto Protocol rules.

As the project is planned to start from 01/Sept/2007 with the renewable crediting periods, the emission reductions during the first crediting period are estimated as shown in the table below.

Table: Summary Emission Reduction 2007-2014

Years (First Crediting Period)	Annual estimation of emission reductions in tonnes of CO₂e
01/Sept - 31/Dec 2007	205,718
2008	822,872
2009	822,872
2010	822,872
2011	822,872
2012	822,872
2013	822,872
01 Jan – 31 Aug 2014	617,154
Total estimated reductions (tonnes of CO₂e)	5,760,106
Total number of crediting years	7 years¹
Annual average over the crediting period of estimated reductions (tonnes of CO₂e)	822,872

A.4.5. Public funding of the project activity:

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

¹ 7 years of each period × 3 crediting periods = 21 crediting years

**SECTION B. Application of a baseline and monitoring methodology****B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:****AM0028 / Version 04**“Catalytic N₂O destruction in the tail gas of Nitric Acid or Caprolactam Production Plants”**B.2 Justification of the choice of the methodology and why it is applicable to the project activity:**

The proposed project activity destroys N₂O emissions by catalytic reduction of N₂O in the tail gas of the nitric acid plant PANNA 3.

The use of the methodology is justified because the following statements are true:

Condition 1: The commercial production of the PANNA 3 nitric acid plant started in 1999. The existing production capacity is applied for the process with the existing ammonia oxidation reactor. Existing production capacity is defined as the designed capacity, measured in tonnes of nitric acid per year as specified in Annex 3.

Condition 2: is not applicable to nitric acid plants.

Condition 3: The PANNA 3 nitric acid plant has currently not installed any N₂O destruction or abatement technology. The project activity will not result in any shut down of an existing N₂O destruction or abatement facility.

Condition 4: The project activity will not cause a nitric acid production increase.

Condition 5: A DeNO_x unit is already installed at PANNA 3 nitric acid plant. The project activity will result in NO_x emission reductions that are at least as effective as the existing DeNO_x units.

Condition 6: The DeNO_x unit installed at PANNA 3 is a Selective Catalytic Reduction (SCR) DeNO_x unit.

Condition 7: The N₂O concentrations will be measured in real time at the inlet and the outlet of the N₂O destruction facilities.

This baseline methodology is used in conjunction with the approved monitoring methodology for AM0028/ Version 04.

**B.3. Description of the sources and gases included in the project boundary**

N₂O is a by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide during the catalytic oxidation of ammonia over platinum/rhodium gauzes. Once leaving the gauzes some of the N₂O may be destroyed in the part of the plant upstream of the absorption tower by high temperature homogeneous gas phase decomposition and by catalytic decomposition on platinum deposits formed from metal lost from the gauzes. Since platinum dust carryover into the tail gas section of the plant is prevented by the absorption tower, which acts as a very efficient scrubber, and the temperatures encountered in the tail gas section of the plant are lower than those leading to homogeneous gas phase N₂O decomposition, there is no loss of N₂O in the tail gas section unless nitrous oxide destruction facility is installed. Nitrous oxide that has reached the tail gas section is thus discharged to atmosphere in the tail gas, and has no economic value.

The project boundary encompasses all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonable attributable to the project activity. More specifically, the project boundary comprises the N₂O destruction facilities including the auxiliary propane input to PANNA 3 nitric acid plant. According to AM0028 the auxiliary ammonia input will be considered equal to ammonia input of the baseline scenario. Note, in case of PANNA 3 a SCR-DeNO_x unit is already installed prior to the starting date of the project activity. For monitoring purposes however, the project boundary encompasses the nitric acid plant, to measure the nitric acid production and the operating parameters at the ammonia oxidation reactor.

The possibility that in the future some national, provincial or local regulation governing the emissions of N₂O or NO_x may occur has been taken into account in the monitoring methodology. Accordingly, the baseline scenario will be re-assessed according to AM0028. If new or modified NO_x emission regulations are introduced after the project start, determination of the baseline scenario will be re-assessed at the start of the following crediting period.

For the purpose of determining project activity emissions, the following emission sources are included:

- N₂O emissions in the tail gas downstream the project activity;
- CO₂ emissions associated with the use of propane as reducing agent.

For the purpose of determining baseline emissions, the following emission sources are included:

- N₂O emissions in the tail gas upstream the project activity.

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

**Table:** Overview on emission sources included or excluded from the project boundary**Baseline Emissions**

<i>Source</i>	<i>Gas</i>		<i>Justification/Explanation</i>
Emissions of N ₂ O as a result of side reaction to the nitric acid production process	N ₂ O	Included	Main emission source, taking national N ₂ O emission regulations into account.
Emissions related to the production of ammonia used for NO _x reduction (Attention: Ammonia used for NO _x -reduction does not cause GHG emissions, only the production of ammonia causes GHG emissions)	CO ₂ CH ₄ N ₂ O	Excluded according to AM0028	In case of PANNA 3 nitric acid plant a SCR DeNO _x unit is already installed prior to the project start: ammonia input for SCR is considered to be of the same magnitude to project related ammonia input for NO _x reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation.
N ₂ O emissions from SCR DeNO _x unit	N ₂ O	Excluded according to AM0028	The presence of a SCR DeNO _x unit tends to increase the N ₂ O emissions. Therefore the ex-post measurement of the baseline emissions at the inlet of the N ₂ O destruction facility represents a conservative determination of the baseline N ₂ O emissions.

Project Emissions

<i>Source</i>	<i>Gas</i>		<i>Justification/Explanation</i>
Emissions of N ₂ O as a result of side reaction to the nitric acid production process	N ₂ O	Included	Main emission source that remains in the tail gas after the N ₂ O destruction facility (taking national N ₂ O emission regulations into account).
Emissions related to the production of ammonia input used for NO _x reduction (Attention: Ammonia used for NO _x -reduction doesn't cause GHG emissions, only production causes GHG emissions)	CO ₂ CH ₄ N ₂ O	Excluded according to AM0028	In case of PANNA 3 nitric acid plant a SCR DeNO _x unit is already installed prior to the project start: ammonia input for SCR is considered of the same magnitude as project related ammonia input for NO _x -reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation.
In case of N ₂ O reduction process installed: Emissions at	CO ₂	Included	At PANNA 3 nitric acid plant a N ₂ O reduction process will be installed and propane will be used as reducing agent. Propane is used to enhance the efficiency of a



the project site resulting from hydrocarbons used as reducing agent and/or re-heating the tail gas			<p>N₂O catalytic reduction facility.</p> <p>In this case hydrocarbons are mainly converted to CO₂, while some hydrocarbons may remain intact.</p> <p>In order to apply a conservative approach propane is assumed to be completely converted to CO₂.</p>
Emissions from electricity demand	CO ₂ CH ₄ N ₂ O	Excluded	GHG emissions related to the electricity consumption are insignificant (< 0.005%) and are excluded as monitoring would lead to unreasonable costs.
Emissions related to the production of the hydrocarbons	CO ₂ CH ₄ N ₂ O	Excluded	GHG emissions related to the production of hydrocarbons used as reducing agent represent less than 0.001% of expected emission reductions and will not be taken into account due to unreasonable costs for monitoring.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The approved baseline methodology AM0028 Vers. 4 “Catalytic N₂O destruction in the tail gas of Nitric Acid or Caprolactam Production Plants “ is applied to the “Catalytic N₂O destruction project in the tail gas of the nitric acid plant PANNA 3 of Enaex S.A.” in the following five steps:

Step 1: Identify technically feasible baseline scenario alternatives to the project activity:

The baseline scenario alternatives should include all technically feasible options which are realistic and credible.

Step 1a: The baseline scenario alternatives should include all possible options that are technically feasible to handle N₂O emissions. For PANNA 3 these options are:

- Status quo: The continuation of the current situation, where there will be no installation of technology for the destruction or abatement of N₂O
- Switch to alternative production method not involving ammonia oxidation process
- Alternative use of N₂O:
 - Recycling of N₂O as a feedstock for the plant;
 - The use of N₂O for external purposes.
- Installation of a Non-Selective Catalytic Reduction (NSCR) DeNO_x unit²
- The installation of a N₂O destruction or abatement technology
 - Tertiary measure for N₂O destruction (proposed project activity)
 - Primary or secondary measures for N₂O destruction or abatement.

These options include the CDM project activity not implemented as a CDM project.

² NSCR: As NSCR DeNO_x unit will reduce N₂O emissions as a side reaction to the NO_x-reduction. Consequently, new NSCR installation can be seen as alternative N₂O reduction technology.



Technologically not feasible options:

The switch to alternative production method not involving ammonia oxidation process is not prevailing and is not available to PANNA 3, because currently the method using ammonia oxidation process is most common for manufacturing nitric acid and is already installed at PANNA 3 nitric acid plant.

The use of N₂O for external purposes is technically not feasible at PANNA 3 nitric acid plant, as the quantity of gas to be treated is enormous compared to the amount of nitrous oxide that could be recovered. Note, the N₂O concentration in the tail gas at PANNA 3 nitric acid plant is expected to be less than 0.2%. The use of N₂O for external purposes is neither in the region/country nor in any other nitric acid plant applied.

The recycling of N₂O as a feedstock for the plant is technically not practicable, as N₂O is not a feedstock for nitric acid production. The recycling of N₂O as a feedstock is neither in the region/country nor in any other nitric acid plant applied.

Therefore the following alternatives are technically not feasible:

- Switch to alternative production method not involving ammonia oxidation process;
- The use of N₂O for external purposes;
- Recycling of N₂O as a feedstock for the plant.

Step 1b: In addition to the baseline scenario alternatives of step 1a, all possible options that are technically feasible to handle NO_x emissions should be considered. The installation of a NSCR DeNO_x unit could also cause N₂O emission reduction. Therefore NO_x emission regulations have to be taken into account in determining the baseline scenario. The respective options are:

- The continuation of the current situation, where DeNO_x units are installed;
- Installation of new Selective Catalytic Reduction (SCR) DeNO_x units;
- Installation of new Non-Selective Catalytic Reduction (NSCR) DeNO_x units;
- Installation of new tertiary measures combining NO_x and N₂O emission reductions. (project scenario).

There are no direct Chilean regulations applicable to NO_x emissions at nitric acid plants. The actual voluntary commitment of Enaex is based on the Swiss regulation (reference: Swiss Confederation Federal Law, October 7, 1983). According to resolution Number 102/2006 (Antofagasta, 26th May 2006, Comisión Regional del Medio Ambiente – COREMA) the NO_x emission limit for Enaex' Prillex América nitric acid plants is 100 ppmv.

Currently, a DeNO_x unit is already in place at PANNA 3 to fulfil the voluntary commitment of Enaex to limit NO_x emissions (NO and NO₂) to a maximum of 100 ppmv and to comply with local Chilean regulations for air emissions. This DeNO_x unit will stay in operation and will complement the EnviNO_x® system.



The following table summarizes the actual emission at the PANNA 3 nitric acid plant of Enaex

Emissions from nitric acid plant PANNA 3	Legal requirements in Chile	Enaex voluntary commitment	Actual emissions (without CDM project)
N ₂ O	not in place	not in place	< 2000 ppm
NO _x	Ref: Swiss Regulation	100 ppm	< 75 ppm

As shown in the table above the NO_x emissions at the PANNA 3 nitric acid plant are limited to 100 ppmv. Actual NO_x emissions regulations are more than fulfilled. Enaex already operates a SCR DeNO_x unit at the PANNA 3 nitric acid plant which results in less than 75 ppmv, with average NO_x emissions in 2004 and 2005 of 69 ppmv and 44 ppmv respectively. This is far below the legal limit of 100 ppmv NO_x from exhaust for existing nitric acid plants. As there is already a SCR DeNO_x unit installed at PANNA 3 nitric acid plant, the installation of an NSCR DeNO_x unit, which is not state of the art³, is not conceivable as baseline alternative. Therefore it is obvious that Enaex will not install another DeNO_x unit.

Therefore the following alternatives are technically not feasible:

- Installation of new Selective Catalytic Reduction (SCR) DeNO_x unit;
- Installation of new Non-Selective Catalytic Reduction (NSCR) DeNO_x unit.

Step 2: Eliminate baseline alternatives that do not comply with legal or regulatory requirements:

Currently, there are no national regulations or legal obligations in the Republic of Chile concerning N₂O emissions. All remaining baseline alternatives are in compliance with all relevant legal and regulatory requirements on N₂O and NO_x emissions. Therefore no baseline alternative is eliminated at step 2.

Step 3: Eliminate baseline alternatives that face prohibitive barriers (barrier analysis):

Sub-Step 3a: On the basis of the alternatives that are technically feasible and in compliance with all legal and regulatory requirements, the project participant should establish a complete list of barriers that would prevent alternatives to occur in the absence of CDM.

In the case of the “Catalytic N₂O destruction project in the tail gas of the nitric acid plant PANNA 3 of Enaex S.A.” project the following barriers that would prevent baseline alternatives to occur in the absence of CDM are identified:

- **Investment barriers (economic/financial barriers):**
N₂O destruction facilities generate no financial or economical benefits other than CDM related income. No income from any kind of potential product or by-product except CERs are able to pay back investment costs as well as running costs for the installation of a N₂O destruction or abatement technology as no marketable product or by-product exists. As national regulations on

³ See also: UBA 2001: Umweltbundesamt. State-of-the-art for production of Nitric Acid with regard to the IPPC Directive. Vienna 2001. EFMA 2000: European Fertilizer Manufacturers' Association, Production of Nitric Acid, Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry, Brussels 2000.



NO_x emissions are more than fulfilled at the PANNA 3 nitric acid plant of Enaex and no national regulations or legal obligations in the Republic of Chile concerning N₂O emissions exists, investment barriers are clearly identified for all baseline options which require significant investments (primary, secondary and tertiary N₂O destruction or abatement).

▪ **Technological barriers:**

In addition to investment barriers identified above, technological barriers are identified as primary and secondary N₂O emission reduction technologies interfere with the nitric acid production process. The implementation of primary or secondary measures could cause an intervention in the nitric acid production process, which is not in the mind of Enaex. Besides, N₂O destruction efficiency is considered significantly lower at primary or secondary measures.

▪ **Barriers due to prevailing practice:**

No nitric acid plant in the Republic of Chile has installed any N₂O destruction or abatement technologies. The proposed project activity is the “first of its kind”.

Therefore the following baseline alternatives are eliminated:

- Primary or secondary measures for N₂O destruction or abatement
- Tertiary measure for N₂O destruction (proposed project activity)

Sub-Step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed CDM project activity):

In conclusion, the single scenario that does not face barriers (see step 3) is:

- The continuation of the current situation, where a DeNO_x unit is installed at PANNA 3 nitric acid plant and national regulations on NO_x emissions are more than fulfilled. No N₂O destruction or abatement technology will be installed. As national regulations on NO_x emissions are more than fulfilled at the PANNA 3 nitric acid plant of Enaex and no national regulations or legal obligations in the Republic of Chile concerning N₂O emissions exists, investment barriers (and also technological barriers and barriers due to prevailing practice) are clearly identified for all baseline options except the continuation of the status quo.

Therefore the continuation of the status quo can be pre-selected as baseline scenario.

As the outcome of the barrier analysis (step 3) is clear, Step 4 of the methodology is omitted.

Step 4: Identify the most economically attractive baseline scenario alternative:

Determine which of the remaining project alternatives that are not prevented by any barrier is the most economically or financially attractive, and then is a possible baseline scenario.

Sub-step 4a: Determine appropriate analysis method

Sub-step 4b: Option I: Apply simple cost analysis



As the outcome of the barrier analysis (step 3) clearly identifies the baseline scenario, Step 4 of the methodology is omitted.

The procedure to identify the baseline scenario clearly results in that the most likely baseline scenario is the continuation of the status quo and therefore the continuation of emitting N₂O to the atmosphere, without the installation of N₂O destruction or abatement technologies.

Therefore the continuation of the current situation is clearly identified as the baseline scenario.

Step 5: Re-assessment of baseline scenario in course of proposed project activity's lifetime:

At the start of a crediting period, a re-assessment of the baseline scenario due to new or modified NO_x or N₂O emission regulations should be executed as follows:

Sub Step 5a: New or modified NO_x emission regulations:

If new or modified NO_x emission regulations are introduced after the project start, determination of the baseline scenario will be re-assessed at the start of a crediting period. Baseline scenario alternatives to be analysed should include, inter alia:

- Selective Catalytic Reduction (SCR);
- Non-Selective Catalytic Reduction (NSCR);
- Tertiary measures incorporating a selective catalyst for destroying N₂O and NO_x emissions;
- Continuation of baseline scenario.

For the determination of the adjusted baseline scenario the project participant should re-assess the baseline scenario and shall apply baseline determination process as stipulated above (Steps 1 – 5).

Potential outcomes of the re -assessment of the baseline scenario (to be in line with NO _x regulation)	Consequence (adjusted baseline scenario)
SCR DeNO _x installation	Continuation of original (N ₂ O) baseline scenario
NSCR DeNO _x installation	The N ₂ O emissions outlet of NSCR become adjusted baseline N ₂ O emissions, as NSCR may reduce N ₂ O emissions as well as NO _x .
Tertiary measure that combines NO _x and N ₂ O emission reduction	Adjusted baseline scenario results in zero N ₂ O emissions reduction
Continuation of original baseline scenario	Continuation of original baseline scenario

Note, PANNA 3 nitric acid plant has already installed a SCR DeNO_x unit. New or modified NO_x emission regulations introduced after the project start will be taken into account for the next crediting period.



Sub Step 5b: New or modified N₂O-regulation:

If legal regulations on N₂O emissions are introduced or changed during the crediting period, the baseline emissions shall be adjusted at the time the legislation has to be legally implemented.

Baseline Scenario:

Therefore the **baseline scenario** is the continuation of the status quo and N₂O emissions are not reduced by any N₂O destruction or abatement technology at PANNA 3 nitric acid plant. The baseline scenario consists of the continuation of the currently installed SCR DeNO_x units in which only NO_x (nitric oxide NO, and nitrogen dioxide NO₂) is reduced to water vapour and nitrogen by reaction with ammonia.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality): >>

The **project scenario** is the implementation of the proposed project activity consisting of the installation of the EnviNOx[®] systems at PANNA 3 nitric acid plant.

Tertiary measures offer a number of advantages:

- The proposed project activity (tertiary measure), as an end-of-pipe technology, is analogous to the various well-established catalytic NO_x reduction processes.
- There is no interference with the nitric acid production process itself. The tertiary N₂O destruction technology will neither cause a nitric acid production increase nor decrease.
- A tertiary process incorporates a selective catalyst suitable for destroying N₂O and NO_x, which will lead to additional environmental benefit.

Taking into account that:

- PANNA 3 nitric acid plant were built by UHDE and UHDE is also the supplier of technology for the proposed project activity,
- the proposed project activity (tertiary measure) is analogous to the already successful implemented SCR DeNO_x unit,
- the expected N₂O reduction rate of tertiary measures up to 99%,
- primary and secondary measures requires modifications to the ammonia oxidation reactor (operational risks),
- a tertiary measures will not influence the production process of Enaex core business.

Based on this line of arguments, Enaex obviously and explicitly gives their technological preference to a tertiary technology.

The EnviNOx[®] system is a tertiary technology for destruction of N₂O emissions in the tail gas of PANNA 3 nitric acid plants and is located between the existing SCR DeNO_x reactor and the tail gas turbine. It is



expected that the project activity reduces minimum 94% of the N₂O emissions that would be emitted without the project activity (under related project circumstances the EnviNOx[®] system reduces more than 99% of N₂O emissions).

A catalytic reduction process will be installed in PANNA 3 nitric acid plant. The design tail gas temperature at this stage of the process is sufficient to permit very high rates of N₂O removal by virtue of the use of propane and ammonia as reducing agents for N₂O and NO_x respectively. The existing SCR (SCR= Selective Catalytic Reduction) DeNO_x unit will stay in operation.

The additionality of the project activity is demonstrated and assessed using the “Tool for demonstration and assessment of additionality” agreed by the Executive Board.

The project activity’s planned starting date is after 31 December 2005 and so no early credits are claimed, instead the start of the crediting period for the project activity is therefore at the date of registration and Step 0 is omitted.

Because of the similarity of both approaches used to determine the baseline scenario and the additionality tool, step1 of the tool for demonstration and assessment of additionality can be ignored.

Step 2. Investment analysis:

Sub-step 2a. Determine appropriate analysis method:

As catalytic N₂O destruction facilities generates no financial or economical benefits other than CDM related income, Option I as stated in the applied baseline methodology (simple cost analysis) has been chosen.

Sub-step 2b. – Apply simple cost analysis

Project scenario: No income from any kind of potential product or by-product except CERs are able to pay back investment costs as well as running costs for the installation of the EnviNOx[®] system as no marketable product or by-product exists.

The investment costs of several million Euros (excluding potential financing costs) consists of the engineering, construction, shipping, erection, installation and commissioning of the EnviNOx[®] system and the measurement equipment. The running costs consist of the regular change of the catalysts, hydrocarbon and ammonia inputs as well as personnel costs for the supervision of the EnviNOx[®] system and the measurement equipment.

Confidential information on investment and operation costs will be provided to the validator.

Baseline scenario: The baseline scenario “The continuation of the current situation” will neither cause any additional investments costs nor any additional running costs.

Therefore, the proposed CDM project activity is, without the revenues from the sale of certified emission reductions, obviously less economically and financially attractive than the baseline scenario.

**Step 4. Common practice analysis**

The proposed project activity is the “first of its kind” in Chile and the whole region, no similar project activity of this kind is currently operational and therefore the proposed project activity is not common practice.

Step 5. Impact of CDM registration

The financial benefits of the revenues obtained by selling CERs from the project activity will lead to the implementation of the project activity.

Based on the ex-ante estimation of N₂O emission reductions over the first crediting period, it is expected that the income from selling of CERs of the registered CDM project activity is at least as high as the investment, financing and running costs. Therefore Enaex is willing to finance the project activity under the condition of the registration of the project activity.

Conclusion: The proposed CDM project activity is undoubtedly additional, since it passes all the steps of the tool for the demonstration and assessment of additionality. No income from any kind of potential product or by-product except CERs are able to pay back investment costs as well as running costs for the installation of the proposed project activity as no marketable product or by-product exists.

The registration of the project activity as a CDM Project and corresponding CER revenues are the single source of project revenues. CDM registration is therefore the decisive factor for the realization of the proposed project activity.

**B.6. Emission reductions:****B.6.1. Explanation of methodological choices:**

The direct emissions from the project activity are equivalent to the N₂O emissions not destroyed plus emissions related to the operation of the N₂O destruction facility (emissions from additional hydrocarbon input).

Project Emissions:

The emissions due to the project activity are composed of (a) the emissions of not destroyed N₂O and (b) emissions from auxiliary ammonia and hydrocarbons input resulting from the operation of the N₂O destruction facility. The procedure of determining the project N₂O emissions is similar to that used for determining baseline emissions. Project emissions are defined by the following equation:

$$PE_y = PE_{ND,y} + PE_{DF,y} \quad (27)$$

where:

PE _y	Project emissions in year y (tCO ₂ e)
PE _{ND,y}	Project emissions from N ₂ O not destroyed in year y (tCO ₂ e)
PE _{DF,y}	Project emissions related to the operation of the destruction facility in year y (tCO ₂ e)

N₂O emissions not destroyed by the project activity:

N₂O emissions not destroyed by the project activity are calculated based on the continuous measurement of the N₂O concentration in the tail gas of the N₂O destruction facility and the volume flow rate of the tail gas stream.

The emissions of non destroyed N₂O are given by:

$$PE_{ND,y} = PE_{N2O,y} \times GWP_{N2O} \quad (28)$$

where:

PE _{ND,y}	Project emissions from N ₂ O not destroyed in year y (tCO ₂ e)
PE _{N2O,y}	Project emissions of N ₂ O in year y (tN ₂ O)
GWP _{N2O}	Global warming potential of N ₂ O = 310

$$PE_{N2O,y} = \sum_i^n F_{TE,i} \times CO_{N2O,i} \times M_i \quad (29)$$

where:

PE _{N2O,y}	Project emissions of N ₂ O in year y (tN ₂ O)
F _{TE,i}	Volume flow rate at the exit of the destruction facility during interval i (m ³ /h)



CO_N2O,i	N ₂ O concentration in the tail gas of the N ₂ O destruction facility during interval i (tN ₂ O/m ³)
M_i	Length of measuring interval i (h)
i	interval
n	number of intervals during the year

Project emissions from the operation of the destruction facility:

The operation of the N₂O destruction facility at PANNA 3 requires the use of hydrocarbon (propane type HD-5) as input streams.

The emissions related to the operation of the N₂O destruction facility are given by on-site emissions due to the hydrocarbons used as input to the N₂O destruction facility. Note, in case of PANNA 3 nitric acid plant a SCR DeNO_x unit is already installed prior to the project start and according to AM0028 the ammonia input for existing SCR is considered of the same magnitude as project related ammonia input for NO_x-reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation.

$$PE_{DF,y} = PE_{NH3,y} + PE_{HC,y} \quad (30)$$

where:

PE_DF,y	Project emissions related to the operation of the destruction facility in year y (tCO ₂ e)
PE_NH3,y	Project emissions related to ammonia input to destruction facility in year y (tCO ₂ e)
PE_HC,y	Project emissions related to hydrocarbon input to destruction facility and/or re-heater in year y (tCO ₂ e)

Ammonia input:

In case of PANNA 3, project emissions related to ammonia input to the destruction facility (PE_NH3,y) are zero.

Hydrocarbon Input:

Propane is used as reducing agent at PANNA 3 to enhance the catalytic N₂O reduction efficiency. In this case hydrocarbons are mainly converted to CO₂ (HCE_C,y), while some methane remain unconverted to CO₂ (HCE_NC,y). Note, according to propane supplier certificates methane is not present.

The fraction of the converted hydrocarbons is OXID_HC.

$$PE_{HC,y} = HCE_{C,y} + HCE_{NC,y} \quad (31)$$

where:

PE_HC,y	Project emissions related to hydrocarbon input to destruction facility in year y (tCO ₂ e)
HCE_C,y	Converted hydrocarbon emissions in year y (tCO ₂)
HCE_NC,y	Methane emissions in year y (tCO ₂ e)

For calculation of the GHG emissions related to the hydrocarbons converted and not converted, the following formulae are used:



$$HCE_NC,y = \rho_CH4 \times Q_CH4,y \times GWP_CH4 \times (1 - OXID_CH4 / 100) \quad (32)$$

where:

HCE_NC,y	Methane emissions in year y (tCO ₂ e)
ρ_CH4	Methane density (t/m ³)
Q_CH4,y	Methane used in year y (m ³)
GWP_CH4	Global warming potential of methane
OXID_CH4	Oxidation factor of methane (%)

For calculation of the GHG emissions related to the hydrocarbons converted, the following formulae is used:

$$HCE_C,y = \frac{\rho_HC \times Q_HC,y \times EF_HC \times OXID_HC}{100} + \rho_CH4 \times Q_CH4,y \times EF_CH4 \times OXID_CH4 \quad (33)$$

where:

HCE_C,y	Converted hydrocarbon emissions in year y (tCO ₂ e)
ρ_HC	Hydrocarbon density (t/m ³)
Q_HC,y	Hydrocarbon, with two or more molecules of carbon, input in year y (m ³)
OXID_HC	Oxidation factor of hydrocarbon (%), with two or more molecules of carbon
EF_HC	Carbon emission factor of hydrocarbon (tCO ₂ /t HC), with two or more molecules of carbon

In case of the PANNA 3 project propane type HD-5 will be used as reducing agent, Methane is not present and therefore Q_CH4,y is zero. In order to apply a conservative approach OXID_HC is assumed to be 100%.

The hydrocarbon CO₂ emission factor is given by the molecular weights and the chemical reaction when hydrocarbons are converted (carbon emission factor of propane is 3 tCO₂/tC₃H₈).

Project emissions are limited to the design capacity of the existing nitric acid plant PANNA 3. If the actual production of nitric acid (P_product,y) exceeds the design capacity (P_product,max) then emissions related to the production above P_product,max will neither be claimed for the baseline nor for the project scenario

Baseline Emissions:

Baseline emissions of the project activity are determined based on the quantity of N₂O emitted in the baseline scenario, taking national regulations, production levels and operating conditions into consideration. The quantity of N₂O is determined based on the measurement of the N₂O at the inlet of the N₂O destruction facility (EnviNOx[®] system), which results in a conservative estimation of baseline emissions.



The N₂O baseline emissions monitoring equipment will measure (1) the tail gas volume flow rate (temperature and pressure are also measured and the volume flow rate is automatically adjusted to standard temperature and pressure), (2) the N₂O concentration at the inlet of the EnviNOx[®] system, (3) the output of nitric acid and (4) the operating conditions of the ammonia oxidation reactor (temperature, pressure, ammonia flow rate). The amount of N₂O baseline emissions can then directly be calculated by multiplying the tail gas volume flow rate and the N₂O concentration or if the actual operating parameters and pressure are outside the range of permitted operating parameters by applying conservative default values.

Baseline emissions are given by the following equation:

$$BE_y = BE_{N_2O} \times GWP_{N_2O} \quad (34)$$

where:

BE _y	Baseline emissions in year y (tCO ₂ e)
BE _{N₂O,y}	Baseline emissions of N ₂ O in year y (tN ₂ O)
GWP _{N₂O}	Global warming potential of N ₂ O = 310

Depending on the implementation of regulations on N₂O emissions and the character of the regulation, baseline N₂O emissions (BE_{N₂O,y}) are calculated as shown below:

Case 1: The most plausible baseline scenario is that no N₂O would be abated in the absence of the project activity (i.e. no secondary or tertiary reductions measures and no NSCR DeNO_x unit would be installed).

$$BE_{N_2O,y} = QI_{N_2O,y} \quad (35)$$

where:

BE _{N₂O,y}	Baseline emissions of N ₂ O in year y (tN ₂ O)
QI _{N₂O,y}	Quantity of N ₂ O supplied to the destruction facility in year y (tN ₂ O)

The quantity of N₂O supplied to the N₂O destruction facility (DF) is calculated based on continuous measurement of the tail gas volume flow rate and the N₂O concentration at the inlet of the N₂O destruction facility. Therefore the quantity of the N₂O at the inlet is given by:

$$QI_{N_2O,y} = \sum_i^n F_{TI,i} \times CI_{N_2O,i} \times M_i \quad (36)$$

where:

QI _{N₂O,y}	Quantity of N ₂ O emissions at the inlet of the destruction facility in year y (tN ₂ O)
F _{TI,i}	Volume flow rate at the inlet of the destruction facility during interval i (m ³ /h)
CI _{N₂O,i}	N ₂ O concentration at destruction facility inlet during interval i (tN ₂ O/m ³)
M _i	Length of measuring interval i (h)
i	Interval
n	Number of intervals during the year



Baseline emissions are limited to the design capacity of the existing nitric acid plant. If the actual production of nitric acid ($P_{product,y}$) exceeds the design capacity ($P_{product,max}$) then emissions related to the production above $P_{product,max}$ will neither be claimed for the baseline nor for the project scenario.

If, $P_{product,y} > P_{product,max}$ (37)

then

$BE_{N2O,y} = SE_{N2O,y} \times P_{product,max}$ (38)

where:

$BE_{N2O,y}$ Baseline emissions of N_2O in year y (tN_2O)
 $SE_{N2O,y}$ Specific N_2O emissions per output nitric acid in year y ($tN_2O/tHNO_3$)
 $P_{product,max}$ Design capacity ($tHNO_3$)

The specific N_2O emissions per unit of output nitric acid are defined as:

$SE_{N2O,y} = QI_{N2O,y} / P_{product,y}$ (39)

where:

$SE_{N2O,y}$ Specific N_2O emissions per unit of output nitric acid in year y ($tN_2O/tHNO_3$)
 $QI_{N2O,y}$ Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O)
 $P_{product,y}$ Production of nitric acid in year y ($tHNO_3$)

Case 2: Legal regulations for N_2O are implemented:

In case national regulations concerning N_2O emissions are implemented during the crediting period, the impact on baseline N_2O emissions is considered without any delay by adjusting the measured N_2O emissions at the time the regulation has to be implemented. Depending on the character of the regulation the adjustment is done as shown below:

Case 2.1: Regulation setting of a threshold for an absolute quantity of N_2O emissions per nitric acid plant over a given time period:

Baseline N_2O emissions are limited by the absolute quantity of N_2O emissions given by the regulation. If the measured baseline N_2O emissions are exceeding the regulatory limit, then measured baseline N_2O emissions are substituted by the regulatory limit.

This leads to the following condition:

If,
 $QI_{N2O,y} > QR_{N2O,y}$ (40)

then,
 $BE_{N2O,y} = QR_{N2O,y}$ (41)

else,
 $BE_{N2O,y} = \min \text{ of } [QI_{N2O,y}, SE_{N2O,y} \times P_{product,max}]$ (42)

where:

$QI_{N2O,y}$ Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O)
 $QR_{N2O,y}$ Regulatory limit of N_2O emissions in year y (tN_2O)
 $BE_{N2O,y}$ Baseline emissions of N_2O in year y (tN_2O)



SE_{N2O,y} Specific N₂O emissions per unit of output nitric acid in year y (tN₂O/tHNO₃)
P_{product,y} Production of nitric acid in year y (tHNO₃)

The quantity of N₂O emissions at the inlet of the N₂O destruction facility (DF) is calculated based on continuous measurement of the tail gas volume flow rate and the N₂O concentration at the inlet of the N₂O destruction facility (see equation 11).

Case 2.2: Regulation setting of a threshold for specific N₂O emissions per unit of product:

This leads to the following condition:

If,

$$SE_{N2O,y} > RSE_{N2O} \quad (43)$$

then,

$$BE_{N2O,y} = \min \text{ of } [RSE_{N2O} \times P_{product,y}, SE_{N2O,y} \times P_{product,max}] \quad (44)$$

else,

$$BE_{N2O,y} = \min \text{ of } [QI_{N2O,y}, SE_{N2O,y} \times P_{product,max}] \quad (45)$$

where:

SE_{N2O,y} Specific N₂O emissions per unit of output nitric acid in year y (tN₂O/tHNO₃)
RSE_{N2O} Regulatory limit of N₂O emissions per unit of output nitric acid (tN₂O/tHNO₃)
BE_{N2O,y} Baseline emissions of N₂O in year y (tN₂O)
P_{product,y} Production of nitric acid in year y (tHNO₃)
QI_{N2O,y} Quantity of N₂O emissions at the inlet of the destruction facility in year y (tN₂O)

The specific N₂O emissions per unit of output of nitric acid are defined as:

$$SE_{N2O,y} = QI_{N2O,y} / P_{product,y} \quad (46)$$

where:

SE_{N2O,y} Specific N₂O emissions per unit of output nitric acid in year y (tN₂O/tHNO₃)
QI_{N2O,y} Quantity of N₂O emissions at the inlet of the destruction facility in year y (tN₂O)
P_{product,y} Production of nitric acid in year y (tHNO₃)

The quantity of N₂O emissions at the inlet of the N₂O destruction facility is calculated based on continuous measurement of the tail gas volume flow rate and the N₂O concentration at the inlet of the N₂O destruction facility.

Case 2.3: Regulation setting of a threshold for N₂O concentration in the tail gas

This leads to the following condition:

If,

$$C_{N2O,y} > CR_{N2O} \quad (47)$$

then

$$BE_{N2O,y} = \sum_i^n C_{N2O,i} \times [F_{TG,i} \times M_i] \quad (48)$$



where $C_{N_2O,i}$ is $\min [C_{N_2O,y}, CR_{N_2O}, \text{ and } \{(SE_{N_2O,y} \times P_{\text{product,max}}) / (\sum(F_{TE,i} \times M_i))\}]$

else,

$$BE_{N_2O,y} = QI_{N_2O,y} \quad (49)$$

where:

$C_{N_2O,i}$	N_2O concentration at destruction facility inlet during interval i (tN_2O/m^3)
$CR_{N_2O,i}$	Regulatory limit for specific N_2O concentration during interval I (tN_2O/m^3)
$BE_{N_2O,y}$	Baseline emissions of N_2O in year y (tN_2O)
$F_{TE,i}$	Volume flow rate at the exit of the destruction facility during interval i (m^3/h)
M_i	Length of measuring interval i (h)
i	Interval
n	Number of intervals during the year
$QI_{N_2O,y}$	Quantity of N_2O emissions at the inlet of the destruction facility in year y (tN_2O)

The quantity of N_2O emissions at the inlet of the N_2O destruction facility is calculated based on continuous measurement of the tail gas volume flow rate and the N_2O concentration at the inlet of the N_2O destruction facility (see equation 11).

Change in N_2O regulations will automatically cause a re-assessment of the baseline scenario.

Procedures used to determine the permitted operating conditions of the nitric acid plant in order to avoid “overestimation of emission reductions”:

In order to avoid that the operation of the nitric acid production plant is manipulated in a way to increase the N_2O generation, thereby increasing the CERs, the following procedures relating to the operating temperature and pressure and the use of ammonia oxidation catalysts is applied.

1. Operating temperature and pressure of the ammonia oxidation reactor (AOR):

If the actual average daily operating temperature or pressure in the ammonia oxidation reactor (T_g and P_g) are outside a “permitted range” of operating temperatures and pressures ($T_{g,hist}$ and $P_{g,hist}$), the baseline emissions are calculated for the respective time period based on lower value between (a) the conservative IPCC default values of the latest IPCC GHG Inventory Guidelines accepted by the IPCC for equivalent N_2O emission process. For nitric acid plants, the figure shall be 4.5 kg N_2O /ton nitric acid, (b) $SE_{N_2O,y}$ and (c) any related value as a result of legal regulations (e.g. $RSE_{N_2O,y}$).

Required monitoring parameters:

$T_{g,d}$	Actual operating temperature AOR on day d ($^{\circ}C$)
$P_{g,d}$	Actual operating pressure AOR on day d (Pa)
$T_{g,hist}$	Historical operating temperature range AOR ($^{\circ}C$)
$P_{g,hist}$	Historical operating pressure range AOR (Pa)

The PANNA 3 nitric acid plant is equipped with one ammonia oxidation reactor. The gauze temperature in the burner is continuously measured by the sensors. The burner is equipped with three temperature sensors and all temperature measurements should theoretically show the same value. In fact, the historical



data are either not available in sufficient samples or show differences or instrument errors between the measured temperatures. These differences are most likely caused by loss of calibration or by deterioration of the thermoelements over time. Also, data went lost due to problems with the data storage system. Therefore, it is not possible to rely sufficiently on the available data.

Therefore the permitted range of operation temperature is determined according to AM0028 by UHDE's operating manual for the PANNA 3 nitric acid plant:

T_{g,hist} 860°C to 940°C from the operating manual provided by the technology provider UHDE

The operating pressure is continuously measured by pressure transmitter in the air compressor discharge line. In fact historical data are available for the PANNA 3 nitric acid plant, but due to loss of calibration or possible deterioration of the measuring device over time it is very unlikely that the indicated pressures correspond to the true gauge pressures.

The operating pressure is continuously being measured by pressure transmitter in the air compressor discharge line. In fact historical data are not available in sufficient samples for the PANNA 3 nitric acid plants, and due to loss of calibration or possible deterioration of the measuring devices over time it is very unlikely that the indicated pressures correspond to the true gauge pressures.

Since the pressure in the ammonia oxidation reactor is an important parameter in the operation of the nitric acid plant, Enaex will either change the pressure transmitter or calibrate it prior to the starting date of the project activity (during the shutdown for project implementation) to obtain more accurate pressure measurements. The implementation of the CDM project will ensure reliable data monitoring in the future. Therefore, the permitted operating range of pressure in the ammonia oxidation reactor is based on the normal range of operating conditions according to UHDE's operating manual for the PANNA 3 nitric acid plant, which is 7 barg to 10 barg.

The effect of pressure in the ammonia oxidation catalyst on N₂O generation in ammonia oxidation on gauzes:

Lower pressure in the burner leads to lower formation of N₂O. This can be concluded from the following. The effect of pressure on the amount of N₂O formed in the ammonia oxidation reactor is well-known and is the reason for monitoring this and other operating parameters that may influence N₂O formation according to AM0028 and applying a conservative default value if a parameter goes out of range.

- Kongshaug (1998)⁴ states, for example, that the N₂O concentration in nitric acid tail gases ranges from about 700 – 1300 ppm (corresponding to 4.4 to 8.1 kg N₂O / t HNO₃) and goes on to say in the next sentence that increasing the pressure slightly increases N₂O emission.
- Further support for the effect of pressure on N₂O generation is provided by the IPCC Guidelines. Given N₂O generation factors [kg N₂O / t HNO₃] clearly demonstrate that higher pressure in the burner leads to higher formation of N₂O.
- Hand in hand with reduced N₂O generation at lower pressures goes an increase in ammonia burner efficiency. That is, the proportion of the ammonia entering the burner which is converted to nitric oxide (NO) increases as the pressure is reduced. This is documented, for example, by

⁴ Kongshaug (1998): Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. Kongshaug, G. IFA Technical Conference, Marrakech, Morocco, 1998. Available from the International Fertilizer Industry Association at <http://www.fertilizer.org/ifa/publicat/pdf/1998_biblio_65.pdf>



Keleti (1985)⁵ The ammonia conversion efficiency ranges from 94%-95% for 10.5 bar burners up to 97%-98% for atmospheric pressure burners.

- The effect is also illustrated in Ullmann (1991)⁶ on page 298, which shows ammonia conversion efficiency (to NO) as a function of gauze temperature for pressures of 1 bar abs and 4 bar abs. The conversion efficiency is 2-3% points lower at 4 bar than at 1 bar.

It is therefore obvious to conclude that if the burner pressure is lower the amount of N₂O generated will decrease and the upper limit of permitted operating pressure is the deciding factor in order to avoid gaming.

The permitted operating range of pressure is based on normal operating conditions for the ammonia oxidation reactors according to UHDE's operating manual for the PANNA 3 nitric acid plant, which is 7.0 barg to 10.0 barg.

P_g,hist 7.0 barg to 10.0 barg from the operating manual of the technology provider UHDE.

If the permissible operating limit recommended in UHDE's operating manual is exceeded for either temperature or pressure, the baseline N₂O emissions for the relevant period are capped at the conservative level of 4.5 kgN₂O/tHNO₃.

2. Composition of ammonia oxidation catalyst:

The plant operator is allowed to use compositions of ammonia oxidation catalysts that are common practice in the region or have been used in the nitric acid plant during the last three years without limitation of N₂O baseline emissions.

In case the nitric acid plant operator wishes to change to a composition not used during the last three years, but is common practice in the region and supplied by a reputable manufacturer, or if it corresponds to a composition that is reported as being in use in the relevant literature, the plant operator is allowed to use these ammonia oxidation catalysts without limitation of N₂O baseline emissions.

In case the nitric acid plant operator changes the composition of ammonia oxidation catalysts and the composition is not common practice in the region and not reported as being in use in the relevant literature, the project applicant has to demonstrate (either by economic or other arguments) that the choice of the new composition was based on considerations other than an attempt to increase the rate of N₂O production. If the project applicant can demonstrate appropriate and verifiable reasons, the plant operator is allowed to use new ammonia oxidation catalysts without limitation of N₂O baseline emissions.

The first composition of ammonia oxidation catalyst used during the crediting period shall be of the same kind of catalyst composition already in operation in the specific nitric acid plant. This is to avoid gaming at the beginning of the project activity.

⁵ Keleti (1985): "Nitric Acid and Fertilizer Nitrates", Cornelius Keleti (Ed.), p.67, Marcel Dekker Inc., New York, 1985 ISBN,0-8247-7332-2

⁶ Ullmann (1991): Ullmann's Encyclopedia of Industrial Chemistry, 5th Ed. Vol. A17, Naphthalene to Nuclear Technology, p.315 VCH Verlagsgesellschaft mbH, Weinheim, Germany, (1991), ISBN 3-527-20117-3



In case the nitric acid plant operator changes the composition of ammonia oxidation catalysts and the composition is not common practice in the region and not reported as being in use in the relevant literature, and the project applicant cannot demonstrate appropriate and verifiable reasons for this, baseline emissions are limited to the maximum specific N_2O emissions of previous periods ($tN_2O/tHNO_3$), documented in the verified monitoring reports.

Required monitoring parameters:

G _{sup}	Supplier of the ammonia oxidation catalyst
G _{sup,hist}	Historical supplier of the ammonia oxidation catalyst
G _{com}	Composition of the ammonia oxidation catalyst
G _{com,hist}	Historical composition of the ammonia oxidation catalyst
SE _{N₂O,y}	Specific N_2O emissions per ton of product nitric acid in year y ($tN_2O/tHNO_3$)

The specification for catalyst gauzes at PANNA 3 nitric acid plant is 90% Platinum, 5% Rhodium and 5% Palladium manufactured by the reputable manufacturer Johnson-Matthey. It is Enaex's intention to continue using a common ammonia oxidation catalyst produced by a reputable manufacturer during the crediting period. The composition of the ammonia oxidation catalyst to be used for the first campaign after project start will be of the same kind of catalyst composition as what is already in operation in PANNA 3 nitric acid plant.

3. Ammonia flow rate to the ammonia oxidation reactor:

If the actual daily ammonia flow rate exceeds the (upper) limit of the maximum historical daily permitted ammonia flow rate, the baseline emissions for this operating day are calculated based on the conservative IPCC default values and are limited by the legal regulations. The upper limit on ammonia flow is determined by plant specific historical operating data the maximum daily average ammonia flow.

Required monitoring parameters on daily basis:

A _{OR,d}	Actual ammonia input to oxidation reactor (tNH_3/day)
A _{OR,hist}	Maximum historical ammonia input to oxidation reactor (tNH_3/day)

Analysis of the historical data for the years 2000-2006 will report the maximum ammonia input to the ammonia oxidation reactor in tNH_3/day .

If the daily ammonia input to the oxidation reactor exceeds the limit on permissible ammonia input, baseline N_2O emissions are capped at conservative IPCC default values.

Leakage:

On condition that an energy converter (e.g. tail gas turbine) is installed at the end of the pipe, the installation of the N_2O destruction facility will not result in significant additional energy consumption at the nitric acid plant and therefore no leakage is expected. Leakage emissions need only be analyzed if the project activity does not involve any energy recovery from the tail gas.



At the nitric acid plant PANNA 3 an energy converter (tail gas turbine) is installed at the end of the pipe. The installation of the N₂O destruction facility will therefore not result in significant additional energy consumption and no leakage is expected. Therefore no monitoring mechanism is being suggested.

Emission Reduction:

The emission reduction (ER_y) by the project activity during a given year *y* is the difference between the baseline emissions (BE_y) and project emissions (PE_y), as follows:

$$ER_y = BE_y - PE_y - LE_y \quad . \quad (50)$$

where:

ER _y	emissions reductions of the project activity during the year <i>y</i> (tCO ₂ e)
BE _y	baseline emissions during the year <i>y</i> (tCO ₂ e)
PE _y	project emissions during the year <i>y</i> (tCO ₂ e)
LE _y	leakage emissions in year <i>y</i> (tCO ₂ e)

**B.6.2. Data and parameters that are available at validation:**

The following tables show the parameters that are not monitored throughout the crediting period but that are determined only once and thus remains fixed throughout the crediting period and that are available when validation is undertaken.

Data / Parameter:	GWP_N2O
Data unit:	tCO ₂ e/tN ₂ O
Description:	Global warming potential of Nitrous Oxide
Source of data used:	IPCC
Value applied:	310
Justification of the choice of data or description of measurement methods and procedures actually applied :	Specified in the AM0028
Any comment:	

Data / Parameter:	Reg_NOx
Data unit:	ppmv
Description:	National regulation on NO _x emissions
Source of data used:	Regional authorities
Value applied:	100 ppmv
Justification of the choice of data or description of measurement methods and procedures actually applied :	Actual NO _x emission limit (COREMA Resolution)
Any comment:	

Data / Parameter:	P_product,max
Data unit:	tHNO ₃ /year
Description:	Design capacity
Source of data used:	Manufacture's specification
Value applied:	337,625 tHNO ₃ /year
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in AM0028
Any comment:	



Data / Parameter:	T_g,hist
Data unit:	°C
Description:	Historical operating temperature range of the ammonia oxidation reactor
Source of data used:	Operating Manual PANNA 3
Value applied:	860 °C – 940 °C
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in AM0028 Historical data are not available in sufficient extend, data from operating manual PANNA 3 are taken.
Any comment:	

Data / Parameter:	P_g,hist,II
Data unit:	barg
Description:	Historical operating pressure range of the ammonia oxidation reactor
Source of data used:	Operating Manual PANNA 3
Value applied:	7.0 barg – 10 barg
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in AM0028 Historical data are not available in sufficient extend, data from operating manual PANNA 3 are taken.
Any comment:	

Data / Parameter:	G_sup,hist
Data unit:	-
Description:	Historical supplier of ammonia oxidation catalyst
Source of data used:	Production reports PANNA 3
Value applied:	Name of the supplier: Johnson & Matthey, Engelhard
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in AM0028
Any comment:	



Data / Parameter:	G_com,hist
Data unit:	%
Description:	Historical composition of the ammonia oxidation catalyst
Source of data used:	Supplier certificate
Value applied:	Pt: 90%; Rh: 5%; Pd: 5%
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in AM0028
Any comment:	

Data / Parameter:	A_OR,hist
Data unit:	tNH3/day
Description:	Max. historical ammonia flow rate to the ammonia oxidation reactor
Source of data used:	tbd (to be determined)
Value applied:	tbd
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in AM0028
Any comment:	

Data / Parameter:	OXID_HC
Data unit:	%
Description:	Hydrocarbon oxidation factor, fraction of the converted hydrocarbons
Source of data used:	AM0028
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in AM0028, conservative baseline approach
Any comment:	According to AM0028, Version 4 and in order to apply a conservative baseline approach the fraction of unconverted hydrocarbons is zero: (OXID_HC = 100%). Hence, reducing agent GHG emissions are calculated based on the hydrocarbon CO ₂ emission factor.



Data / Parameter:	Type_HC
Data unit:	-
Description:	Type of hydrocarbon
Source of data used:	Hydrocarbon supplier
Value applied:	Propane
Justification of the choice of data or description of measurement methods and procedures actually applied :	As specified in AM0028
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Ex-ante estimation of emission reduction is made by projecting nitric acid output, N₂O formation, efficiency of the catalytic N₂O destruction process as well as the demand of hydrocarbon. Estimation is for reference purposes only, actual project and baseline emissions will be determined on measurement results on an ex-post basis.

Data as shown in Annex 3 are applied for the conservative ex-ante calculation of emission reduction, nitric acid production of 305,250 tHNO₃/a, inlet N₂O concentration of 1,500 ppmv and an efficiency of the EnviNOx[®] system of 94%. Please note that under related project circumstances the EnviNOx[®] system reduces more than 99% of N₂O emissions.

As described in chapter B.6.1 the emission reduction are calculated as specified in the applied methodology AM0028.

Project Emissions:

$$\begin{aligned}
 PE_y &= PE_{ND,y} + PE_{DF,y} = \\
 &= PE_{N2O,y} \times GWP_{N2O} + PE_{HC,y} = \\
 &= \sum_i^n F_{TE,i} \times CO_{N2O,i} \times M_i \times GWP_{N2O} + HCE_{C,y} = \\
 &= \sum_i^n F_{TE,i} \times CO_{N2O,i} \times M_i \times GWP_{N2O} + \rho_{HC} \times Q_{HC,y} \times EF_{HC} \times \\
 &\quad OXID_{HC}/100 =
 \end{aligned}$$



$$= 121,470 \times 1.77 \times 10^{-7} \times 7,920 \times 310 + 1.83 \times 10^{-3} \times 519,344 \times 3 \times 100/100 =$$

$$= 55,557 \text{ tCO}_2\text{e/a}$$

Baseline Emissions:

$$\text{BE}_y = \text{BE}_{\text{N}_2\text{O}} \times \text{GWP}_{\text{N}_2\text{O}} =$$

$$= \sum_i^n F_{\text{TI},i} \times \text{CI}_{\text{N}_2\text{O},i} \times M_i \times \text{GWP}_{\text{N}_2\text{O}} =$$

$$= 121,470 \times 2.95 \times 10^{-6} \times 7,920 \times 310 =$$

$$= 878,429 \text{ tCO}_2\text{e/a}$$

Leakage Emissions:

As described the project activity will not result in any relevant leakage emission, therefore:

$$\text{LE}_y = 0$$

Emission Reductions:

$$\text{ER}_y = \text{BE}_y - \text{PE}_y - \text{LE}_y =$$

$$= 878,429 - 55,557 =$$

$$= 822,872 \text{ tCO}_2\text{e/a}$$

The following table summarizes the emission reductions of the project activity.

Emissions Summary		Unit	Year	% of BL GHG Emissions
Baseline emissions	BE_y	tCO₂e	878,429	100.00%
Project emissions related to the operation of the DF	PE_DF _y	tCO ₂ e	2,851	0.32%
Project emissions from N ₂ O not destroyed	PE_ND _y	tCO ₂ e	52,706	6.00%
Project emissions	PE_y	tCO₂e	55,557	6.32%
Total Leakage GHG Emissions	L_E_y	tCO₂e	0	0.00%
Total GHG Emissions Reduction	ER_y	tCO₂e	822,872	93.68%

**B.6.4 Summary of the ex-ante estimation of emission reductions:**

The anthropogenic emissions of the proposed project activity within the project boundary consist of the emissions of non destroyed N₂O and emissions from hydrocarbon input related to the operation of the N₂O destruction facility. Estimation is for reference purposes only, actual project and baseline emissions will be determined on measurement results on an ex-post basis.

Expected starting date of project activity:
PANNA 3: 1st September 2007

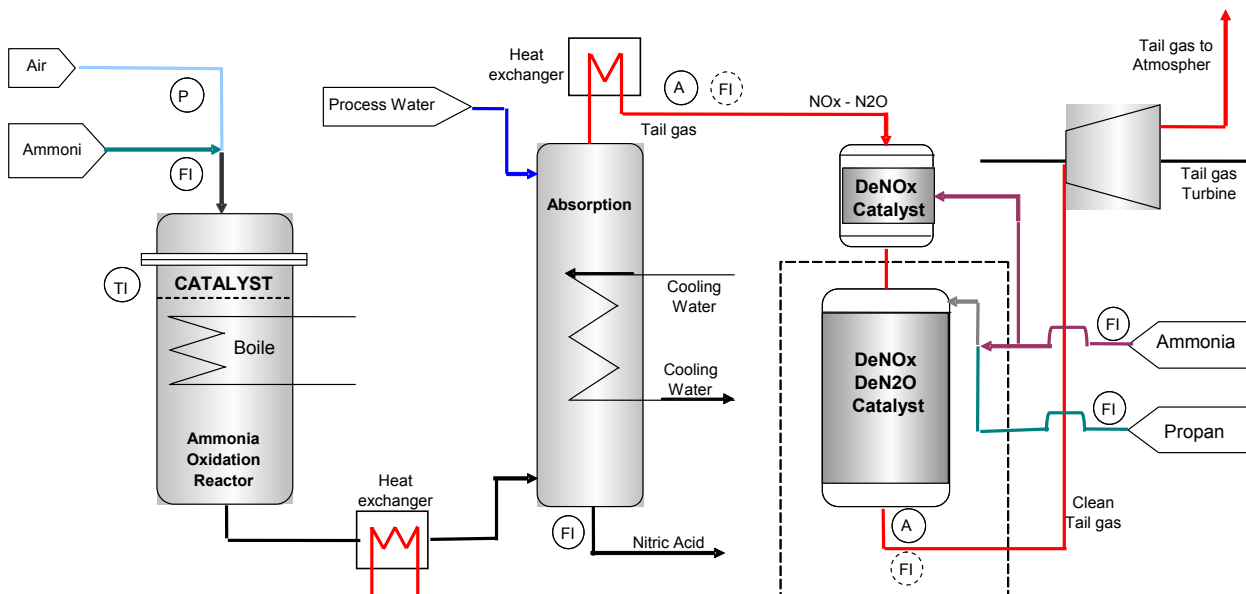
The table below summarizes the project emissions by sources.

Year	Estimation of Project Activity Emissions (tonnes of CO ₂ e)	Estimation of Baseline Emissions (tonnes of CO ₂ e)	Estimation of Leakage (tonnes of CO ₂ e)	Estimation of overall Emission Reductions (tonnes of CO ₂ e)
2007	13,889	219,607	0	205,718
2008	55,557	878,429	0	822,872
2009	55,557	878,429	0	822,872
2010	55,557	878,429	0	822,872
2011	55,557	878,429	0	822,872
2012	55,557	878,429	0	822,872
2013	55,557	878,429	0	822,872
2014	41,668	658,822	0	617,154
Total (tonnes of CO₂e)	388,899	6,149,005	0	5,760,106

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

The following figure shows the monitoring points for the key parameters that need to be monitored for the project activity.

Figure 2: Location of the EnviNOx system as a tertiary measure



B.7.1 Data and parameters monitored:	
Data / Parameter:	F_{TE,i}
Data unit:	m ³ /h
Description:	Volume flow rate at the exit of destruction facility during interval i
Source of data to be used:	Venturi tube, designed and manufactured in accordance with ISO 5167-4:2003
Value of data applied for the purpose of calculating expected emission reductions in section B.5	121,470 m ³ /h (m ³ means cubic meters at standard conditions) Design parameter according to technology provider Standard Normal Conditions: 1,013.25 hPa, 273,15K)
Description of measurement methods and procedures to be applied:	Flow metering system will automatically record volume flow adjusted to standard temperature and pressure. The uncertainty of the mass flow measurement with the venturi tube is to be calculated with the formula given in ISO 5167-1:2003.
QA/QC procedures to be applied:	See Annex 4
Any comment:	Key parameter



Data / Parameter:	CO_N2O,i
Data unit:	tN2O/ m ³
Description:	N2O concentration at destruction facility outlet
Source of data to be used:	Non-dispersive infrared photometry for N ₂ O
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1.77 x 10 ⁻⁷ tN2O/m ³
Description of measurement methods and procedures to be applied:	In the effluent of the EnviNOx®- system, the concentrations of nitrous oxide (N ₂ O) is analysed continuously. Analysis is done by using non-dispersive infrared photometry for N ₂ O. Sample handling includes provisions for pressure reduction, separation of residual solids, sample flow adjustment, and supply with test gases. The analyser is, as far as technically possible, corrected for any applicable cross sensitivity.
QA/QC procedures to be applied:	According to AM0028, results will be checked by sampling the gas chromatography periodically. QA/QC shall be subject to the EN14181 (see Annex 4)
Any comment:	Key parameter

Data / Parameter:	P_HNO3,y
Data unit:	tHNO ₃
Description:	Plant output of HNO ₃
Source of data to be used:	Production reports
Value of data applied for the purpose of calculating expected emission reductions in section B.5	305,250 tHNO ₃ /a
Description of measurement methods and procedures to be applied:	The actual nitric acid production is measured according to the already installed instruments. The instrument signals will be recorded in control rooms and used to determine whether the nitric acid production is within the historical designed capacity. Recorded nitric acid production data considers concentration and density.
QA/QC procedures to be applied:	Enaex will contact plausibility checks on a regular basis based on the ammonia nitrogen balance of the plant. Meters used to measure the nitric acid production are already installed and are integrated in quality management system (ISO 9001:2000).
Any comment:	



Data / Parameter:	F TI,i
Data unit:	m ³ /h
Description:	Volume flow rate at the inlet of destruction facility during interval i
Source of data to be used:	Venturi tube, designed and manufactured in accordance with ISO 5167-4:2003
Value of data applied for the purpose of calculating expected emission reductions in section B.5	121,470 m ³ /h (m ³ means cubic meters at standard conditions) Design parameter according to technology provider Standard Normal Conditions: 1,013.25 hPa, 273,15K
Description of measurement methods and procedures to be applied:	Flow metering system will automatically record volume flow adjusted to standard temperature and pressure. The uncertainty of the mass flow measurement with the venturi tube is to be calculated with the formula given in ISO 5167-1:2003.
QA/QC procedures to be applied:	See Annex 4
Any comment:	

Data / Parameter:	CI N₂O,i
Data unit:	tN ₂ O/ m ³
Description:	N ₂ O concentration at destruction facility inlet
Source of data to be used:	Non-dispersive infrared photometry for N ₂ O
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2.95 x 10 ⁻⁶ tN ₂ O/m ³
Description of measurement methods and procedures to be applied:	In the feed of the EnviNOx®- system, the concentrations of nitrous oxide (N ₂ O), is analysed continuously. Analysis is done by using non-dispersive infrared photometry in a combined analyser device. Sample handling includes provisions for pressure reduction, separation of residual solids, sample flow adjustment, and supply with test gases. The analyser is, as far as technically possible, corrected for any applicable cross sensitivity.
QA/QC procedures to be applied:	According to AM0028, results will be checked by sampling the gas chromatography periodically. QA/QC shall be subject to the EN14181 (see Annex 4)
Any comment:	Key parameter



Data / Parameter:	T_g
Data unit:	°C
Description:	Actual operating temperature ammonia oxidation reactor
Source of data to be used:	Thermocouple
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not needed
Description of measurement methods and procedures to be applied:	The actual temperature at the ammonia oxidation catalyst will be measured with the already installed or exchanged measuring devices.
QA/QC procedures to be applied:	Devices will be subject to a regular maintenance and testing regime according to manufacturer instruction and are integrated in quality management system (ISO 9001:2000).
Any comment:	If the actual average daily operating temperature in the ammonia oxidation reactor (T _g) is outside this “permitted range”, the baseline N ₂ O emissions for that period are capped at 4.5 kgN ₂ O/tonne of nitric acid conservatively applying the IPCC default value.

Data / Parameter:	P_g
Data unit:	barg
Description:	Actual operating pressure ammonia oxidation reactor
Source of data to be used:	Pressure transmitter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not needed
Description of measurement methods and procedures to be applied:	The actual pressure at the ammonia oxidation catalyst will be measured with the already installed or exchanged measuring devices.
QA/QC procedures to be applied:	Devices will be subject to a regular maintenance and testing regime according to manufacturer instruction and are integrated in quality management system (ISO 9001:2000).
Any comment:	If the actual average daily operating pressure at the ammonia oxidation reactor (P _g) is outside this “permitted range”, the baseline N ₂ O emissions for that period are capped at 4.5 kgN ₂ O/tonne of nitric acid conservatively applying the IPCC default value.



Data / Parameter:	G_{sup}
Data unit:	-
Description:	Supplier of the ammonia oxidation catalyst
Source of data to be used:	Ammonia oxidation catalyst supplier
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not needed
Description of measurement methods and procedures to be applied:	Information on supplier will be monitored
QA/QC procedures to be applied:	Not needed
Any comment:	No

Data / Parameter:	G_{com}
Data unit:	%
Description:	Composition of the ammonia oxidation catalyst
Source of data to be used:	Ammonia oxidation catalyst supplier
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not needed
Description of measurement methods and procedures to be applied:	Information composition will be monitored
QA/QC procedures to be applied:	Not needed
Any comment:	No

Data / Parameter:	A_{OR,d}
Data unit:	tNH ₃ /d
Description:	Actual ammonia flow rate to the ammonia oxidation reactor
Source of data to be used:	Flow meter
Value of data applied for the purpose of	Not needed



calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	The actual ammonia flow to the ammonia oxidation reactor will be measured with the already installed measuring devices. Flow is converted to standard conditions based on temperature and pressure measurements.
QA/QC procedures to be applied:	Devices will be subject to a regular maintenance and testing regime according to manufacturer instruction and are integrated in quality management system (ISO 9001:2000).
Any comment:	If the actual ammonia flow rate to the ammonia oxidation reactor is outside the “permitted range”, the baseline N ₂ O emissions for that period are capped at 4.5 kgN ₂ O/tonne of nitric acid conservatively applying the IPCC default value.

Data / Parameter:	Q_{HC,y}
Data unit:	m ³
Description:	Hydrocarbon input (reducing agent)
Source of data to be used:	Flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	519,344 m ³ /a Design parameter according to technology provider
Description of measurement methods and procedures to be applied:	The propane used as reducing agent will be measured by standard flow meters. Flow is converted to standard conditions based on temperature and pressure measurement.
QA/QC procedures to be applied:	Devices will be subject to a regular maintenance and testing regime according to manufacturer instruction.
Any comment:	No

Data / Parameter:	ρ_{HC}
Data unit:	t/m ³
Description:	Hydrocarbon density
Source of data to be used:	Hydrocarbon supplier
Value of data applied for the purpose of calculating expected emission reductions in	0.00183 t/m ³ Standard Normal Conditions: 1,013.25 hPa, 273,15K



section B.5	
Description of measurement methods and procedures to be applied:	Hydrocarbon supplier or default value
QA/QC procedures to be applied:	Not required
Any comment:	No

Data / Parameter:	EF_HC
Data unit:	tCO ₂ e/t
Description:	Hydrocarbon CO ₂ emission factor
Source of data to be used:	Hydrocarbon supplier or IPCC
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3 tCO ₂ e/THC
Description of measurement methods and procedures to be applied:	The hydrocarbon CO ₂ emission factor is given by the molecular weights and the chemical reaction when hydrocarbons are converted.
QA/QC procedures to be applied:	Not required, the value does not affect the final results significantly.
Any comment:	No

B.7.2 Description of the monitoring plan:

Enaex has been operating the nitric acid plant since the commissioning of the plant and has sufficient and well-experienced staffs. Enaex has been in production of the nitric acid for number of years and measurement of various production parameters including operation of analyzers which are managed by Production team.

The project employs 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 monitoring procedures will be fully integrated in PANNA 3 quality management system. Please note, PANNA 3 is already ISO 9001:2000 certificated. All monitoring equipment will be serviced, calibrated and maintained according to the manufacturers' instructions and international standards. Parameters to be monitored are described above.

It is the responsibility of the Project Operator to ensure that required and experienced capacity is available and that their operational staffs participate in training to be enable to operate the monitoring system



properly. Initial training will be provided to the staff before the project activity starts operation. It is also the responsibility of the Project Operator to organize and implement a quality management system that ensures the integrity of the data.

The system is designed for automatic operation, so that activities by operation personnel are not required during normal operation. However, it is required to observe the system for possible failures, and to perform required maintenance activities on a regular basis.

As mentioned above the proposed project activity also includes training course for operation of the EnviNOx® system and also for accurate monitoring. It is Enaex responsibility to ensure that the required capacity and internal training is made available to assigned staff, to enable them to undertake the tasks required by the project operation and monitoring. All staff involved in any procedures will be trained before the start of the crediting period.

The supplier of the measurement equipment will carry out an on-site training course for operation and maintenance of the measurement equipment prior to the start of the crediting period. Contents and procedures of the training are detailed in the operating manual of the monitoring system. UHDE will also carry out an on-site training for operation and maintenance of the EnviNOx® system.

Malfunction of system components is indicated on the operator console in the control room as an alarm. The occurrence of such an alarm requires the operator to immediately take measures to remedy the problem. This is normally done by informing the instrument department, which then decides whether the problem can be fixed immediately by themselves, or whether external support from manufacturer is required. In such a case it is important to act immediately in order to avoid loss of valuable data. Detailed instructions on how to proceed in such cases are given in the manufacturer's documentation.

Enaex will perform a visual inspection of system on a regular basis by the operating staff. Such an inspection can give indications on oncoming problems and allow to be prepared for them.

Enaex already conduct periodic plausibility checks based on the ammonia nitrogen balance of the plant. Such plausibility checks will be conducted for nitric acid production during the crediting period.

Internal review of project performance and calculation of emission reductions will be executed by Enaex and CARBON on a regular basis.

The monitoring of the N₂O for the project will be responsible by Production team and the operation and maintenance of the N₂O monitoring system will be incorporated to the ISO 9001-2000 quality management system.

Production team will be appointed to be responsible for the operation of the N₂O Monitoring system. Production team will follow the Monitoring plan and report the data on regular intervals to Management team and Plant Manager in ascending order.



Find below a list of persons (expected) to be nominated for the monitoring of the CDM Project:

Activity	Person nominated (expected)
CDM Project Manager	Oscar Jadue
Project Administration	Jorge Saffie
Project Communication DOE	Jorge Saffie
Project Operation	Rafael Visedo
Project Maintenance	Gerardo Díaz
Project Construction	Gerardo Díaz
Project Review: Monitoring Reports	Gerald Dunkel
Project Monitoring (data collection)	Gerardo Díaz

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion of the application of the methodology to the project activity study 21/12/2006
Persons/entities responsible for the application of the baseline and monitoring methodology to the project activity are show below.

<i>Persons/entities</i>	<i>Project Participant Yes / No</i>
CARBON Projektentwicklung GmbH Ortsring 41 A-3485 Grunddorf Austria Tel. +43 2735 77 135 Fax. +43 2735 20 531 Gerald Dunkel Ferdinand Heilig Email: dunkel@carbon-austria.com Email: heilig@carbon-austria.com	YES

**SECTION C. Duration of the project activity / crediting period****C.1 Duration of the project activity:****C.1.1. Starting date of the project activity:**

Starting date of the project activity: 03/11/2006

C.1.2. Expected operational lifetime of the project activity:

25 years

C.2 Choice of the crediting period and related information:**C.2.1. Renewable crediting period****C.2.1.1. Starting date of the first crediting period:**

Expected starting date of first crediting period: 01/09/2007

C.2.1.2. Length of the first crediting period:

7 years, 0 months

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

Not chosen

C.2.2.2. Length:

Not chosen

**SECTION D. Environmental impacts****D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:**

>>

The catalytic N₂O 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:

The ex-ante GHG emission reduction is estimated to be about 5.76 million tonnes of CO₂e over the first seven years crediting period. Additionally, the EnviNOx[®] system will reduce NO_x emissions (additional environmental benefit in expected).

On December 6, 2006, Enaex and CARBON presented the project to the Regional Commission of Environment (COREMA) located in Antofagasta. In their preliminary statement, the authority indicated that an Environmental Impact Assessment would most probably not be required as no negative impacts were expected such as impacts on soil, water and regarding waste, noise, emissions, etc. A final notification from COREMA is expected to be issued by January 2007.

No transboundary impacts are expected.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Not applicable, as no significant environmental impacts are considered.

SECTION E. Stakeholders' comments**E.1. Brief description how comments by local stakeholders have been invited and compiled:**

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

A local stakeholder conference was held by Enaex and CARBON in Antofagasta on December 6, 2006, addressing stakeholders and residents living near the proposed 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 newspaper 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.

Stakeholder Meeting: Antofagasta – 06/12/2006

**E.2. Summary of the comments received:**

Date: December 6, 2006

Location: Public auditorium of Mutual de Seguridad CCHC, Antofagasta

Number of attendants: 68

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

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	Constructing 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	
Total	44	

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 region will benefit from this CDM project?	44	0	0
Is your company or the organization you are working for / you are presenting influenced by this CDM project?	27	16	1
Will your company or the organization you are working for / you are presenting play a role in the implementation of this CDM project?	24	15	5
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 how due account was taken of any comments received:

All remarks and questions were discussed at great length. The project owner will pay attention to the comments and questions of stakeholders and will make all conceivable effort to achieve environmental benefits, social benefits 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 questions and answers of the stakeholder conference:

Q: Questions from stakeholders
A: Answers
Q: Will there be a measurement system to verify the amount of gases that will be released to the atmosphere at the Mejillones community?
A: <i>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 N₂O and NO_x 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.</i>
Q: In terms of transparency, it would be highly appreciated if the company would keep the



community informed about the implementation of the project.

A: *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.*

Q: Do you consider a similar project for PANNA I and PANNA II?

A: *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 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 N₂O destruction. Besides, no positive impact on the NO_x 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.*

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

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

**Annex 3****BASELINE INFORMATION**

The following table summarizes information on data used for ex-ante calculation of GHG emission reductions (for reference purposes only) – note, actual baseline and project emissions and emission reductions will be determined based on measurement results on ex-post basis. Furthermore information on data that are available when validation is undertaken is shown.

Table: Baseline data

Data	Unit	Value	Data Source
Tail gas flow rate	Nm ³ /h	121,470	Uhde: EnviNOx® design parameter
Production days	d/a	330	ENAEX
Additional Ammonia demand by EnviNOx® System	kgNH ₃ /tHNO ₃	-	AM0028
Efficiency DF	%	94%	Uhde: min. efficiency EnviNOx®
N ₂ O GWP	-	310	Kyoto Protocol rules
Hydrocarbon: Propane			
Type of Hydrocarbon	-	Propane	Uhde: EnviNOx® design parameter
Propan Input	kg/h	120	Uhde: EnviNOx® design parameter
Carbon emission factor of hydrocarbon	tCO ₂ /tHC	3.00	AM0028: default factor
Oxidation factor of hydrocarbon	%	100	AM0028: conservative assumption
Methane GWP	-	21	Kyoto Protocol rules
Data ENAEX:			
Historical supplier of ammonia oxidation catalyst	-	Johnson Matthey Engelhard C.	ENAEX: plant operating records 2000-2006
Historical composition of the catalyst	%	90% Pt 5% Rh 5% Pd	Catalyst supplier
Maximum historical ammonia input to AOR	tNH ₃ /day	tbd	ENAEX: plant operating records 2000-2006
Designed capacity	tHNO ₃ /a	337,625	Uhde
Historical operating temperature range of AOR	°C	860 - 940	Uhde: Manufacturer's Operating Manual
Historical operating pressure range of the AOR	barg	7.0 - 10.0	Uhde: Manufacturer's Operating Manual
Standard Conditions:			
Temperature	K	273.15	ISO 10780
Pressure	hPa	1,013.25	ISO 10780



Annex 4

MONITORING INFORMATION

The “Catalytic N₂O destruction project in the tail gas of the nitric acid plant PANNA 3 of Enaex S.A.” employs the latest state of the art monitoring and control equipment that measures, records and reports all key parameters to determine the GHG emission reductions.

Historical data required for the project monitoring are already being collected and documented in this Project Design Document. All remaining required data are automatically transferred to the digital process control system where they are displayed, evaluated, and stored. Evaluation includes calculation of flow rate at standard conditions and mass flow rates of N₂O. The system also performs calculation of daily mean values and generates automated reports.

Accuracy of the N₂O emissions monitoring results is to be ensured by installing a monitoring system that has been certified to meet or exceed 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) or equivalent standards available in Chile, which prescribes the features needed for Automated Measuring Systems (AMS) need and how they are to be calibrated and maintained, shall be used as the basis for selecting and operating the monitoring system.

The monitoring procedures will be fully integrated in PANNA 3 quality management system. Please note, PANNA 3 is already ISO 9001/2000. All monitoring equipment will be serviced, calibrated and maintained according to the manufacturers’ instructions and international standards.

Monitoring equipment:

Measurement of tail gas flow:

The tail gas flow is measured by using a venturi tube, which is designed and manufactured in accordance with ISO 5167-4:2003. The venturi tube is of rough welded sheet iron type with annular pressure tapping chambers. Differential pressure is measured with two (redundant) differential pressure transmitters. For calculation of the volume flow rate at standard conditions or (with known molecular weight) the mass flow, the system is equipped with two (redundant) pressure transmitters and two (redundant) temperature measurements.

On-line analysis of tail gas feed and effluent:

Analysis is done by using non-dispersive infrared photometry analyser device. The analyzer will take readings at least at 1 minute intervals. Readings of these raw data will be stored. Based on the raw data average daily figures will be calculated, reported and stored at the data storage system. Sample handling includes provisions for pressure reduction, separation of residual solids, sample flow adjustment, and supply with test gases. The analyser is, as far as technically possible, corrected for any applicable cross sensitivity.

Actual production of Nitric Acid:

The actual nitric acid production is measured according to the already installed instruments. The instrument signals will be recorded in control rooms and used to determine whether the nitric acid production exceeds the annual designed capacity. Recorded nitric acid production data considers concentration and density.

Actual temperature and pressure of the ammonia oxidation reactor:

The actual temperature and pressure of the ammonia oxidation reactor is monitored using the calibrated existing instruments in the nitric acid plant. The instrument signals will be recorded in the control rooms and used to determine whether the nitric acid plant is being operated within the normal range of operation (daily basis).

Actual ammonia input to the ammonia oxidation reactor:

The actual ammonia flow to the ammonia oxidation reactor is monitored using the existing instruments in the PANNA 3 nitric acid plant. The instrument signals will be recorded in the control rooms and used to determine whether the nitric acid plant is being operated within the normal range of operation (daily basis).

Composition of the ammonia oxidation catalyst:

The composition of the ammonia oxidation catalyst will be monitored according to catalyst supplier information.

Propane input:

The propane used as reducing agent will be measured by standard flow meters. Flow is converted to standard conditions based on temperature and pressure measurements.

Data acquisition and storage:

The measured values are transferred to a digital process control system, where they are displayed, evaluated, and stored. Evaluation includes calculation of flow rate at standard conditions and mass flow rates of N₂O. The system also performs calculation of daily mean values and generates reports. Data storage for raw data as well as for evaluated data is done automatically on a computer network which is directly connected to the process control system. Data storage is designed redundantly. The software for data storage is designed in a way that manipulation of data is excluded, and that any change of configuration is recorded.

Instrument Container, DCS and data logging:

The instrument containers house the analysers, parts of the sample handling system, and the controllers of the DCS. Data logging will be carried out with redundant storage. It controls the EnviNOx® system, generates alarm and trip signals as necessary and logs all process data in the EnviNOx® system area and, in addition, selected operating data from the nitric acid plants, as required by the relevant CDM methodology AM0028. These are mainly the operating parameters of the ammonia oxidation burners.



Annex 5

ISO Certificate

