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

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Fosfertil Cubatão NAP4 Nitrous Oxide Abatement Project
Version 3
25 February 2008

A.2. Description of the project activity:

Nitrous Oxide (N_2O) is an undesired by-product gas from the manufacture of nitric acid. Nitrous oxide is formed during the catalytic oxidation of Ammonia. Over a suitable catalyst, a maximum 98% (typically 92-96%) of the fed Ammonia is converted to Nitric Oxide (NO). The remainder participates in undesirable side reactions that lead to the production of Nitrous Oxide, among other compounds.

Waste N_2O from nitric acid production is typically released into the atmosphere, as it does not have any economic value or toxicity at typical emission levels. N_2O is an important greenhouse gas which has a high Global Warming Potential (GWP) of 310.

The project activity involves the installation of a secondary catalyst to abate N_2O inside the reactor once it is formed.

The baseline scenario is determined to be the release of N_2O emissions to the atmosphere at the currently measured rate, in the absence of regulations to restrict N_2O emissions. If regulations on N_2O emissions are introduced during the crediting period, the baseline scenario shall be adjusted accordingly.

Baseline emissions rate will be determined by measuring N_2O emission factor (t N_2O/t HNO_3) during a *complete* production campaign prior to project implementation. To assure that the data obtained during the initial N_2O measurement campaign for baseline emission factor determination are representative of the actual GHG emissions from the source plant, a set of process parameters known to affect N_2O generation that are under the control of the plant operator, will be controlled from historical data.

Baseline emissions will be dynamically adjusted from activity levels on an ex-post basis through monitoring the amount of nitric acid production. Project N_2O emission will be monitored directly in real time. Additional N_2O monitoring and recording facilities will be installed to measure the amount of N_2O emitted by the project activity.

Project additionality is determined using the most recent version of the “Tool for demonstration and assessment of additionality” version 04 (EB 36), approved by the CDM Executive Board.

The project activity will contribute to the sustainable development of the country through industrial technology transfer (catalyst technology from a developed country to Brazil). The project activity will reduce N_2O emissions and will not increase nor decrease direct emissions of other air pollutants.

The project does not impact on the local communities or access of services in the area. The project activity will not cause job losses at Fosfertil Cubatão NAP(Nitric Acid Plant) 4. Fosfertil Nitrous Oxide

Abatement Project has the potential to be replicated by other nitric acid plants in the country and in other developing countries.

A.3. Project participants:

Name of Party involved (*). ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicates if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	Ultrafertil S/A Private entity. Project Developer.	No
Switzerland	Ecoinvest Carbon S.A.	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.		

With an operational infrastructure that includes its own mines, processing plants and industrial processing units, in addition to an efficient logistics system, Fosfertil is the Brazil's main producer of phosphated and nitrogened raw materials for fertilizer production.

Currently, Fosfertil has approximately 2,600 employees in four different Brazilian states. The chemical plants are located in Araucária (State of Paraná), Cubatão (State of São Paulo), Piaçagüera, in the city of Cubatão (São Paulo) and Uberaba (State of Minas Gerais).

The mining facilities are listed in Catalão (State of Goiás), Tapira and Patos de Minas (Minas Gerais) – Catalão and Patos de Minas also have industrial units for production of phosphated inputs. Fosfertil also counts with a Marine Terminal in Santos (São Paulo), a geology research unit in Patrocínio (MG) and the São Paulo Headquarters.

In all these places Fosfértil operates in an ethical, responsible way, seeking to make partnerships with the communities aimed at obtaining social and economic benefits.

Our History

1958: The Fertilizer Factory of Cubatão (Fafer) is inaugurated.

1965: With participation of Philips/PS Petroleum, Grupo Ultra and international financial entities, Ultrafertil S/A is constituted in Cubatão (São Paulo).

1969: Ultrafertil’s Marine Terminal starts its operations in Santos (São Paulo).

1970: Ultrafertil inaugurates its fertilizer industrial facility in Piaçagüera, Cubatão.

1974: Petrobras purchases Ultrafertil’s shareholding control.

1977: Fertilizantes Fosfatados S/A – Fosfertil is created as a State-owned company to exploit the Patos de Minas (MG) phosphate rock deposit.

1977: Fafer is merged into Ultrafertil.

1980: Fosfertil incorporates Valep, a phosphate mining company in Tapira (Minas Gerais), and Valefertil, a fertilizer chemical complex in Uberaba (Minas Gerais).

1982: A new Ultrafertil’s industrial plant starts operating in Araucária (Paraná).

1992: Under the National Program of Destatization, Fosfertil is privatized and its shareholding control is acquired by the Fertifós Consortium, a group of fertilizer-industry companies.

1992: Fosfertil becomes a publicly-traded company, with shares traded on the stock exchange.

1993: Ultrafertil's privatization auction is carried out. The company is acquired by Fosfertil.

1995: Ultrafertil is merged into Goiasfertil, a wholly-owned subsidiary of Fosfertil dedicated to the extraction of phosfhate rock in Catalão (Goiás). After the merger, Goiasfertil’s corporate name changes to Ultrafertil S/A.

2004: Even maintaining the corporate names Fertilizantes Fosfatados S/A - Fosfertil and Ultrafertil S/A, the company decides to adopt a single corporate identity — Fosfertil — and updates its logo.
Therefore Ultarfertil S/A is the Corporate Name and Fosfertil is the Trade Mark Name

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Brazil

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

Sao Paulo

A.4.1.3. City/Town/Community etc:

Cubatão, Raiz da Serra

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

The project activity takes place at Fosfertil Cubatão NAP 4 located in Avenida Bernardo Geisel Filho, s/no, Cubatão (23º 52’ 44’’ South; 46º 26’ 30’’ west), state of Sao Paulo, Brazil.

Figure 1. Location of Fosfertil facilities in Brazil

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

The project activity fall within *Sectoral scope*: “(5) Chemical industries”.

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

The Ostwald process

Nowadays, all commercial Nitric Acid is produced by the oxidation of ammonia, and subsequent reaction of the oxidation products with water, through the Ostwald process.

The basic Ostwald process involves 3 chemical steps:

A) Catalytic oxidation of ammonia with atmospheric oxygen, to yield Nitrogen Monoxide (or Nitric Oxide).

(1) $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$

B) Oxidation of the Nitrogen Monoxide to Nitrogen Dioxide or Dinitrogen Tetroxide

(2) $2\ NO + O_2 \rightarrow 2\ NO_2 \rightarrow N_2O_4$

C) Absorption of the Nitrogen Oxides with water to yield Nitric Acid

(3) $3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$

Reaction 1 is favored by lower pressure and higher temperature. Nevertheless, at too high temperature, secondary reactions take place that lower yield (affecting nitric production); then, an optimal is found between 850-950 C, affected by other process conditions and catalyst chemical composition (figure 2)[1]. Reactions 2 and 3 are favored by higher pressure and lower temperatures.

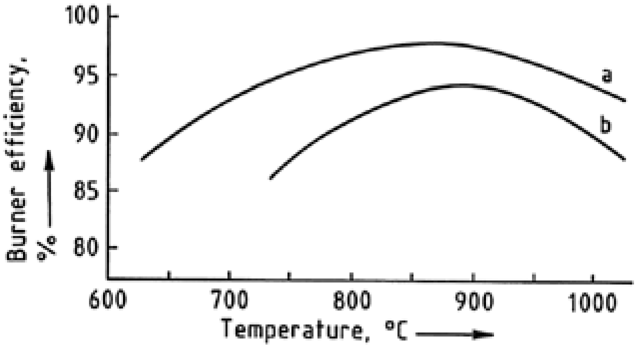

Figure 2. Conversion of Ammonia to Nitrogen Monoxide on Platinum Gauze as a function of temperature a) 100 kPa; (b) 400 kPa [1]

The way in which these three steps are implemented, characterizes the various Nitric Acid processes found throughout the industry. In mono pressure or single pressure processes ammonia combustion and nitrogen oxide absorption take place at the same working pressure. In dual pressure or split pressure plants the absorption pressure is higher than the combustion pressure.

Nitrous Oxide formation

Nitrous oxide is formed during the catalytic oxidation of Ammonia. Over a suitable catalyst, a maximum 98% (typically 92-96%) of the fed Ammonia is converted to Nitric Oxide (NO) according to reaction (1) above. The remainder participates in undesirable side reactions that lead to Nitrous Oxide (N_2O), among other compounds.

Side reactions during oxidation of Ammonia:

(4) $4\ NH_3 + 4\ O_2 \rightarrow 2\ N_2O + 6\ H_2O$ (Nitrous Oxide formation).

(5) $4\ NH_3 + 3\ O_2 \rightarrow 2\ N_2 + 6\ H_2O$

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[1] Thieman et al., “Nitric Acid, Nitrous Acid, and Nitrogen Oxides”, *Ullmann’s Encyclopedia of Industrial Chemistry 6th Edition*, Wiley-VCH Verlag GmbH & Co. KGaA. All rights reserved.

(6) $2\,NO \rightarrow N_2 + O_2$

(7) $4\,NH_3 + 6\,NO \rightarrow 5\,N_2 + 6\,H_2O$

N_2O abatement technology classification

The potential technologies (proven and under development) to treat N_2O emissions at Nitric acid plants, have been classified as follows, based on the process location of the control device:

Primary: N_2O is prevented from forming in the oxidation gauzes.
Secondary: N_2O once formed, is eliminated anywhere between the outlet of the ammonia oxidation gauzes and the inlet of the absorption tower.
Tertiary: N_2O is removed at the tail gas, after the absorption tower and previous to the expansion turbine.
Quaternary: N_2O is removed following the expansion turbine, and before the stack.

Selected technology for the project activity

General description

The current project activity involves the installation of a new (not previously installed) catalyst below the oxidation gauzes (a “secondary catalyst”) whose sole purpose is the decomposition of N_2O; the secondary approach has the following advantages:

- The catalyst does not consume electricity, steam, fuels or reducing agents (all sources of leakage) to eliminate N_2O emissions; thus, operating costs are negligible and the overall energy balance of the plant is not affected.
- Installation is extremely simple and does not require any new process unit or re-design of existing ones (only in a few cases, the reactor basket needs some minor modifications to accommodate the new catalyst).
- Installation is also very fast, so it is done simultaneously with a primary gauze changeover; thus, the plant has no loss in production due to incremental down time.
- Considerably lower capital cost when compared to other approaches.

Fosfertil is determined to install a secondary catalyst system (upon successful registration as a CDM project) and have selected Johnson Matthey Technology

Johnson Matthey has been developing solutions for a “secondary” catalyst whose sole purpose is to decompose N_2O without affecting Nitric Acid production. Typically the catalyst has a very high activity for N_2O decomposition (minimum of 85% of abatement can be reached). Beyond high abatement of N_2O, some other advantages of the use of secondary catalyst are: proven performance, no measurable effect on ammonia to nitric oxide yield, and its implementation does not lead to increased NO_X emissions.

The catalyst is placed directly after the platinum catalyst, partially replacing the supports (Raschig-rings) of that catalyst. In this case, retrofit is relatively simple. Fosfertil Cubatão NAP 4 has a Raschig-rings bed as part of the support/homogenization of system on their oxidation reactors. Due to its high degree of selectivity (towards N_2O decomposition) the depth of the secondary catalyst bed to be installed is only a few centimetres thick, thinner than the actual Raschig-rings bed. To create space to insert the new catalyst, enough layers of Raschig rings will be removed from the basket. Once the secondary catalyst is installed, the primary gauzes are placed on top of the basket, as usual. Then, the secondary catalyst acts as support system for the primary gauze pack and both catalysts are in close contact.

The chosen N_2O abatement catalyst vendor will be obligated by Fosfertil to guarantee a minimum of 85% of N_2O decomposition, as well as to take back the catalyst at the end of their useful life and refine, recycle or dispose of it according to the prevailing standards and hence fulfil sustainability standards

Once installed, the catalyst itself and the AMS will be operated by the local Fosfertil Cubatão NAP 4 employees. All project participants will work together on training Fosfertil Cubatão NAP 4 workers to reliably supervise the effective operation of the catalyst technology, apply the installed monitoring system to measure the emissions levels and collect the data in a manner that allows the successful completion of each verification procedure.

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

Total *ex-ante* emissions reductions are estimated to be 109,555 tonnes CO_2e/year for the first seven-year crediting period, which may be renewed. This value included the total emission reductions considering the two reactors involved in the project. Note that actual emissions reductions will be based on monitored data and may differ from this estimate.

Year	**Annual estimation of emission reduction in tonnes of CO_2e**
2008[2]	30,128
2009	109,555
2010	109,555
2011	109,555
2012	109,555
2013	109,555
2014	109,555
2015[3]	79,427
Total estimated reductions (tonnes of CO_2e)	**766,885**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	109,555

A.4.5. Public funding of the project activity:

No funds from public national or international sources are involved in any aspect of the proposed project.

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:

The selected methodology is AM0034 “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants” version 02. (EB 27)
AM0028 “Catalytic reduction of N_2O in the tail gas of Nitric Acid or Caprolactam Productions Plants” version 04.1 (EB 28) is used to select the baseline scenario”.
The “Tool for the demonstration and assessment of additionality” version 04 (EB 36) is used to demonstrate additionality.

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The proposed project activity would reduce N_2O emissions from Fosfertil Cubatão NAP 4 meeting all the conditions specified in the selected approved methodology (AM0034):

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[2] Year 2008 includes 3.3 months; from middle of September to December

[3] Year 2015 includes 8.7 months; from January to middle of September

- Fosfertil Cubatão NAP 4 plant limits the application of this project activity to existing nitric acid production capacity of 97,205 t HNO_3/ year installed in 1974. The Cubatão NAP 4 was installed in 1974 with 220 t/d of design capacity but this nitric acid production capacity was enlarged before 31 December 2005, obtaining the current number.
- Currently Fosfertil Cubatão NAP 4 doesn’t have any N_2O destruction or abatement facility or equipment that could be affected by the project activity
- The project activity will not affect the level of nitric acid production
- There are currently no regulatory requirements or incentives to reduce levels of N_2O emissions from nitric acid plants in Brazil.
- As it was said above, no N_2O abatement technology is currently installed in Fosfertil Cubatão NAP 4.
- The secondary catalyst technology to be installed as project activity has been tested in several industrial trials and has been demonstrated that its installation does not increase NO_X emissions
- NO_X abatement catalyst installed, prior to the start of the project activity, is a Selective Catalytic Reduction $DeNO_X$ unit.
- As it was explained before, the secondary catalyst technology to be installed as project activity has been tested in several industrial trials and has been demonstrated that its operation does not lead to any process emissions of greenhouse gases, directly or indirectly.
- Continuous real-time measurements of N_2O concentration and total gas volume flow will be carried out in the stack:
  - Prior to the installation of the secondary catalyst for one campaign, and
  - After the installation of the secondary catalyst throughout the chosen crediting period of the project activity.

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

The project boundary encompasses the physical, geographical site of Fosfertil Cubatão NAP 4 and equipment for the complete nitric acid production process from the inlet to the ammonia burner to the stack. The only GHG emission relevant to the project activity is N_2O contained in the waste stream exiting the stack. The abatement of N_2O is the only GHG emission under the control of the project participant.

The secondary catalyst utilizes the heat liberated by the highly exothermal oxidation reaction (that occurs on the precious metal gauzes of the primary catalyst) to reach its effective operating temperature. Once the operating temperature is reached, no incremental energy is necessary to sustain the reaction.

	Source	**Gas**	**Included?**	**Justification / Explanation**
Baseline	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	Excluded	The project does not lead to any change in CO_2 or CH_4 emissions, and, therefore, these are not included.
		CH_4	Excluded	
		N_2O	Included	
Project Activity	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	Excluded	The project does not lead to any change in CO_2 or CH_4 emissions
		CH_4	Excluded	
		N_2O	Included	
	Leakage emissions from production, transport, operation and decommissioning of the catalyst.	CO_2	Excluded	No leakage emissions are expected.
		CH_4	Excluded	
		N_2O	Excluded	

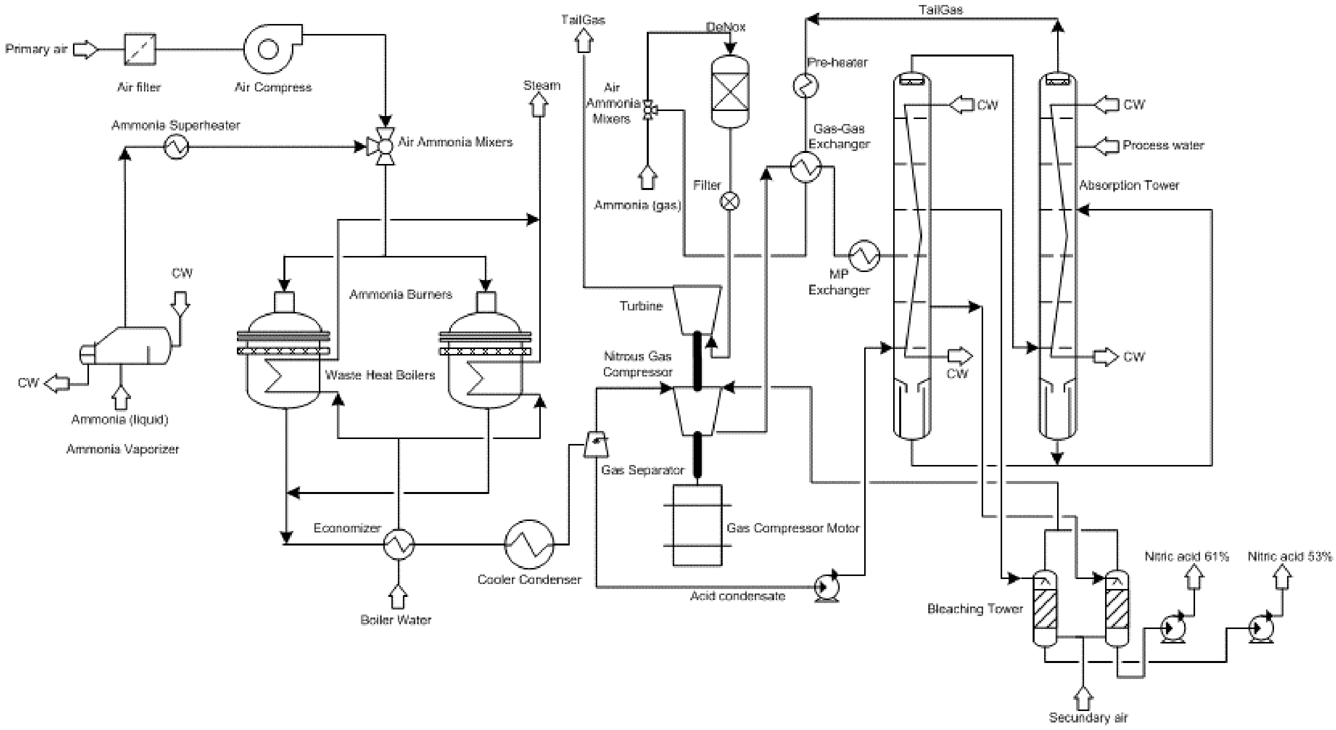

Figure 3. Project boundary of Cubatão NAP 4.

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

The baseline methodology application first involves an identification of possible baseline scenarios, and eliminating those that would not qualify. The procedures followed for baseline scenario selection correspond to AM0028 “Catalytic N_2O destruction in the tail gas of Nitric Acid and Caprolactam Production Plants” Version 04.1 as it is specified in selected AM0034, version 02. The analysis of baseline scenarios involves five steps:

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

The first step in determining the baseline scenario is to analyse all options available to project participants. These include the business-as-usual case, considering sectoral policies and circumstances to determine whether this case corresponds to the continuation or not of the current operation of the nitric acid industry, the project scenario, and any other scenarios that might be applicable. This *first step* can be further broken down into two sub-steps:

Step 1a: The baseline scenario alternatives should include all possible options that are technically feasible to handle N_2O emissions. These options include:

- Continuation of *status quo*. The continuation of the current situation, where there will be no installation of technology for the destruction or abatement of N_2O.

- Switch to alternative production method not involving ammonia oxidation process
- Alternative use of N_2O, such as:
  - Recycling N_2O as a feedstock
  - Use of N_2O for external purposes
- The installation of an N_2O destruction or abatement technology:
  - Primary approach
  - Secondary approach
  - Tertiary approach, including Non Selective Catalytic Reduction (or NSCR De NO_X)[4]
  - Quaternary (or end of pipe) approach.

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

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, since some NO_X technical solutions could also have an effect on N_2O emissions. The alternatives include:

- The continuation of the current situation, whether a DeNO_X unit is installed or not
- Installation of a new Extended Absorption tower
- Installation of a new Selective Catalytic Reduction (SCR) DeNO_X unit
- Installation of a new Non Selective Catalytic Reduction (NSCR) De NO_X unit
- Installation of a combined NO_X /N_2O abatement unit (e.g. UHDEs Envinox® process)
- Installation of a new end-of-pipe treatment such as chemical (H_2O_2) scrubbing system

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

Currently, there are no national regulations or legal obligations in Brazil concerning N_2O emissions. It is unlikely that any such limits on N_2O emissions will be imposed in the near future. In fact, given the cost and complexity of suitable N_2O destruction and abatement technologies, it is unlikely that a limit would be introduced at Brazil considering it has ratified the Kyoto Protocol and actively participates in CDM.

The Fosfertil NAP 4 at Cubatão Site has installed a Selective Catalytic Reduction (SCR) DeNOx unit since 1984 and fulfils the Operating License issued by the Environmental Agency of Sao Paulo State (Cetesb) which set a limit of 250ppm. NOx concentration in the stack gas of the nitric acid plant is lower than or equal at 250 ppm volume expressed as NO_2. Therefore the continuation of the status quo is a valid baseline alternative.

None of the baseline alternatives can be eliminated in this step because they are all in compliance with legal and regulatory requirements.

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

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[4] A NSCR DeNO_X-unit will reduce N_2O emissions as a side reaction to the NO_X--reduction, consequently, new NSCR installation can be seen as an alternative N_2O reduction technology.

On the basis of the alternatives that are technically feasible and in compliance with all legal and regulatory requirements, a complete list of barriers that would prevent alternatives to occur in the absence of CDM is established.

The identified barriers are:

- Investment barriers, inter alia:
  - Debt funding is not available for this type of innovative project activity;
  - No access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented.

- Technological barriers, inter alia:
  - Technical and operational risks of alternatives;
  - Technical efficiency of alternatives (e.g. N_2O destruction, abatement rate);
  - Skilled and / or properly trained labour to operate and maintain the technology is not available and no education / training institution in the host country provides the needed skill, leading to equipment disrepair and malfunctioning;
  - Lack of infrastructure for implementation of the technology;

- Barriers due to prevailing practice, inter alia:
  - The project activity is the “first of its kind”: No project activity of this type is currently operational in the host country or region.(Rhodia Poliamida e Especialidades Ltda, at Paulínia, state of Sao Paulo, has installed a secondary catalyst to eliminate N_2O emissions, also as CDM project activity).

There are four different groups of N_2O destruction or abatement technologies at nitric acid plants: primary, secondary, tertiary and quaternary (or end of pipe) measures.

Currently, there is no technology from the primary approach group that reaches high enough removal efficiency, as to represent a potential N_2O abatement solution in itself.

Available tertiary approaches are the NSCR (Non Selective Catalytic Reduction) and the EnviNO$_X$® process commercialized by Uhde GmbH (Germany); both systems are not selective towards N_2O abatement, and also actuate over acidic species (NO_X). Although Uhde’s process is more efficient than the traditional NSCR system, both technologies have significant requirements regarding space and downtime for installation, and consume reducing agents (fuels and/or Ammonia) to attain N_2O abatement (high operating costs). Furthermore, the plant has already a DeNO$_X$ system of the SCR type, and then the installation of either technology is partly redundant (the already existing SCR would have to be removed and DeNO$_X$ catalyst disposed of properly). Regardless of these drawbacks, such constraints could be solved from the technical standpoint, so both technologies are considered viable alternatives to abate N_2O emissions.

The potential removal of N_2O after the expansion turbine (the quaternary or end-of-pipe approach) has been only studied from the theoretical standpoint and at a laboratory scale. Worldwide, no full scale installations that use such technology are known.

Switch to alternative production method not involving ammonia oxidation process is not an option because there is no other commercially viable alternative to produce nitric acid.

The use of N_2O for external purposes is technically not feasible at Fosfertil Cubatão NAP 4, as the quantity of gas to be treated is extremely high compared to the amount of nitrous oxide that could be recovered. Note that N_2O concentration in the tail gas at Fosfertil Cubatão NAP 4 is expected to be in the range of 452 ppmv to 1,360 ppmv. The use of N_2O for external purposes is practiced neither in Brazil nor anywhere else.

We may discard recycling N_2O as a feedstock for the nitric acid plant. This is because nitrous oxide is not a feedstock for nitric acid production. Nitrous oxide is not recycled at nitric acid plants in Brazil, or anywhere else.

Therefore the following baseline alternatives are eliminated in this step:

- Installation of a primary or quaternary N_2O abatement technology
- The use of N_2O for external purposes
- Recycling of N_2O as a feedstock for the plant

Other possible alternatives face no major technological barriers, but require additional investments. These alternatives are considered in Step 4 below.

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

To conduct the investment analysis, the following sub-steps are used:

Sub-step 4a: Determine appropriate analysis method:

Since the project alternatives generate no financial or economic benefits other than CDM related income, then the simple cost analysis should be applied.

Sub-step 4b: Apply simple cost analysis:

The possible alternatives listed in Step 1a above, and not discarded in the barrier analysis stage, involve the installation of some form of secondary or tertiary N_2O destruction or abatement technology. Both approaches involve substantial investment, and would need to provide benefits other than CDM revenue in order to qualify as valid baselines. Furthermore, tertiary technologies have incremental environmental costs for Fosfertil; since both consume fuels and/or reducing agents to operate, and their installation require the removal of the existing $DeNO_X$ system which catalyst would have to be disposed of properly.

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 any available secondary or tertiary abatement systems as no marketable products or by-products are generated by these N_2O treatment methods.

According to the baseline methodology,

> *"If all alternatives do not generate any financial or economic benefits, then the least costly alternative among these alternative pre-selected as the most plausible baseline scenario."*

As a result the only feasible baseline is a continuation of the *status quo*, which meets current regulations, and requires neither additional investments nor additional running costs.

Therefore the continuation of the current situation can be pre-selected as the baseline scenario.

Sub-step 4c is not applied, since a simple cost analysis is adequate for this project.

Sub-step 4d: Sensitivity analysis

Since the economic analysis is based on simple cost analysis, the baseline methodology does not require a sensitivity analysis: the results are not sensitive to such factors as inflation rate, investment costs, etc. since there are no economic benefits.

Step 5: Re-assessment of Baseline Scenario in course of proposed project activity lifetime:

At the start of a crediting period, a re-assessment of the baseline scenario due to new or modified NO_X or N_2O emission regulations in Brazil, will 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 analyzed will include, inter alia:

- Selective Catalytic Reduction (SCR);
- Non-Selective Catalytic Reduction (NSCR);
- Tertiary measures incorporating a selective catalyst for destroying N_2O and NO_X emissions;
- Continuation of baseline scenario.

For the determination of the adjusted baseline scenario, the baseline determination process will be applied as stipulated above (Steps 1– 5)

Sub Step 5b: New or modified N_2O –regulation

If legal regulations on N_2O emissions are introduced or changed during the crediting period, the baseline emissions will be adjusted at the time the legislation will be legally implemented.
The methodology is applicable if the procedure to identify the baseline scenario results in that the most likely baseline scenario is the continuation of emitting N_2O to the atmosphere, without the installation of N_2O destruction or abatement technologies, including technologies that indirectly reduce N_2O emissions (e.g. NSCR DeNOx units).

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):

Fosfertil Cubatão NAP 4 Abatement Project involves the installation of secondary catalysts whose only purpose and effect is the decomposition of nitrous oxide once it is formed.

Following the selected methodology project emissions are determined from N_2O measurements in the stack gas of the nitric acid plants.

Baseline emissions are calculated from an emission factor measured before the implementation of the project activity (the installation of a secondary catalyst). Then, baseline will be determined by measuring N_2O baseline emission factor (tonne N_2O/tonne HNO_3) during a *complete* production campaign, called "initial N_2O measurement campaign for baseline determination", prior to project implementation

To ensure that data obtained during such initial campaign are representative of the actual GHG emissions from the source plant, a set of process parameters known to affect N_2O generation and that are (to some extent) under the control of the plant operator, are monitored and compared to limits or ranges called "Normal operating conditions".

Normal operating conditions are defined based on plant historical operating conditions, and or plant design data. A range or maximum value for any given parameter has been established considering specific control capabilities of Cubatão NAP 4. In order to properly characterize baseline emission rates, operation during such initial campaign is controlled during the specified range (a maximum or range has been established for each parameter). Only those N_2O measurements taken when the plant is operating within the permitted range will be considered in the calculation of baseline emissions. The level of uncertainty determined for the N_2O monitoring equipment will be deducted from the baseline emissions factor.

Baseline Campaign at Fosfertil Cubatão NAP 4 began on November, 10th, 2007 and will last until September 2008. The emissions factor determined from such measurements will be used for crediting of emission reductions.

The additionality of the project activity is demonstrated and assessed using the fourth version of the "Tool for demonstration and assessment of additionality". We will demonstrate that the baseline scenario is the continuation of the status quo and N_2O emissions are not reduced by any N_2O destruction or abatement technology at Fosfertil Cubatão NAP 4.

Step 1 of the tool can be avoided since the selection of alternative scenarios was already covered in analysis carried out in section B.4 above.

Step 2. Investment analysis:

Sub-step 2a. Determine appropriate analysis method:

As catalytic N_2O destruction facilities generates no financial or economical benefits other than CDM related income, a simple cost analysis is applied.

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 secondary catalyst as no marketable product or by-product exists.

The investment (excluding potential financing costs) consists of the engineering, construction, shipping, installation and commissioning of the secondary catalyst and the measurement equipment. The running costs consist of the regular change of the catalysts as well as personnel costs for the supervision and the measurement equipment.

Baseline scenario: The baseline scenario “The continuation of the current situation” will neither require 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.

A net present value (NPV) of zero has been chosen to be the relevant financial indicator for the project activity. The NPV is the difference between the sum of the discounted cash flows which are expected from the investment and the amount which is initially invested. This financial indicator is used by most companies including Fosfertil group, to assess the economical value of a project. Unless there is a regulatory constraint, projects are required to have a positive NPV with the discount rate defined by the company’s management. Otherwise, they are ruled out. Then, projects are ranked and those with the highest NPV are selected.

As there is no alternative investment to the project activity that would generate similar services, the NPV is calculated in the following only for the project activity. If the NPV is lower or equals zero the proposed project activity is additional.

The following table shows the net present values (NPV) of the investment in the decomposition device, considering discount rates of 0%, 5%, 10% and 15%.

Net present values (NPV) of the investment in the decomposition facility depending on different discount rates

Discount rate	0%	5%	10%	15%
NPV (R$)	-6,139,016	-5,171,757	-4,459,475	-3,922,605

Step 3. Barrier analysis is not used for demonstrating additionality in this project.

Step 4. Common practice analysis

The proposed project activity (or any other form of nitrous oxide abatement technology) is not common practice since no similar project at nitric acid plants are identified in Brazil. The nitric acid industry typically releases into the atmosphere the N_2O generated as a by-product, as it does not have any economic value or toxicity at typical emission levels. N_2O emissions in the stack gas can be considered the business-as-usual activity and it is spread all over the country. No nitric acid plant in Brazil has a secondary catalyst (or any other type of N_2O abatement technology) installed, except for Rhodia Poliamida e Especialidades Ltda, at Paulínia, state of Sao Paulo that installed a secondary catalyst, also as CDM project activity.

Since similar project activities are not observed the proposed project activity is not common practice.

Conclusion:

Currently, there are no national regulations or legal obligations in Brazil concerning N_2O emissions. It is unlikely that any such limits on N_2O emissions will be imposed in the near future. In fact, given the cost and complexity of suitable N_2O destruction and abatement technologies, it is unlikely that a limit would be introduced by Brazil that has ratified the Kyoto Protocol and actively participates in CDM.

Fosfertil is in no need to invest in any N_2O destruction or abatement technology. Neither are there any national incentives or sectoral policies to promote similar project activities.

Without the sale of the CER's generated by the project activity the NPV and IRR of the project would be negative, no revenue would be generated and the technology would not be installed. The secondary catalyst technology when installed will reduce the Nitrous Oxide emissions by up to 85% below what they would otherwise be without the catalyst technology installed.

The proposed CDM project activity is undoubtedly additional, since it passes all the steps of the Version 04 "Tool for demonstration and assessment of additionality", approved by the CDM Executive Board. 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 approval and registration of the project activity as a CDM activity, and the attendant benefits and incentives derived from the project activity, will offset the substantial cost of the catalyst and any plant modifications and will enable the project activity to be undertaken.

Based on the *ex-ante* estimation of N_2O 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 Fosfertil is willing to finance the project activity under the condition of the registration of the project activity.

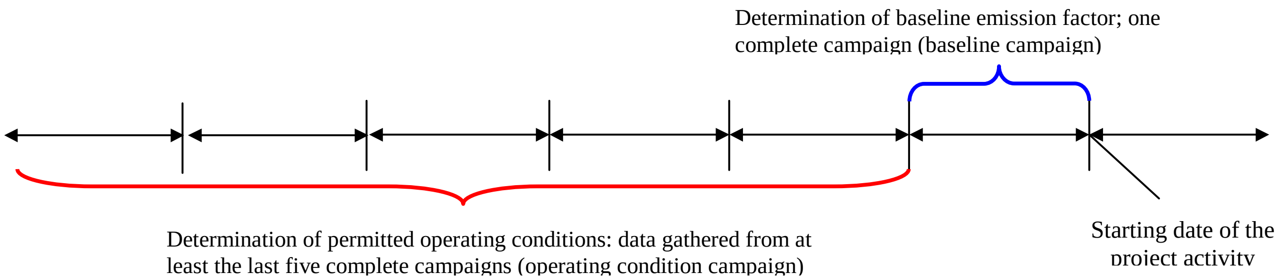
B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Baseline emissions procedure

Following AM0034 the baseline shall be established through continuous monitoring of both N_2O concentration and gas flow volume in the stack of the nitric acid plant for *one complete* campaign prior to project implementation.

The schematic of the procedure is as follows:



1 - Determination of the permitted operating conditions of the nitric acid plant to avoid overestimation of baseline emissions:

Oxidation temperature and pressure

For Cubatão NAP 4, the range of oxidation temperature and pressure as indicated in equipment design documents based in the operating manual of the plant is used to determined “permitted operating conditions”, due to lack of sufficient historical data.

Technical documents to demonstrate design operating conditions will be available for the validation process of the project activity.

Ammonia gas flow rates and ammonia to air ratio input into the ammonia oxidation reactor

The upper limits for ammonia flow and ammonia to air ratio as specified by the ammonia oxidation catalyst manufacturer will be used to determined “permitted operating conditions”.

Ammonia oxidation catalyst design data as per the gauze manufacturer will be available for the validation process of the project activity

2 - Determination of baseline emission factor: measurement procedure for N_2O concentration and gas volume flow

For the determination of the baseline emission factor N_2O concentration and gas volume flow will be monitored throughout the baseline campaign. Separate readings for N_2O concentration and gas flow volume for a defined period of time (e.g. every hour of operation, it provides an average of the measured values for the previous 60 minutes) will be performed. Error readings (e.g. downtime or malfunction) and extreme values will be eliminated from the output data series.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to maverick. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is to be applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure will be applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Then, the average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following eq. 1 from AM0034:

$$BE_{BC} = VSG_{BC} \cdot NCSG_{BC} \cdot 10^{-9} \cdot OH_{BC} \qquad \text{(Eq. 1)}$$

where:

BE_{BC}	Total baseline emissions in the baseline measurement period, in, tN_2O
VSG_{BC}	Mean stack gas volume flow rate in the baseline measurement period, in Nm^3/h
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas in the baseline measurement period, in mg N_2O/Nm^3
OH_{BC}	Number of operating hours in the baseline measurement period, in h

The plant specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over *one full campaign* is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid for that period for baseline emission factor determination.

Following AM0034, the N_2O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) will be reduced by the estimated percentage error (*UNC*):

$$EF_{BL} = \frac{BE_{BC}}{NAP_{BC}}(1 - \frac{UNC}{100}) \qquad \text{(Eq. 2)}$$

where:

EF_{BL}	Baseline emission factor, in tN_2O/ $tHNO_3$
NAP_{BC}	Nitric acid production during the baseline campaign, in, $tHNO_3$

UNC	Overall measurement uncertainty of the monitoring system, in %, calculated as the combined uncertainty of the applied monitoring equipment

Impact of regulations

Should N_2O emissions regulations that apply to nitric acid plants be introduced in Brazil or jurisdiction covering the location of nitric acid plants, such regulations shall be compared to the calculated baseline emission factor (EF_{BL}), regardless of whether the regulatory level is expressed as:

- An absolute cap on the total volume of N_2O emissions for a set period;
- A relative limit on N_2O emissions expressed as a quantity per unit of output; or
- A threshold value for specific N_2O mass flow in the stack;

In this case, a corresponding plant-specific emissions factor cap (max. allowed $tN_2O/tHNO_3$) is to be derived from the regulatory level. If the regulatory limit is lower than the baseline factor determined for the project activity, the regulatory limit shall become as the new baseline emission factor, that is.

If $EF_{BL} > EF_{reg}$, then $EF_{BL} = EF_{reg}$ for all the calculations.

Composition of the ammonia oxidation catalyst

The composition of the ammonia oxidation catalyst used for the baseline campaign and after the implementation of the project are identical to that used in the campaigns for setting the operating conditions (previous five campaigns), then there shall be no limitations on N_2O baseline emissions.

Campaign Length

In order to take into account the variations in campaign length and its influence on N_2O emission levels, the historic campaign lengths and the baseline campaign length are to be determined and compared to the project campaign length. Campaign length is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes.

Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), will be used as a cap on the length of the baseline campaign.

Historical data and statistical analysis to determine “historic campaign length” will be available for the validation process of the project activity.

If baseline campaign length *(CL_{BL}) is lower or equal* than CL_{normal}, all N_2O values measured during the baseline campaign can be used for the calculation of EF_{BL} (subject to the elimination of data that was monitored during times where the plant was operating outside of the “permitted range”).

If baseline campaign length (CL_{BL}) *is higher* than CL_{normal} , all N_2O values measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) will be eliminated from the calculation of EF_{BL}.”

Parameters to be monitored for composition of the catalyst are as follows:
GS_{normal} Gauze supplier for the operation condition campaigns
GS_{BC} Gauze supplier for baseline campaign
$GS_{project}$ Gauze supplier for the project campaign
GC_{normal} Gauze composition for the operation condition campaigns
GC_{BC} Gauze composition for baseline campaign
$GC_{project}$ Gauze composition for the project campaign

Project emission procedure

Actual project emissions will be determined during the project activity from continuous measurements of N_2O concentration and total flow rate in the stack gas of the nitric acid plant.

Project measurements are subjected to exactly the same procedure as the baseline measurements in order to be coherent.

Estimation of campaign-specific project emissions

The monitoring system will provide separate reading for N_2O concentration and gas flow for a define period of time (e.g. every hour of operation, i.e. an average of the measuring values of the past 60 minutes). Error readings (e.g. downtime or malfunction) and extreme values are eliminated from the output data series. Next, the same statistical evaluation that was applied to the baseline data series has to be applied to the project data series:

a) calculate the sample mean (x)
b) calculate the sample standard deviation (s)
c) calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) eliminate all data that lie outside the 95% confidence interval
e) calculate the new sample mean from the remaining values

The mean values of N_2O concentration and total flow rate are used in the following formula (Eq. 3 from AM0034) to calculate project emissions:

$$PE_n = VSG_n \cdot NCSG_n \cdot 10^{-9} \cdot OH_n \qquad \text{(Eq. 3)}$$

where:

PE_n	Total Project emissions of the nth campaign, in tN_2O
VSG_n	Mean stack gas volume flow rate for the nth project campaign, in Nm^3/h
$NCSG_n$	Mean concentration of N_2O in the stack gas for the project campaign, in mg N_2O/Nm^3
OH_n	Number of operating hours in the project campaign, in h

Derivation of a moving average emission factor

In order to take into account possible long-term emissions trends over the duration of the project activity and to take a conservative approach a moving average emission factor is estimated as follows:

Step1: estimate campaign specific emissions factor for each campaign during the project's crediting period by dividing the total mass of N_2O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign.

For example, for the *nth* campaign the campaign specific emission factor would be:

$$EF_n = \frac{PE_n}{NAP_n} \qquad \text{(Eq. 4)}$$

where:

EF_n	Emission factor calculated for the *nth* campaign, in t N_2O/t HNO_3
PE_n	Total Project emissions of the *nth* campaign, in tN_2O
NAP_n	Nitric acid production in the *nth* campaign, in ton 100% HNO_3

Step 2: estimate a moving average emissions factor calculated at the end of the *nth* project campaign as follows:

$$EF_{ma,n} = \frac{\sum_n EF_n}{n} \qquad \text{(Eq. 5)}$$

This process will be repeated for each campaign such that a moving average, $EF_{ma,n}$ is established over time, becoming more representative and precise with each additional campaign.

To calculate the total emission reductions achieved in the *nth* campaign, the higher of the two values $EF_{ma,n}$ and $EF_{,n}$ shall be applied as the emission factor relevant for that particular campaign (EF_p).

If $EF_{ma,n} > EF_{,n}$, then $EF_{,p} = EF_{ma,n}$
If $EF_{ma,n} < EF_{,n}$, then $EF_{,p} = EF_n$ (Eq. 6)

Minimum project emission factor

A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum (EF_{min}). If any of the later project campaigns results in an EF_n that is lower than EF_{min}, the calculation of the emission reductions for that particular campaign shall used EF_{min} and not EF_n.

Project Campaign Length

a. Longer Project Campaign

If the length of each individual project campaign CL_n is longer than or equal to the average historic campaign length CL_{normal}, then all N_2O values measured during the baseline campaign can be used for the calculation of EF_n (subject to the elimination of data from the Ammonia/Air analysis).

b. Shorter Project Campaign

If $CL_n < CL_{normal}$, recalculate EF_{BL} by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tonnes produced) from the calculation of EF_n.

Leakage procedure

No leakage calculation is required.

Emission reduction calculation

The emission reductions of the project activity, *ER*, expressed in tonnes of CO_2 equivalent per year (tCO_2e/yr), are given by Eq. 7 (Eq. 7 from AM0034):

$$ER_n = (EF_{BL} - EF_p) \cdot NAP_n \cdot GWP_{N_2O} \qquad \text{(Eq. 7)}$$

where

ER_n	Emission reductions for the *nth* campaign , tCO_2e
EF_{BL}	Baseline emission factor, in $tN_2O/\ tHNO_3$
EF_p	Project emission factor, in $tN_2O/\ tHNO_3$
NAP	Nitric acid production during the *nth* campaign of the project activity, in, $tHNO_3$
GWP_{N_2O}	Global warming potential, of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period

Note. The nitric acid production used to calculate emission reduction should not exceed the design capacity (nameplate) of the nitric acid plant.

Documentation to prove design capacity (nameplate) of the nitric acid plant will be available for the validation process of the project activity.[5]

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[5] By nameplate (design) implies the total yearly capacity (considering 365 days of operation per year) as per the documentation of the plant technology provider (such as the Operation Manual). If the plant has been modified to increase production, and such de-bottleneck or expansion projects were completed before December 2005, then the new capacity is considered nameplate, provided proper documentation of the projects is available (such as, but not limited to: properly dated engineering plans or blueprints, engineering, materials and/or equipment expenses, or third party construction services, etc.).

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

(Copy this table for each data and parameter)

Data / Parameter:	**Normal Operating Temperature, OT_{normal} (range of temperature)**
Data unit:	ºC
Description:	Range of oxidation temperature of the ammonia reactor.
Source of data used:	Design data were used
Value applied:	810ºC - 900ºC
Justification of the choice of data or description of measurement methods and procedures actually applied :	At Cubatão NAP 4 complete historical registers of oxidation temperature (previous 5 campaigns) are not available, then plant design data was used to determine normal oxidation temperature.
Any comment:	None

Data / Parameter:	**Normal Operating Pressure, OP_{normal} (range of pressure)**
Data unit:	Pa abs
Description:	Range of oxidation pressure of the ammonia reactor.
Source of data used:	Design data were used
Value applied:	139,000 Pa abs -273,000 Pa abs
Justification of the choice of data or description of measurement methods and procedures actually applied :	At Cubatão NAP 4 complete historical registers of oxidation pressure (previous 5 campaigns) are not available, then plant design data was used to determine normal oxidation pressure
Any comment:	None

Data / Parameter:	**Maximum Ammonia Flow Rate, AFR_{max}**
Data unit:	kg NH_3/hour
Description:	Ammonia flow rate to the ammonia oxidation reactor.
Source of data used:	Defined considering option b (as specified by the ammonia oxidation catalyst manufacturer).
Value applied:	3,736 kg NH_3/hour
Justification of the choice of data or description of measurement methods and procedures actually applied :	Complete historical registers for ammonia flow to reactor (five historical campaigns) are not available; then, maximum ammonia load as specified by the primary catalyst manufacturer was used to determine maximum ammonia flow rate.
Any comment:	None

Data / Parameter:	**Maximum Ammonia to Air Flow Rate, $AIFR_{max}$**
Data unit:	Kg NH_3/kg air
Description:	Ammonia to air flow rate to the ammonia oxidation reactor.
Source of data used:	Defined considering option b (as specified by the ammonia oxidation catalyst manufacturer)
Value applied:	0.0746 Kg NH3/Kg air
Justification of the choice of data or description of measurement methods and procedures actually applied :	At NAP 4, complete historical registers for ammonia to air flow rate to the reactor (previous five campaigns) are unavailable; then, maximum ammonia to air flow rate as specified by the primary catalyst manufacturer was used to determine maximum ammonia to air flow rate.
Any comment:	None

Data / Parameter:	**Normal Campaign Length, CL_{normal}**
Data unit:	tonne 100% HNO_3
Description:	Campaign length is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes.
Source of data used:	Calculated from historical process data.
Value applied:	81,466 tonne 100% HNO_3
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated as described (above), from historical data. One campaign was ignored for not being representative of normal operation (campaign was cut for maintenance activities). This campaign was replaced by the previous one. Daily production was measured by using a volume flow meter (Magnetic head principle), and correcting by the average of several (3 to 5) concentration checkups performed in analytical lab
Any comment:	None

Data / Parameter:	**Normal Gauze Supplier, GS_{normal}**
Data unit:	Umicore
Description:	Gauze supplier during operating condition campaigns (the previous five campaigns).
Source of data used:	From historical process data
Value applied:	Umicore
Justification of the choice of data or description of measurement methods and procedures actually applied :	Umicore supplies primary catalyst package to Fosfertil on a contract basis for commercial/economic reasons
Any comment:	None

Data / Parameter:	**Normal Gauze Composition, GC_{normal}**

Data unit:	%
Description:	Gauze composition for the operation condition campaigns (the previous five campaigns). Cubatão NAP 4 has weave gauzes.
Source of data used:	From historical process data.
Value applied:	Pt 92%, Rh 8%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Current gauze composition delivers acceptable performance (as per contractual basis considering commercial/economic issues
Any comment:	None

B.6.3 Ex-ante calculation of emission reductions:

For completing this PDD with the estimation of project emissions the following assumptions are used:

- Nitric acid production is assumed to be constant, so that project emissions do not vary from year to year. Nitric Acid production is estimated as the daily average production multiplied by the operational factor (348 days)
- An N_2O emission factor (EF_{BL}) calculated from monitored data available at the moment of submitting this PDD. The final baseline emission factor will be calculated after the completion of baseline campaign measurements
- The technology provider, indicate that the estimated reduction efficiency to be achieved as a consequence of project implementation is 85%. Then, in order to present estimative values in this PDD, we consider N_2O concentration in the stack gas during the project campaign equal to 15% of the N_2O concentration in the stack gas during the baseline campaign ($NCSG = 0.15 * NSCG_{BC}$)
- Then, *ex-ante* estimations of emission reduction are determined using the following equations:

$$BE_{BC} = VSG_{BC} \cdot NCSG_{BC} \cdot 10^{-9} \cdot OH_{BC} \qquad \text{(Eq. 8)}$$

$$BE_{BC} = 35{,}121 \cdot 1{,}515 \cdot 10^{-9} \cdot 564 = 29.98\, tN_2O \qquad \text{(Eq. 9)}$$

$$EF_{BL} = \frac{BE_{BC}}{NAP_{BC}}(1 - \frac{UNC}{100}) \qquad \text{(Eq. 10)}$$

$$EF_{BL} = \frac{29.98}{6{,}345} \cdot (1 - \frac{5.95}{100}) = 0.00444 tN_2O / tHNO_3 \qquad \text{(Eq. 11)}$$

$$PE_n = VSG \cdot NCSG \cdot 10^{-9} \cdot OH \qquad \text{(Eq. 12)}$$

$$PE_n = 35{,}121 \cdot 0.15 \cdot 1{,}515 \cdot 7{,}200 \cdot 10^{-9} = 57{,}45\, tN_2O \qquad \text{(Eq. 13)}$$

$$EF_p = \frac{PE_n}{NAP_n} \qquad \text{(Eq. 14)}$$

$$EF_p = \frac{57.45}{81{,}466} = 0.00071\, tN_2O / tHNO_3 \qquad \text{(Eq. 15)}$$

Then,

$$ER_n = (EF_{BL} - EF_p) \cdot NAP \ \cdot GWP_{N_2O} \qquad \text{(Eq. 16)}$$

$$ER_n = (0.00444 - 0.00071) \cdot 94{,}512 \cdot 310 = 109{,}555\, tonCO_2e / year \qquad \text{(Eq. 17)}$$

Where

BE_{BC}	Total baseline emissions in the baseline measurement period, in, tN_2O
VSG_{BC}	Mean stack gas volume flow rate in the baseline measurement period, in Nm^3/h
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas in the baseline measurement period, in mg N_2O/Nm^3
OH_{BC}	Number of operating hours in the baseline measurement period, in h
EF_{BL}	Baseline emission factor, in tN_2O/ $tHNO_3$
NAP_{BC}	Nitric acid production during the baseline campaign, in, $tHNO_3$
UNC	Overall uncertainty of the AMS, %
PE_n	Estimated N_2O emission for the project campaign, tN_2O
VSG	Estimated mean stack gas volume flow rate for the project campaign, in Nm^3/h
$NCSG$	Estimated mean concentration of N_2O in the stack gas for the project campaign, in mg N_2O/Nm^3
OH	Estimated number of operating hours in the project campaign, in h
EF_p	Estimated project emission factor, in tN_2O/ $tHNO_3$
NAP_n	Nitric acid production for the project campaign, $tHNO_3$
ER_n	Emission reductions for the *nth* campaign , tCO_2e
NAP	Nitric acid production during year *y*, in, $tHNO_3$/year
GWP_{N2O}	Global Warming Potential of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period

The assumptions parameters are specified in the following table:

Estimated values	**Fosfertil Cubatão NAP 4**
NAP^{6}, $t\ HNO_3/yr$	94,512
OH, h	7,200
GWP_{N_2O} tCO_2e/tN_2O	310

Note: In order to follow the calculations see Spreadsheet "-Fosfertil Cubatão NAP 4. Baseline Emission factor calculation.xls"

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

The ex-ante estimations of project emission reductions are summarized in the table below:

Years	**Estimation of project activity emissions (tonnes of CO_2e)**	**Estimation of baseline emissions (tonnes of CO_2e)**	**Estimation of leakage (tonnes of CO_2e)**	**Estimation of overall emission reduction (tonnes of CO_2e)**
2008[7]	35,809	5,682	-	30,127
2009	130,216	20,661	-	109,555
2010	130,216	20,661	-	109,555
2011	130,216	20,661	-	109,555
2012	130,216	20,661	-	109,555
2013	130,216	20,661	-	109,555
2014	130,216	20,661	-	109,555
2015[8]	94,406	14,979	-	79,427
Total	**911,511**	**144,627**	**-**	**766,884**

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

B.7.1 Data and parameters monitored:

(Copy this table for each data and parameter)

Data / Parameter:	**Baseline Volume Flow in the Stack Gas, VSG_{BC}**
Data unit:	Nm^3 / hour
Description:	Mean gas volume flow rate in the stack gas during baseline campaign
Source of data to be	AMS (Flow meter) at Fosfertil Cubatão NAP 4

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[6] This Nitric Acid Production involves the production of the two reactors.

[7] Year 2008 includes 3.3 months; from middle of September to December

[8] Year 2015 includes 8.7 months; from January to middle of September

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	35,121 Nm^3 / hour
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181) as reference method. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will set up.
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds

Data / Parameter:	**Baseline Temperature of the Stack Gas, TSG_{BC}**
Data unit:	ºC
Description:	Temperature of the gas in the stack gas during baseline campaign
Source of data to be used:	AMS (Flow meter).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds

Data / Parameter:	**Baseline Pressure of the Stack Gas, PSG_{BC}**
Data unit:	Kg/cm^2
Description:	Pressure in the stack gas during baseline campaign
Source of data to be	AMS (Flow meter)

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds

Data / Parameter:	**Baseline N_2O Concentration in the Stack Gas, $NCSG_{BC}$**
Data unit:	mg N_2O/ Nm^3 (converted from ppm if necessary)
Description:	Mean concentration of N_2O in the stack gas for the baseline campaign
Source of data to be used:	AMS (Infrared gas analyzer) at Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,515 mg N_2O/ Nm^3
Description of measurement methods and procedures to be applied:	N_2O concentration is measured by on-line analyzer (Non Dispersive Infra Red principle). A gas stream is continuously drawn from the stack by the sampling system under proper conditions (line is heat traced to avoid condensation), and driven to the infrared cell. The device is set up to measure concentration and record the output electronically every 2 seconds.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181) as reference method. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will set up.
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds

Data / Parameter:	**Baseline Operating Hours, OH_{BC}**
Data unit:	Hours
Description:	Total operating hours for the baseline campaign
Source of data to be	Operation log book.

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	564 hours
Description of measurement methods and procedures to be applied:	Operating hours are measured when a flow of nitric acid enters the storage tank.
QA/QC procedures to be applied:	Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Measured daily during a complete campaign before project implementation to properly characterize baseline emissions factor.

Data / Parameter:	**Uncertainty of the monitoring system, UNC**
Data unit:	%
Description:	Overall uncertainty of the monitoring system, calculated as the combined uncertainty of the applied monitoring equipment
Source of data to be used:	The value was obtained as result of the QAL2 test.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	5.95%
Description of measurement methods and procedures to be applied:	The overall uncertainty was calculated as the combined uncertainty of the flow meter and the uncertainty of the N_2O concentrations measurements, using the law of propagation of uncertainty.
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	Calculated once

Data / Parameter:	**Nitric Acid Production, NAP_{BC}**
Data unit:	tonne 100% HNO_3
Description:	Total nitric acid production for the baseline campaign
Source of data to be used:	Production logs of Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	6,345 tonne 100% HNO_3

Description of measurement methods and procedures to be applied:	Daily production is measured by using a very accurate magnetic flow meter, and eventually checkups are performed comparing its result with measures obtained by one calibrated mass flow meter that acts as support NAP4 produces nitric acid at two concentrations (53% and 61%); analyses of concentrations of the nitric acid productions are accomplished (6 analyses for each concentration of produced nitric acid). These calculations are used on the mass balance calculations, the daily production is reported in total mass of 100% nitric acid
QA/QC procedures to be applied:	Mass balance at the end-product storage tanks is performed on a monthly basis; cross checking of production from mass balance with direct flow measurement is performed routinely. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Measured daily during a complete campaign before project implementation to properly characterize baseline emissions factor.

Data / Parameter:	**Baseline Emission Factor, EF_{BL}**
Data unit:	tonne N_2O / tonne 100% HNO_3
Description:	Baseline emission factor is calculated from monitored data for the baseline campaign
Source of data to be used:	Calculated from monitored data.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For the purpose of calculating expected emission reductions, an N_2O emission factor (EF_{BL}) calculated from monitored data available at the moment of submitting this PDD is used. The final baseline emission factor will be calculated after the completion of the baseline campaign measurements. It is expected that the final emission factor will be higher than the emission factor used in this PDD since the emission factor increases during the campaign. The N_2O emission factor used for ex ante calculation is: 0.00444 tonne N_2O/ tonne 100% HNO_3
Description of measurement methods and procedures to be applied:	Calculated from monitored data.
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	Baseline emission factor per unit of nitric acid produced will be calculated based on measurements of the nitric acid production, stack gas flow rate, N_2O concentration, and the operating hours. All parameters will be measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Calculated once at the end of the baseline campaign

Data / Parameter:	**Baseline Oxidation Temperature, OT_{BC}**
Data unit:	ºC

Description:	Oxidation temperature of the ammonia reactor for the baseline campaign
Source of data to be used:	Distributed Control System of Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The permitted range has been established using plant design data (810ºC-900ºC). Any N_2O baseline data that is measured during hours where the oxidation temperature is outside the permitted range will be eliminated from the calculation of the baseline emissions factor.
Description of measurement methods and procedures to be applied:	Reactor temperature is measured by two thermocouples installed through the reactor wall, near the oxidation catalyst, the signal from such device will be acquired by the Distributed Control System and stored electronically at a given time interval. Oxidation temperature is calculated as the average of readings of four thermocouples (two for each reactor), every data obtained when the oxidation temperature is outside the permitted range is eliminated from baseline emission factor calculation.
QA/QC procedures to be applied:	New thermocouple units are installed immediately after failure reading (open signal).
Any comment:	Monitored during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation. Measured every hour

Data / Parameter:	**Baseline Oxidation Pressure, OP_{BC}**
Data unit:	Pa
Description:	Oxidation pressure of the ammonia reactor for the baseline campaign
Source of data to be used:	Distributed Control System of Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The permitted range has been established using plant design data (139,000 Pa abs - 273,000 Pa abs) Any N_2O baseline data that is measured during hours where the oxidation pressure is outside the permitted range will be eliminated from the calculation of the baseline emissions factor.
Description of measurement methods and procedures to be applied:	Oxidation pressure is tracked by measuring device installed near oxidation reactor (one device for both reactors); the signal from this device will be acquired by the Distributed Control System and stored electronically at a given time interval.
QA/QC procedures to be applied:	Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Monitored during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation. Measured every hour

Data / Parameter:	**Baseline Ammonia Flow Rate, AFR_{BC}**

Data unit:	Kg NH_3/hour
Description:	Ammonia flow rate to the ammonia oxidation reactor for the baseline campaign.
Source of data to be used:	Distributed Control System of Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The permitted range has been established using specifications given by the ammonia oxidation catalyst manufacturer (3,736 kg NH_3/hour) Any N_2O baseline data that is measured during hours where the ammonia flow rate is outside the permitted range will be eliminated from the calculation of the baseline emissions factor.
Description of measurement methods and procedures to be applied:	Ammonia flow to oxidation reactor is tracked by a mass flow measuring device (V cone principle); the signal will be acquired by the Distributed Control System and stored electronically at a given time interval. The System is compensated by pressure and temperature.
QA/QC procedures to be applied:	Overall mass balances of ammonia to the plant are performed on a monthly basis to cross check flows and overall conversion efficiency. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Monitored continuously during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation.

Data / Parameter:	**Baseline Ammonia to Air Flow Rate, $AIFR_{BC}$**
Data unit:	(Kg NH_3/ Kg Air)
Description:	Ammonia to air flow rate to the ammonia oxidation reactor for the baseline campaign.
Source of data to be used:	Distributed Control System of Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The permitted range has been established using specifications given by the ammonia oxidation catalyst manufacturer (0.0746 kg NH_3/kg air) Any N_2O baseline data that is measured during hours where the ammonia to air flow rate is outside the permitted range will be eliminated from the calculation of the baseline emissions factor.
Description of measurement methods and procedures to be applied:	Air flow to oxidation reactor is tracked by mass flow measuring device (Venturi tube principle); the signal from the device will be acquired by the Distributed Control System and stored electronically with the other data at a given time interval. The Ammonia to Air ratio is calculated based on the actual flow analysis from the individual streams.
QA/QC procedures to be applied:	Overall mass balances of ammonia to the plant are performed on a routine basis to cross check flows.
Any comment:	Monitored during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation. Measured every hour

Data / Parameter:	**Baseline Campaign Length, CL_{BL}**
Data unit:	ton 100% HNO_3
Description:	Campaign length is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes. (see baseline nitric acid production, NAP_{BC})
Source of data to be used:	Plant production log book
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The normal campaign length has been set as 81,466 ton 100% $HNO_{3.}$ If production at a given campaign is lower or equal than normal (CL_{Normal}), then the baseline is recalculated by ignoring the data generated after production exceeds normal campaign length.
Description of measurement methods and procedures to be applied:	Daily production is measured by using a very accurate magnetic flow meter, and eventually checkups are performed comparing its result with measures obtained by one calibrated mass flow meter that acts as support NAP4 produces nitric acid at two concentrations (53% and 61%); analyses of concentrations of the nitric acid productions are accomplished (6 analyses for each concentration of produced nitric acid). These calculations are used on the mass balance calculations, the daily production is reported in total mass of 100% nitric acid
QA/QC procedures to be applied:	Cross checking of production from mass balance with direct flow measurement is performed routinely. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Measured once.

Data / Parameter:	**Baseline Gauze Supplier, GS_{BC}**
Data unit:	Umicore
Description:	Gauze supplier for the baseline campaign
Source of data to be used:	Nitric plant procurement office
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Umicore
Description of measurement methods and procedures to be applied:	Cover of supply contract for gauzes for baseline campaign, or equivalent document to prove commercial transaction.
QA/QC procedures to be applied:	None
Any comment:	Recording once

Data / Parameter:	**Baseline Gauze Composition, GC_{BC}**
Data unit:	% precious metals (Platinum, Rhodium)
Description:	Gauze composition for the baseline campaign
Source of data to be used:	Nitric plant procurement office and/or gauze Supplier technical service department.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Pt 92%, Rh 8%
Description of measurement methods and procedures to be applied:	Section of supply contract for gauzes that specifies the technical characteristics agreed during baseline campaign. If necessary, additional data could be requested to supplier’s technical service office in order to provide complete technical profile of gauzes.
QA/QC procedures to be applied:	None
Any comment:	Recording once

Data / Parameter:	**Project Volume Flow in the Stack Gas, $VSG_{project}$**
Data unit:	N m^3 / hour
Description:	Volume flow rate in the stack gas for the project campaign
Source of data to be used:	AMS (Flow meter) at Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	35,121 Nm^3 / hour
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181). Staff will be trained in monitoring procedures and a reliable technical support infrastructure will set up.
Any comment:	Measured during the complete lifetime of the project activity. Recorded every two seconds.

Data / Parameter:	**Project Temperature of the Stack Gas, $TSG_{project}$**
Data unit:	ºC
Description:	Temperature of the gas in the stack gas during project campaign
Source of data to be used:	AMS (Flow meter).
Value of data applied	Not applicable. We do not use this parameter to estimate expected emission

for the purpose of calculating expected emission reductions in section B.5	reduction.
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.
Any comment:	Measured during the complete lifetime of the project activity. Recorded every two seconds

Data / Parameter:	**Project Pressure of the Stack Gas, $PSG_{project}$**
Data unit:	Kg / cm^2
Description:	Pressure in the stack gas during baseline campaign
Source of data to be used:	AMS (Flow meter).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.
Any comment:	Measured during the complete lifetime of the project activity. Recorded every two seconds

Data / Parameter:	**Project N_2O Concentration in the Stack Gas, $NCSG_{project}$**
Data unit:	mg N_2O/ Nm^3 (converted from ppm if necessary)
Description:	N_2O concentration in the stack gas for the project campaign
Source of data to be used:	AMS (Infrared gas analyzer) at Fosfertil’s plants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	227.25 mg N_2O/ Nm^3

Description of measurement methods and procedures to be applied:	N_2O concentration is measured by on-line analyzer (Non Dispersive Infra Red principle). A gas stream is continuously drawn from the stack by the sampling system under proper conditions (line is heat traced to avoid condensation), and driven to the infrared cell. The device is set up to measure concentration and record the output electronically every 2 seconds.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181). Staff will be trained in monitoring procedures and a reliable technical support infrastructure will set up.
Any comment:	Measured during the complete lifetime of the project activity. Recorded every two seconds

Data / Parameter:	**Project Operating Hours, $OH_{project}$**
Data unit:	Hours
Description:	Total operating hours for the project campaign
Source of data to be used:	Process control system at Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	7,200 hours
Description of measurement methods and procedures to be applied:	Operating hours are measured when a flow of nitric acid enters the storage tank.
QA/QC procedures to be applied:	Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Measured daily during the complete lifetime of the project activity.

Data / Parameter:	**Project Nitric Acid Production, $NAP_{project}$**
Data unit:	ton 100% HNO_3
Description:	Total nitric acid production for the project campaign
Source of data to be used:	Production logs of Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Nitric acid production is assumed to be constant, so that project emissions do not vary from year to year. The value of the nitric acid production used for the calculation of expected emission reductions is: 94,512 ton HNO_3/year.
Description of measurement methods and procedures to be applied:	Daily production is measured by using a very accurate magnetic flow meter, and eventually checkups are performed comparing its result with measures obtained by one calibrated mass flow meter that acts as support NAP4 produces nitric acid at two concentrations (53% and 61%); analyses of concentrations of the nitric acid productions are accomplished (6 analyses for

	each concentration of produced nitric acid). These calculations are used on the mass balance calculations, the daily production is reported in total mass of 100% nitric acid
QA/QC procedures to be applied:	Mass balance at the end-product storage tanks is performed on a monthly basis; cross checking of production from mass balance with direct flow measurement is performed routinely. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Measured daily during the complete lifetime of the project activity.

Data / Parameter:	**Project Emission Factor, EF_n**
Data unit:	ton N_2O / ton 100% HNO_3
Description:	Project emission factor calculated from monitored data for the project campaign
Source of data to be used:	Calculated from monitoring data.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.00071 ton N_2O / ton 100% HNO_3
Description of measurement methods and procedures to be applied:	Calculated from monitored data.
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	Project emission factor per unit of nitric acid produced will be calculated based on measurements of the nitric acid production, stack gas flow rate, N2O concentration, and the operating hours. All parameters will be measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Calculated once at the end of the project campaign

Data / Parameter:	**Project Campaign Length, CL_n**
Data unit:	Ton 100% HNO_3
Description:	The project campaign length for the *nth* campaign (CL_n) is defined as the nitric acid produced during the *nth* campaign (see project Nitric Acid Production)
Source of data to be used:	Production logs of Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	81,466 ton 100% HNO_3

Description of measurement methods and procedures to be applied:	Daily production is measured by using a very accurate magnetic flow meter, and eventually checkups are performed comparing its result with measures obtained by one calibrated mass flow meter that acts as support NAP4 produces nitric acid at two concentrations (53% and 61%); analyses of concentrations of the nitric acid productions are accomplished (6 analyses for each concentration of produced nitric acid). These calculations are used on the mass balance calculations, the daily production is reported in total mass of 100% nitric acid
QA/QC procedures to be applied:	Mass balance at the end product storage tanks is performed on a monthly basis; cross checking of production from mass balance with direct flow measurement is performed routinely. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Calculated once at the end of the project campaign

Data / Parameter:	**Project Gauze Supplier, GS_n**
Data unit:	Umicore
Description:	Gauze supplier for the project campaign
Source of data to be used:	Procurement offices of Fosfertil Cubatão NAP 4.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Umicore
Description of measurement methods and procedures to be applied:	Cover of supply contract or bill for gauzes for project campaigns, or equivalent document to prove commercial transaction.
QA/QC procedures to be applied:	None
Any comment:	Recording each campaign

Data / Parameter:	**Project Gauze Composition, GC_n**
Data unit:	% precious metals (Platinum, Rhodium, Palladium)
Description:	Gauze composition for the project campaign
Source of data to be used:	Nitric plant procurement office and gauze Supplier technical service department.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Pt 92%, Rh 8%

Description of measurement methods and procedures to be applied:	Section of supply contract for gauzes that specifies the technical characteristics agreed during baseline campaign. If necessary, additional data could be requested to supplier's technical service office in order to provide complete technical profile of gauzes.
QA/QC procedures to be applied:	None
Any comment:	Recording each campaign

Data / Parameter:	**Emission Factor set by regulation, EF_{reg}**
Data unit:	kg N_2O/ ton HNO_3
Description:	Local and national regulations on N_2O and NO_X emissions
Source of data to be used:	Local and National Regulations
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	At date of introducing or change of regulation.
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	None.

Data / Parameter:	**Moving average emission factor, $EF_{ma,n}$**
Data unit:	kg N_2O/ ton HNO_3
Description:	Moving average of emission factor
Source of data to be used:	Calculated from campaign emissions factors
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Calculated as the average of the emission factors of each project campaigns.
QA/QC procedures to be applied:	No QA/QC is needed.
Any comment:	Calculated at the end of each project campaign

Data / Parameter:	**Minimum Emission Factor , EF_{min}**
Data unit:	kg N_2O/ ton HNO_3
Description:	Minimum emission factor after ten campaigns
Source of data to be used:	Determined from campaign emission factors
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Calculated from monitored data.
QA/QC procedures to be applied:	No QA/QC is needed
Any comment:	Calculated after end of ten campaigns

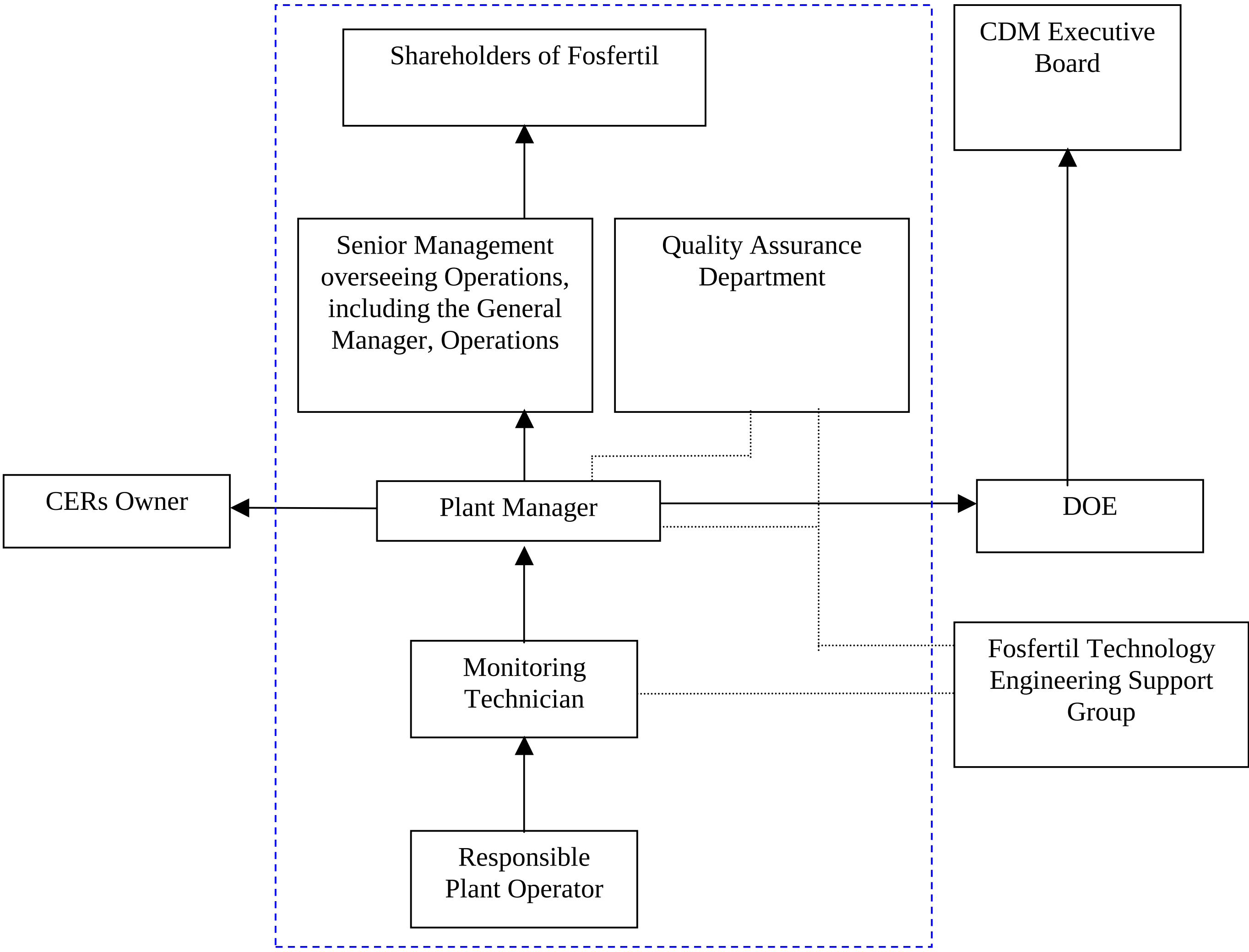
B.7.2 Description of the monitoring plan:

Fosfertil Cubatão NAP 4 is operated by, a qualified staff which is experienced at operating technical equipment to a high level of quality standards.
Furthermore, plant has been operating stack emissions units (f.e. NO_X) for a number of years. The plant has access to specialized technical services available from the Fosfertil Technology Group.

The plant manager will be responsible for the ongoing operation and maintenance of the N_2O monitoring system. Operation, maintenance, calibration and service intervals will be according to the manufacturer specifications and incorporated into the management structure of ISO 9000 standard procedures.

The proposed CDM project will be closely monitored, metered and recorded. The management and operation of the proposed nitrous oxide abatement project at the nitric acid plant will be the responsibility of the plant. The emission reductions will be annually verified by an independent entity, which will be a Designated Operational Entity (DOE). A regular (annual) reporting of the emission reductions generated by the project will be emitted to the CERs owner, coincidently with the DOE verification.

An illustrative scheme of the operational and management structure that will monitor the proposed CDM project activity is as follows:



Note: the dashed line shows the operational and management structure boundaries of the proposed project.

The relation between the project operational and management structure, and other actors of the proposed CDM project activity, is described as follows:

- The responsible Plant Operator will be in charge of the supervision of the data acquisition system (DAS) that will be implemented to record plant operation data. Supported by the DAS, the Plant Operator will report the relevant data to the Monitoring Technician.

- The Monitoring Technician will be a member of the plant staff structure that will also be in charge of processing the data generated by the data acquisition system. The Monitoring Technician will receive the relevant plant data from the responsible Plant Operator. These data will by entered into a spreadsheet especially designed for the monitoring plan.

- The Plant Manager will be responsible to ensure that the CDM project activity at plant level is implemented in compliance with the PDD and other relevant standards. The Plant Manager will be assisted by the Quality Assurance Department which will conduct routine compliance audits. The Plant Manager will routinely report to the General Manager Operations as to the overall progress with the CDM project activity. At any time that the Plant Manager wants or needs to follow the implementation of the CDM project activity, he/she will ask for a report from the Monitoring Technician. For every one year period, the Plant Manager will send a report which will basically be the monitoring plan spreadsheet to the CERs owner, as well as to the corresponding DOE.

- Fosfertil’s Technology Engineering Support Group can at any time be used as a support function to the Monitoring Technician in case of personnel loss or changes. The relevant Plant Manager and QA Department also have Fosfertil’s Technology available as a resource for assistance when required.

- The DOE will then send the corresponding verification report to the CDM Executive Board in order to evaluate it and make able the issuance of the CERs.

- Shareholders of Fosfertil will receive annually from the plant manager, the same report sent to the DOE.

Fosfertil NAP 4 is next to plants UAN and UCAN, which are nitric acid plant and concentration plant respectively.
Personnel in charge of monitoring the DSC’s system are the same for the three plants.
The computer for data acquisition system and the AMS’s control panel were installed in the control room of UCAN plant, based on the following reasons:

- Control room of UCAN plant has appropriate climate conditions that guarantee AMS’s perfect functioning.
- UCAN plant has a DCS installed, prepared to receive and process operational data of NAP4.
- NAP 4 doesn’t have a computerized DCS system installed; to install one would result in a big inversion, only for the CDM project.
- Fosfertil are planning to centralize the operational control of the three plants in this room, in the future

Considering the arguments and the schematic illustration above, a compliance with the monitoring methodology and the monitoring plan will be completely guaranteed.

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 this baseline and monitoring methodology to this project activity is: 17/09/2008 (prevision).

The baseline and monitoring methodology has been applied by:
Walter Hügler, Nuria Zanzottera, and María Inés Hidalgo, MGM International Ltda. (not a project participant).

Tel: +54-11-5219-1230
e-mail: whugler@mgminter.com; nzanzottera@mgminter.com; ihidalgo@mgminter.com

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:

21/09/2008, following completion of measurements to establish baseline emissions factor.

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:

21/09/2008

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

Not selected.

C.2.2.1. Starting date:

N.A.

C.2.2.2. Length:

N.A.

SECTION D. Environmental impacts

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

Fosfertil Cubatão NAP 4 Nitrous Oxide Abatement involves the installation of secondary catalysts whose only purpose and effect is the decomposition of nitrous oxide once it is formed. After project implementation waste N_2O will be converted into N_2 and O_2 avoiding the high global warming effects of the GHG.

The installation of secondary catalysts has a positive environmental impact because it reduces N_2O emissions to the atmosphere and thereby results in cleaner overall air quality.

The project activity involves the installation of a secondary catalyst system inside the reactor immediately underneath the primary gauze system. The exhausted catalyst will be removed and replaced by the technology provider, who has developed the selected technology. No waste liquids, solids or gases are generated by using this technology. No further environmental impacts are expected.

Then, an Environmental Impact Assessment (EIA) is not necessary for this activity as it is stated in the national regulation. Fosfertil Cubatão NAP 4 fulfils the Operating License issued by the Environmental Agency of Sao Paulo State (Cetesb). NOx concentration in the stack gas of the nitric acid plant is lower than or equal at 250 ppm volume expressed as NO_2.

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:

No significant negative environmental impacts are expected from the implementation of the project activity. An environmental impact study is not required by Brazilian authorities

SECTION E. Stakeholders' comments

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

On September 11, 2003, the CIMGC, which is the Brazilian DNA issued the Resolution number 1, which was revised and complemented on October 18, 2005. This Resolution establishes some rules on how to conduct the local stakeholders' consultation process. The stakeholders' process for the "Fosfertil Cubatão NAP 4 Nitrous Oxide Abatement Project" was carried out according to these rules.

An invitation letter was sent to the main stakeholders, communicating Fosfertil's intention of submitting a greenhouse gas emission reduction project to the national and international authorities in order to generate carbon credits in the international market, called **Clean Development Fosfertil – N_2O Abatement in Cubatão**. The letters were addressed to the main representatives of the following entities:

- Municipality of Cubatão
- Alderman Chamber of Cubatão
- Environmental City Secretariat of Cubatão;
- Environmental Secretariat of the State of São Paulo
- Environmental Sanitation Tecnology Company (CETESB) – Cubatão Region – of the Environmental State Secretariat
- Cubatão Justice Prosecution
- Brazilian Forum of NGOs – Forum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente e Desenvolvimento
- Federation of Industries of São Paulo Satate – FIESP
- Center of Industries of the São Paulo State – Region of Cubatão
- Workers Syndicate in Chemical, Pharmaceutical and Fertilizer Industries of Santos Lowlands (Sindquim)

The letter also informed that the full content of the Project Design Document, as well as the Annex 3 regarding its contribution to sustainable development, would be made available on the internet (at www.fosfertil.com.br, item “Responsabilidade Social/ Meio Ambiente/ Desenvolvimento Limpo”) and asked recipients to provide their opinion, doubts or comments in written about the project.

E.2. Summary of the comments received:

Two comments were received, from CETESB and CIESP. The paragraph below summarizes the comments.

CETESB stated the global warming effect, mainly caused by atmospheric emissions, evidences the need of measures in order to mitigate and minimize the effect consequences. In this way, CETESB understands the project proposed by Fosfertil is a positive attitude which improves the local environment; moreover, any environmental license is required for this improvement. Finally, they explained the project must be submitted to Federal Ministry of Science and Technology analysis.

CIESP stated that the project consists in an important contribution to sustainable development of the city of Cubatão, since it reduces gases emissions maintaining economical activity, and it founds the bases for future new environmental projects.

E.3. Report on how due account was taken of any comments received:

As the comments received were favourable, no adjustment in the project was necessary.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	ULTRAFERTIL S/A
Street/P.O.Box:	Avenida Bernardo Geisel Filho, s/no.
Building:	
City:	Cubatão
State/Region:	São Paulo
Postfix/ZIP:	11520-971
Country:	Brazil
Telephone:	
FAX:	
E-Mail:	
URL:	www.fosfertil.com.br
Represented by:	
Title:	
Salutation:	
Last Name:	Prado Santos
Middle Name:	
First Name:	Ricardo
Department:	
Mobile:	
Direct FAX:	(41) 3643-3151
Direct tel:	(41) 3641-1907
Personal E-Mail:	ricardosantos@fosfertil.com.br

Organization:	Ecoinvest Carbon S.A
Street/P.O.Box:	Route de Florissant 13
Building:	
City:	Geneva-12
State/Region:	
Postfix/ZIP:	**CH-1211**
Country:	Switzerland
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	
Salutation:	
Last Name:	Evans
Middle Name:	
First Name:	Alfred
Department:	
Mobile:	
Direct FAX:	41 22 5929100
Direct tel:	41 22 5929621
Personal E-Mail:	alfred.evans@bunge.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funds are available for the financing of the project activity. Therefore, Fosfertil will finance the project activity on the expectation of its approval.

Annex 3

BASELINE INFORMATION

Baseline emissions will be calculated from an emission factor measured during a complete campaign before the implementation of the project activity, under normal operation conditions.

Ex-ante estimations of the key baseline parameters are listed in the following table:

Parameter	
Typical Nitric acid production output (ton 100% HNO_3/year)	94,512
Number of reactors	2
N_2O baseline emission factor (ton N_2O / ton 100% HNO_3)	0.00444
N_2O destruction factor (%)	85
N_2O concentration (mg N_2O/Nm^3)	1,515
UNC (%)	5.95
Operating days	348

Annex 4

MONITORING INFORMATION

The current CDM project “Fosfertil Cubatão NAP 4 Nitrous Oxide Abatement Project” will measure on a quasi-continuous basis (uninterrupted sampling of flue gases with concentration and normalized flow analysis on short, discrete time periods) the N_2O mass flow leaving the Nitric acid plant through an Automated Measuring System (AMS[9]) using technologies and procedures in accordance with AM0034: “Catalytic reduction of N_2O inside the Ammonia burner of nitric acid plants”.
Plant is currently ISO 9001/2000 and ISO 14001/2004 certified; certification documents will be available on site during validation for their review. The monitoring procedures (deployed as per the current monitoring plan and being an integral part of it), will be fully integrated into Fosfertil Cubatão NAP 4 Quality and Environmental Management System.

Fosfertil Cubatão NAP 4 is operated by, a qualified staff which is experienced at operating technical equipment to a high level of quality standards.
Furthermore, Cubatão NAP 4 has been operating stack emissions units (f.e. NO_X) since 1984. The plant has access to specialized technical services available from the Fosfertil Technology Group.

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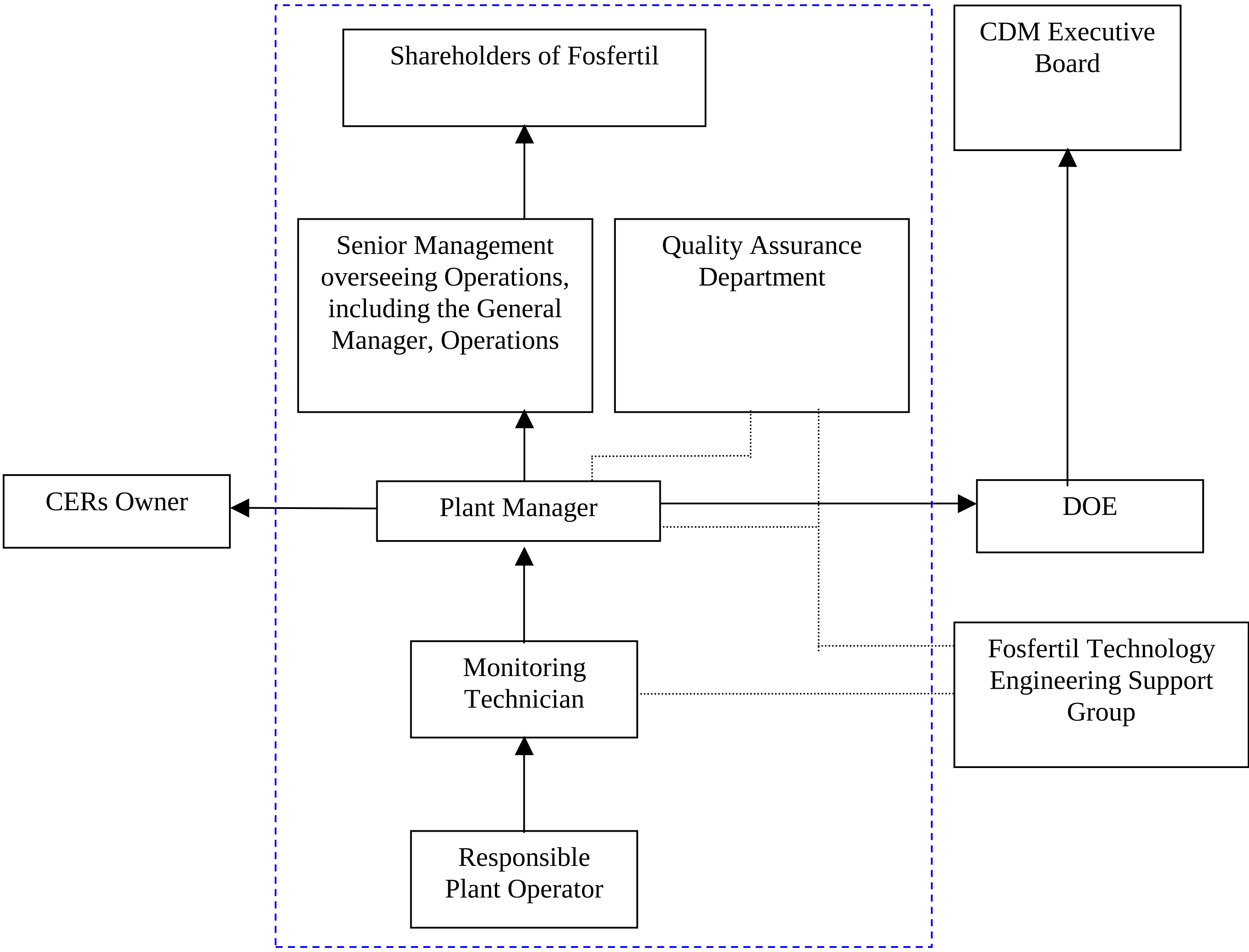
[9] As per “Terms and definitions” of EN 14181:2004 (E), AMS definition is: Measuring system permanently installed on site for continuous monitoring of emissions. An AMS is a method which is traceable to a reference method. Apart from the analyzer, an AMS includes facilities for taking samples and for sample conditioning. This definition also includes testing and adjusting devices that are required for regular functional checks.

All trainings required as consequence of the implementation of the CDM project activity were already developed and included as part of the ISO 9000 standard procedures.

The plant manager will be responsible for the ongoing operation and maintenance of the N_2O monitoring system. Operation, maintenance, calibration and service intervals will be according to the manufacturer specifications and international standards (see QA/QC section below), and incorporated into the management structure of ISO 9000 standard procedures.

The proposed CDM project will be closely monitored, metered and recorded. The management and operation of the proposed Fosfertil Cubatão NAP 4 nitrous oxide abatement will be the responsibility of the plant. The emission reductions will be verified at least annually by an independent entity, which will be a Designated Operational Entity (DOE). A regular (annual) reporting of the emission reductions generated by the project will be emitted to the CERs owner, coincidently with the DOE verification.

An illustrative scheme of the operational and management structure that will monitor the proposed CDM project activity is as follows:



Note: the dashed line shows the operational and management structure boundaries of the proposed project.

The relation between the project operational and management structure, and other actors of the proposed CDM project activity, is described as follows:

- The responsible Plant Operator will be in charge of the supervision of automated measuring system (AMS) and the data acquisition system (DAS) that are installed to measure and acquire both emission and process data. Supported by the DAS, the Plant Operator will report the relevant data to the Monitoring Technician

- The Monitoring Technician will be a member of the plant staff structure that will also be in charge of processing the data generated by the data acquisition system. The Monitoring Technician will receive the relevant plant data from the responsible Plant Operator. These data will be entered into a spreadsheet especially designed for the monitoring plan. The Project Developer will support the Monitoring Technician at analyzing data and assure appropriate and consistent procedural application during report preparation.

- The Plant Manager will be responsible to ensure that the CDM project activity at plant level is implemented in compliance with the PDD and other relevant standards. The Plant Manager will routinely report to the General Manager Operations as to the overall progress of the CDM project activity. At any time that the Plant Manager wants or needs to follow the implementation of the CDM project activity, he/she will ask for a report from the Monitoring Technician. For every one period, the Plant Manager will send a report which will basically be the monitoring plan spreadsheet to the CERs owner, as well as to the corresponding DOE.

- Fosfertil Technology Engineering Support Group can at any time be used as a support function to the Monitoring Technician in case of personnel loss or changes. The relevant Plant Manager and QA Department also have Fosfertil Technology available as a resource for assistance when required.

- The DOE will then send the corresponding verification report to the CDM Executive Board in order to evaluate it and make able the issuance of the CERs.

- Shareholders of Fosfertil will receive annually from the plant manager, the same report sent to the DOE.

Fosfertil NAP 4 is next to plants UAN and UCAN, which are nitric acid plant and concentration plant respectively.
Personnel in charge of monitoring the DSC's system are the same for the three plants.
The computer for data acquisition system and the AMS's control panel were installed in the control room of UCAN plant, based on the following reasons:

- Control room of UCAN plant has appropriate climate conditions that guarantee AMS's perfect functioning.
- UCAN plant has a DCS installed, prepared to receive and process operational data of NAP4.
- NAP 4 doesn't have a computerized DCS system installed; to install one would result in a big inversion, only for the CDM project.
- Fosfertil are planning to centralize the operational control of the three plants in this room, in the future

Tables on section B.7.1 of the PDD describe the parameters to be acquired and recorded as per the current monitoring plan, for both baseline campaign as well as (future) project campaigns. Furthermore, the baseline methodology requires that certain process parameters are monitored (to be compared vs the permitted operating conditions) during baseline campaign; such process parameters are also described in tables B.7.1. Only those N_2O measurements taken when the plant is operating within the permitted range will be considered during the calculation of baseline emissions.

All the relevant instrumentation to measure process parameters are calibrated on a routinely basis as per ISO system. The signals generated by these instruments are acquired and logged electronically by the Distributed Control System (DCS) of the plant. The specific data generated by the AMS is stored on the DCS every 2 seconds (after filtering for downtime and error readings). The DCS provides an hourly average, which is then transferred onto a common spreadsheet (excel) for further analysis/calculations and reporting purposes. Actual emission reduction calculation will use values from such spreadsheet. Due to space constraints on the DCS hard-drive, from time to time, historical data will be archived on a separate hard drive or CDs, to be safeguard for at least 2 years. Raw (detailed) data will be accessible only through the DCS software platform, which insures the stored data cannot be manipulated.

All parameters measured during the baseline campaign will be archived in electronic and paper format during the entire crediting period.
All parameters measured during projects campaigns will be archived in electronic and paper format for at least two years.

Emission reduction calculations

The amount of mass (tons) of N_2O that the project actually avoids from being vented to the atmosphere on each production campaign, expressed as Carbon Dioxide equivalent (or tCO_2e), will be calculated by applying the following formulas:

$$BE_{BC} = VSG_{BC} \cdot NCSG_{BC} \cdot 10^{-9} \cdot OH_{BC}$$

Where:

BE_{BC}	Total baseline emissions in the baseline measurement period, in, tN_2O
VSG_{BC}	Mean stack gas volume flow rate in the baseline measurement period, in Nm^3/h
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas in the baseline measurement period, in mg N_2O/Nm^3
OH_{BC}	Number of operating hours in the baseline measurement period, in h

$$EF_{BL} = \frac{BE_{BC}}{NAP_{BC}}(1 - \frac{UNC}{100})$$

Where:

EF_{BL}	Baseline emission factor, in tN_2O/ $tHNO_3$
NAP_{BC}	Nitric acid production during the baseline campaign, in, $tHNO_3$
UNC	Overall measurement uncertainty of the monitoring system, in %, calculated as the Combined uncertainty of the applied monitoring equipment

Project emissions are calculated from mean values of N_2O concentration and total flow rate:

$$PE_n = VSG_n \cdot NCSG_n \cdot 10^{-9} \cdot OH_n$$

where:

PE_n	Total Project emissions of the nth campaign, in tN_2O
VSG_n	Mean stack gas volume flow rate for the nth project campaign, in Nm^3/h
$NCSG_n$	Mean concentration of N_2O in the stack gas for the project campaign, in mg N_2O/Nm^3
OH_n	Number of operating hours in the project campaign, in h

For the *nth* campaign, the campaign specific emission factor would be:

$$EF_n = \frac{PE_n}{NAP_n}$$

where:

EF_n	Emission factor calculated for the *nth* campaign, in kg N_2O/ton HNO_3
PE_n	Total Project emissions of the *nth* campaign, in tN_2O
NAP_n	Nitric acid production in the *nth* campaign, in ton 100% HNO_3

Then,

$$ER_n = (EF_{BL} - EF_p) \cdot NAP_n \cdot GWP_{N_2O}$$

where

ER_n	Emission reductions of the project for the *nth* campaign, tCO_2e
EF_{BL}	Baseline emission factor, in tN_2O/ $tHNO_3$
EF_p	Project emission factor, applicable to the *nth* campaign, in tN_2O/ $tHNO_3$
NAP_n	Nitric acid production during the *nth* campaign of the project activity, in, $tHNO_3$
GWP_{N_2O}	Global warming potential, of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period

Following AM0034, several restrictions and adjustments will be applied to the formulas (above), among others:

1. All data series are filtered to eliminate mavericks and outliers.

   The monitoring system will provide separate reading for N_2O concentration and gas flow for a define period of time (e.g. every hour of operation, i.e. an average of the measuring values of the past 60 minutes). Error readings (e.g. downtime or malfunction) and extreme values are eliminated from the output data series. Next, the same statistical evaluation that was applied to the baseline data series will be applied to the project data series:

   a) calculate the sample mean (x)
   b) calculate the sample standard deviation (s)
   c) calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
   d) eliminate all data that lie outside the 95% confidence interval
   e) calculate the new sample mean from the remaining values

2. NAP (acid production) cannot exceed nameplate capacity of the plant

   Nitric acid production will be compare to nameplate capacity. If nitric acid production at a given campaign is larger than nameplate, then emission reductions will be calculated ignoring data generated after production exceeds nameplate.

3. A moving average of the emission factors (EF_{ma}) must be calculated

   The campaign specific emissions factor (EF_n) for each campaign during the project's crediting period is compared to a moving average emission factor calculated as the average emission factor of the factors generated in the previous campaigns ($EF_{ma,n}$).

   To calculate the total emission reductions achieved in the *nth* campaign, the higher of the two values $EF_{ma,n}$ and EF_n shall be applied as the emission factor relevant for that particular campaign (EF_p).

4. A minimum project emission factor should also be determined (EF_{min}), defined as the lowest among the emission factor of the 10 first campaigns

   After the first ten campaigns of the crediting period of the project, the lowest emission factor (EF_n) observed during those campaigns will be adopted as a minimum (EF_{min}). If any of the later project campaigns results in an EF_n that is lower than EF_{min}, the calculation of the emission reductions for that particular campaign shall used EF_{min} and not EF_n.

5. The emission factor to be applied for a particular campaign calculation (EF_p) must be the higher between the above mentioned moving average or the specific campaign emission factor (and not lower than minimum emission factor, after 10 campaigns)

   This will be checked according to procedures detailed in steps 4 and 5 above.

6. The level of uncertainty (*UNC*) determined for the AMS installed at the plant, must be deducted from the baseline emissions factor.

   The overall measurement uncertainty (*UNC*), calculated by summing in an appropriate manner (using gauss law of error propagation) all the relevant uncertainties arising from the individual performance characteristics of the AMS components, will be used to reduce the baseline emission factor, The following formulae will be applied:

$$EF_{BL} = EF_{BC} * (1 - \frac{UNC}{100})$$

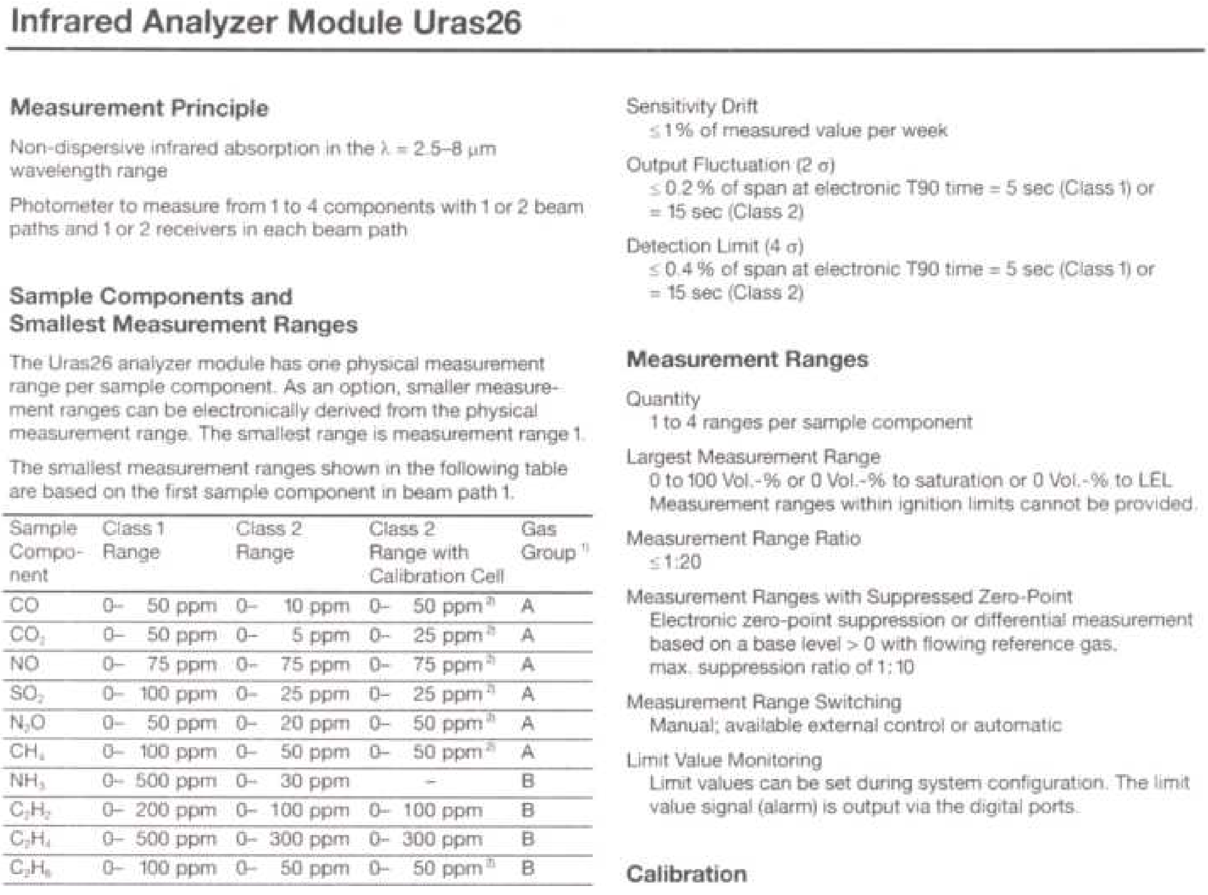
7. If production at a given campaign is lower than normal (CL_{Normal}), then the baseline is recalculated by ignoring the data generated after production exceeds normal campaign length.

   The production at a given campaign will be compared to normal campaign length (CL_{Normal}). If the length of each individual project campaign CL_n is shorter than the average historic campaign length, then EF_{BL} will be re-calculated by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tonnes produced) from the calculation of EF_n.

Please note the specific calculations and adjustments to be followed according to the current monitoring plan are already described in detail in section B.6.1 "Explanation of methodological choices" of the Project Design Document.

Description of the AMS

Fosfertil Cubatão NAP 4 has installed continuous gas analyzers from the supplier ABB, model AO2000, while the specific module to measure N_2O is a non-dispersive infrared called URAS 26. Below are the instruments descriptions as per manufacturer



Infrared Analyzer Module Uras26

Measurement Principle

Non-dispersive infrared absorption in the λ = 2.5–8 μm wavelength range

Photometer to measure from 1 to 4 components with 1 or 2 beam paths and 1 or 2 receivers in each beam path

Sample Components and Smallest Measurement Ranges

The Uras26 analyzer module has one physical measurement range per sample component. As an option, smaller measurement ranges can be electronically derived from the physical measurement range. The smallest range is measurement range 1.

The smallest measurement ranges shown in the following table are based on the first sample component in beam path 1.

Sample Component	Class 1 Range	Class 2 Range	Class 2 Range with Calibration Cell	Gas Group [1]
CO	0– 50 ppm	0– 10 ppm	0– 50 ppm [2]	A
CO_2	0– 50 ppm	0– 5 ppm	0– 25 ppm [2]	A
NO	0– 75 ppm	0– 75 ppm	0– 75 ppm [2]	A
SO_2	0– 100 ppm	0– 25 ppm	0– 25 ppm [2]	A
N_2O	0– 50 ppm	0– 20 ppm	0– 50 ppm [2]	A
CH_4	0– 100 ppm	0– 50 ppm	0– 50 ppm [2]	A
NH_3	0– 500 ppm	0– 30 ppm	–	B
C_2H_2	0– 200 ppm	0– 100 ppm	0– 100 ppm	B
C_2H_4	0– 500 ppm	0– 300 ppm	0– 300 ppm	B
C_2H_6	0– 100 ppm	0– 50 ppm	0– 50 ppm [2]	B

Sensitivity Drift
≤ 1 % of measured value per week

Output Fluctuation (2 σ)
≤ 0.2 % of span at electronic T90 time = 5 sec (Class 1) or = 15 sec (Class 2)

Detection Limit (4 σ)
≤ 0.4 % of span at electronic T90 time = 5 sec (Class 1) or = 15 sec (Class 2)

Measurement Ranges

Quantity
1 to 4 ranges per sample component

Largest Measurement Range
0 to 100 Vol.-% or 0 Vol.-% to saturation or 0 Vol.-% to LEL
Measurement ranges within ignition limits cannot be provided.

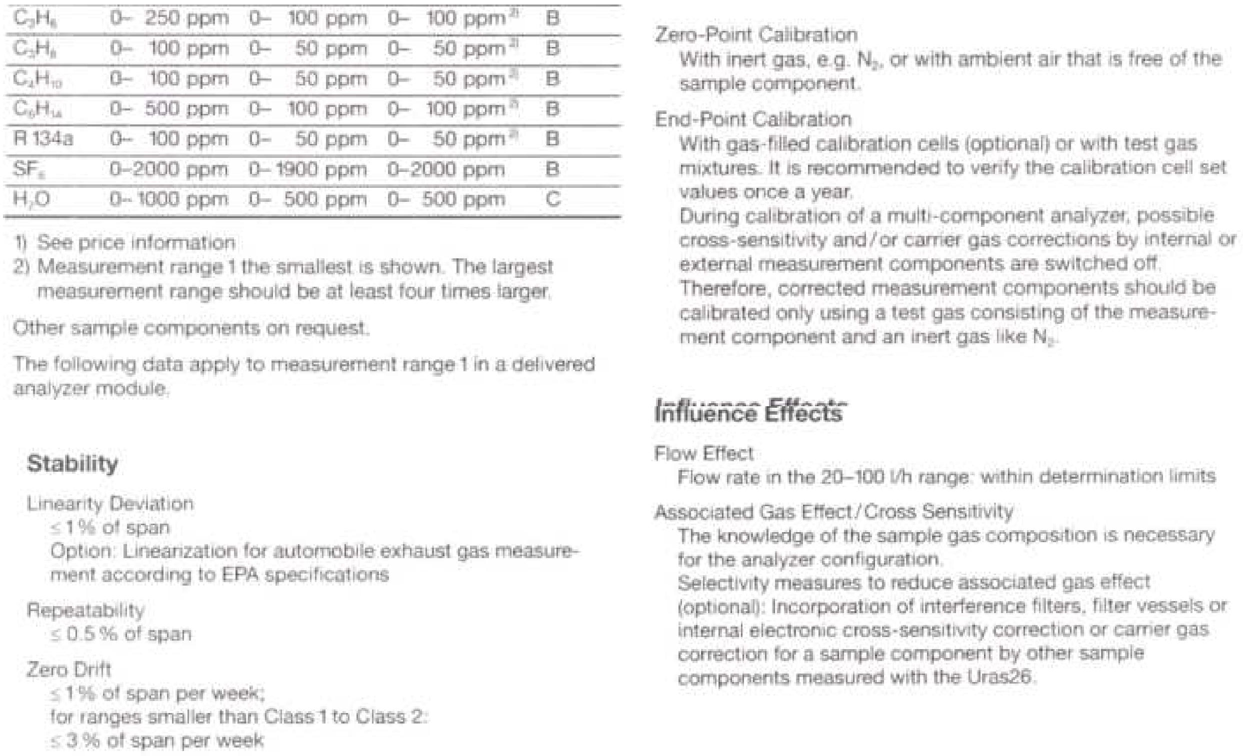
Measurement Range Ratio
≤ 1:20

Measurement Ranges with Suppressed Zero-Point
Electronic zero-point suppression or differential measurement based on a base level > 0 with flowing reference gas.
max. suppression ratio of 1:10

Measurement Range Switching
Manual; available external control or automatic

Limit Value Monitoring
Limit values can be set during system configuration. The limit value signal (alarm) is output via the digital ports.

Calibration



C_3H_6	0– 250 ppm	0– 100 ppm	0– 100 ppm 2)	B
C_3H_8	0– 100 ppm	0– 50 ppm	0– 50 ppm 2)	B
C_4H_{10}	0– 100 ppm	0– 50 ppm	0– 50 ppm 2)	B
C_6H_{14}	0– 500 ppm	0– 100 ppm	0– 100 ppm 2)	B
R 134a	0– 100 ppm	0– 50 ppm	0– 50 ppm 2)	B
SF_6	0–2000 ppm	0–1900 ppm	0–2000 ppm	B
H_2O	0–1000 ppm	0– 500 ppm	0– 500 ppm	C

1) See price information
2) Measurement range 1 the smallest is shown. The largest measurement range should be at least four times larger.

Other sample components on request.

The following data apply to measurement range 1 in a delivered analyzer module.

Stability

Linearity Deviation
$\leq$ 1 % of span
Option: Linearization for automobile exhaust gas measurement according to EPA specifications

Repeatability
$\leq$ 0.5 % of span

Zero Drift
$\leq$ 1 % of span per week;
for ranges smaller than Class 1 to Class 2:
$\leq$ 3 % of span per week

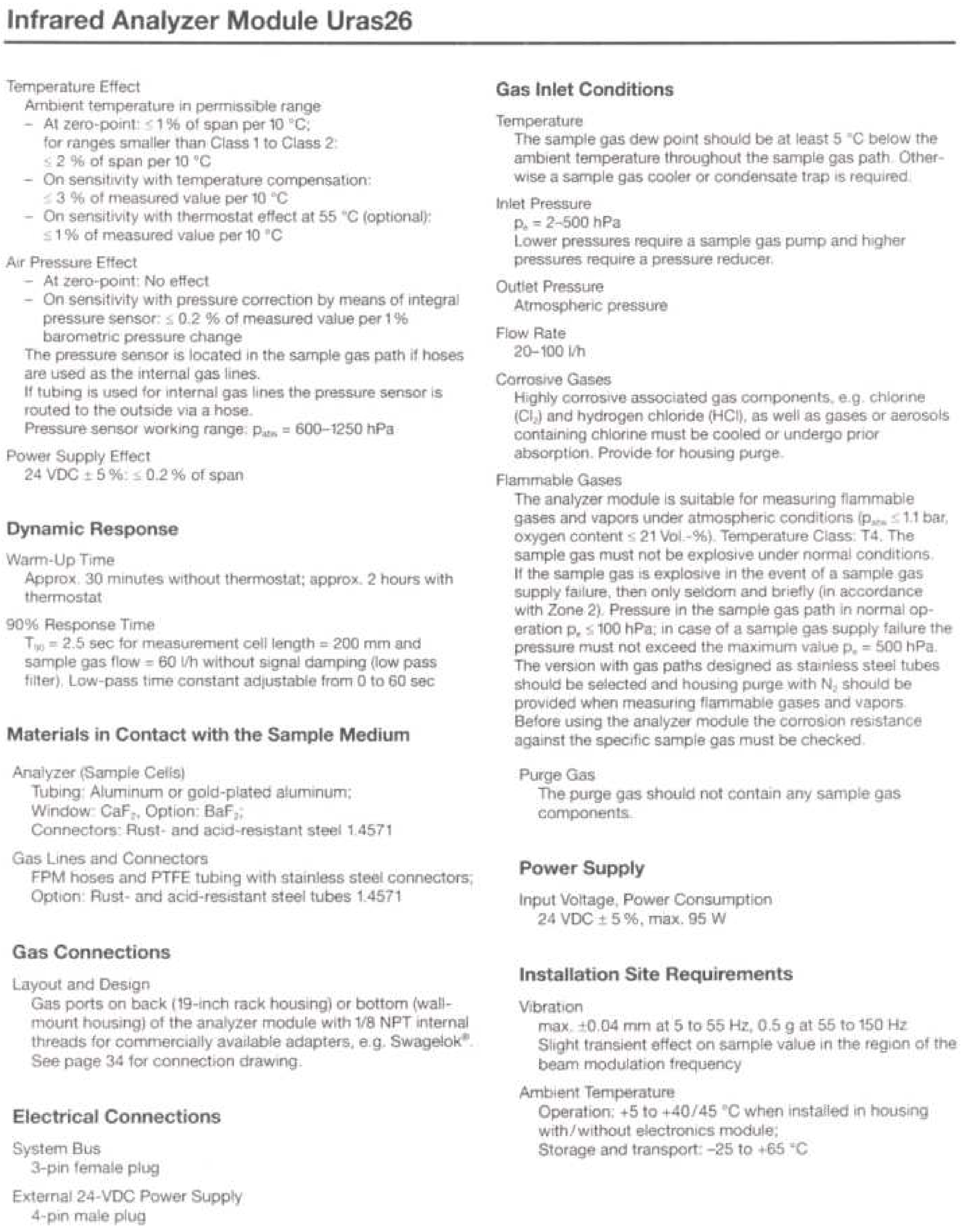
Zero-Point Calibration
With inert gas, e.g. N_2, or with ambient air that is free of the sample component.

End-Point Calibration
With gas-filled calibration cells (optional) or with test gas mixtures. It is recommended to verify the calibration cell set values once a year.
During calibration of a multi-component analyzer, possible cross-sensitivity and/or carrier gas corrections by internal or external measurement components are switched off. Therefore, corrected measurement components should be calibrated only using a test gas consisting of the measurement component and an inert gas like N_2.

Influence Effects

Flow Effect
Flow rate in the 20–100 l/h range: within determination limits

Associated Gas Effect/Cross Sensitivity
The knowledge of the sample gas composition is necessary for the analyzer configuration.
Selectivity measures to reduce associated gas effect (optional): Incorporation of interference filters, filter vessels or internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Uras26.



Infrared Analyzer Module Uras26

Temperature Effect

Ambient temperature in permissible range

- At zero-point: $\leq$ 1 % of span per 10 °C;
  for ranges smaller than Class 1 to Class 2:
  $\leq$ 2 % of span per 10 °C
- On sensitivity with temperature compensation:
  $\leq$ 3 % of measured value per 10 °C
- On sensitivity with thermostat effect at 55 °C (optional):
  $\leq$ 1 % of measured value per 10 °C

Air Pressure Effect

- At zero-point: No effect
- On sensitivity with pressure correction by means of integral pressure sensor: $\leq$ 0.2 % of measured value per 1 % barometric pressure change

The pressure sensor is located in the sample gas path if hoses are used as the internal gas lines.
If tubing is used for internal gas lines the pressure sensor is routed to the outside via a hose.
Pressure sensor working range: p_{abs} = 600–1250 hPa

Power Supply Effect

24 VDC ± 5 %: $\leq$ 0.2 % of span

Dynamic Response

Warm-Up Time

Approx. 30 minutes without thermostat; approx. 2 hours with thermostat

90% Response Time

T_{90} = 2.5 sec for measurement cell length = 200 mm and sample gas flow = 60 l/h without signal damping (low pass filter). Low-pass time constant adjustable from 0 to 60 sec

Materials in Contact with the Sample Medium

Analyzer (Sample Cells)

Tubing: Aluminum or gold-plated aluminum;
Window: CaF_2, Option: BaF_2;
Connectors: Rust- and acid-resistant steel 1.4571

Gas Lines and Connectors

FPM hoses and PTFE tubing with stainless steel connectors;
Option: Rust- and acid-resistant steel tubes 1.4571

Gas Connections

Layout and Design

Gas ports on back (19-inch rack housing) or bottom (wall-mount housing) of the analyzer module with 1/8 NPT internal threads for commercially available adapters, e.g. Swagelok®. See page 34 for connection drawing.

Electrical Connections

System Bus

3-pin female plug

External 24-VDC Power Supply

4-pin male plug

Gas Inlet Conditions

Temperature

The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is required.

Inlet Pressure

p_e = 2–500 hPa
Lower pressures require a sample gas pump and higher pressures require a pressure reducer.

Outlet Pressure

Atmospheric pressure

Flow Rate

20–100 l/h

Corrosive Gases

Highly corrosive associated gas components, e.g. chlorine (Cl_2) and hydrogen chloride (HCl), as well as gases or aerosols containing chlorine must be cooled or undergo prior absorption. Provide for housing purge.

Flammable Gases

The analyzer module is suitable for measuring flammable gases and vapors under atmospheric conditions (p_{abs} $\leq$ 1.1 bar, oxygen content $\leq$ 21 Vol.-%). Temperature Class: T4. The sample gas must not be explosive under normal conditions. If the sample gas is explosive in the event of a sample gas supply failure, then only seldom and briefly (in accordance with Zone 2). Pressure in the sample gas path in normal operation p_e $\leq$ 100 hPa; in case of a sample gas supply failure the pressure must not exceed the maximum value p_e = 500 hPa. The version with gas paths designed as stainless steel tubes should be selected and housing purge with N_2 should be provided when measuring flammable gases and vapors. Before using the analyzer module the corrosion resistance against the specific sample gas must be checked.

Purge Gas

The purge gas should not contain any sample gas components.

Power Supply

Input Voltage, Power Consumption

24 VDC ± 5 %, max. 95 W

Installation Site Requirements

Vibration

max. ±0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz
Slight transient effect on sample value in the region of the beam modulation frequency

Ambient Temperature

Operation: +5 to +40/45 °C when installed in housing with/without electronics module;
Storage and transport: −25 to +65 °C

For flow measurements Cubatão NAP4 has installed a flow meter Digimat, model Sonda 6.

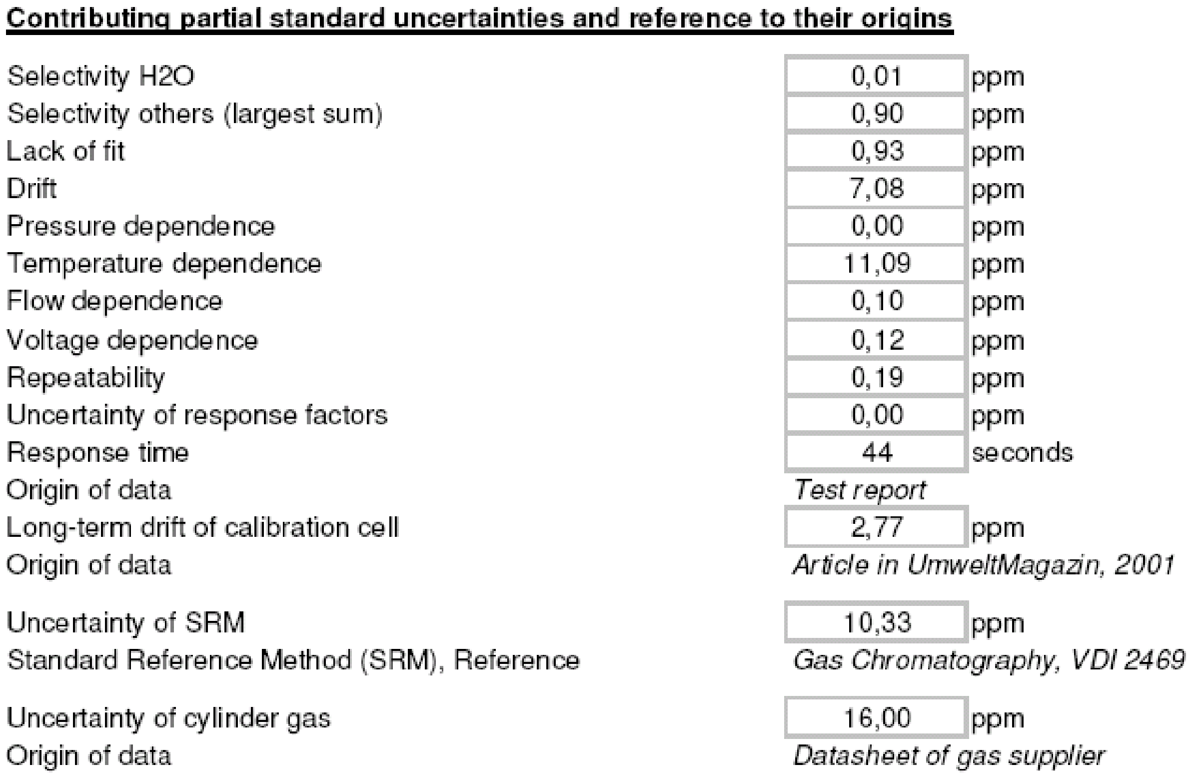
Good monitoring practice and performance characteristics

Regarding QA/QC, the European Norm EN 14181:2004, which is recommended as guidance regarding the selection, installation and operation of the AMS under Monitoring Methodology AM0034, stipulates three levels of Quality Assurance Levels (QAL), and one Annual Surveillance Test (AST):

QAL1: Suitability of the AMS for the specific measuring task.

The suitability evaluation and its measuring procedure are described in ISO 14956:2002 “Air quality – Evaluation of the suitability of a measurement procedure by comparison with a required measuring uncertainty”. Using this standard, it shall be proven that the total uncertainty of the results obtained from the AMS meets the specification for uncertainty stated in the applicable regulations (f.e. EU Directives 2000/76/EU or 2001/80/EU). Since European regulations do not yet cover the measurement of N_2O at nitric acid plants, there is no official specification for uncertainty available. Then, considering official specification of uncertainties defined for equivalent pollutants (f.e. NOx, SO_2) as per EU regulations, a 20% of the ELV (Emission Limit Value, in this case taken as the actual test concentration or calibration gas) has been considered by the equipment manufacturer as the required measurement quality for N_2O, for purpose of expanded uncertainty calculations. The specific performance characteristics of the monitoring system chosen by the project shall be listed in the Project Design Document, as per AM0034. Then, tables below indicate such characteristics as per the corresponding QAL 1 report (extracted from the original QAL1 Report of each instrument)

The QAL1 report for the N_2O Analyser, URAS26, shows the following:



Contributing partial standard uncertainties and reference to their origins

Selectivity H2O	0,01	ppm
Selectivity others (largest sum)	0,90	ppm
Lack of fit	0,93	ppm
Drift	7,08	ppm
Pressure dependence	0,00	ppm
Temperature dependence	11,09	ppm
Flow dependence	0,10	ppm
Voltage dependence	0,12	ppm
Repeatability	0,19	ppm
Uncertainty of response factors	0,00	ppm
Response time	44	seconds
Origin of data	*Test report*	
Long-term drift of calibration cell	2,77	ppm
Origin of data	*Article in UmweltMagazin, 2001*	
Uncertainty of SRM	10,33	ppm
Standard Reference Method (SRM), Reference	*Gas Chromatography, VDI 2469*	
Uncertainty of cylinder gas	16,00	ppm
Origin of data	*Datasheet of gas supplier*	

The QAL1 report for flow meter, Digimat Sonda 6, shows the following:

Table 1 presents average values obtained for draining speeds in the duct and its respective uncertainties

Table 1: Average speeds in the transversal section

Surveyed	Average Speed (m/s)	Specific Mass (kg/m^3)	Expanded Uncertainty (%)
Horizontal	51.3	0.82	2.4
Vertical	49.8	0.82	2.3

Table 2 shows the average values obtained for flow in the duct and its respective uncertainties

Table 2-Average flow in the transversal section

Flow (m^3/s)	Expanded Uncertainty (%)
13.97	2.5

Table 3 shows the value of the discharge coefficient calculated, draining average Reynolds number, and the uncertainty associated with that discharged coefficient.

Discharge coefficient (K)	Reynolds number	Expanded uncertainty (%)
0.715	1,044,900	2.5

The expanded uncertainties declared are based on its standard uncertainties combined, multiplied by the coverage factor K equal to2; considering 95% possibility of coverage approximately

The complete EN 14181: 2004 QAL1 reports are provided by the equipment manufacturers considering the performance characteristics as measured by a qualified Technical Inspection Authority (such as the German TÜV) and the specific installation characteristics and site conditions at the plant.
The complete QAL1 Reports will be available for validation.

The overall measurement uncertainty (*UNC*) is calculated by summing in an appropriate manner (using gauss law of error propagation) all the relevant uncertainties arising from the individual performance characteristics of the AMS components (then UNC = ((N_2O Analyzer uncertainty)^2 + (Flow meter uncertainty)^2)$^{1/2}$). The overall measurement uncertainty will be available for the validation of the project activity.

QAL2: Validation of the AMS following its Installation.

The next level of quality assurance prescribed on EN14181:2004 (QAL2), describes a procedure for the determination of the calibration function and its variability, by means of certain number of parallel measurements (meaning simultaneously with the AMS), performed with a Standard Reference Method (which should be a proven and accurate[10] analytical protocol as per relevant norms or legislation). The variability of the measured values obtained with the AMS is then compared with the uncertainty given by the applicable legislation, if the measured variability is lower than the permitted uncertainty, it is concluded the AMS has passed the variability test. Since (as explained above), official uncertainty is not available, an appropriate level is determined based on those that do exist for similar pollutants and techniques (in this case 20% of ELV). As per international standards, there are two potentially suitable Standard Reference Methods: 1) bench scale gas chromatography as per VDI standard 2469 or 2) Non-dispersive Infrared Method, as per ISO 21258 (draft).

The testing laboratories performing the measurements with the Standard Reference Method shall have an accredited quality assurance system according to EN ISO/IEC 17025 or relevant (national) standards.
QAL2 test was performed during October at Cubatão NAP 4.
The QAL2 report from the certified lab will be available for DOE review during the validation. Any data collected previous to the reception of the QAL2 lab report were corrected through proper application of the calibration function.

As condition precedent for a QAL2 test, it is required that the AMS has been correctly installed and commissioned, considering (for example) that the AMS is readily accessible for regular maintenance and other necessary activities and that the working platform to access the AMS allows for parallel sampling.

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[10] Considering EN 14181 does not specify what SRM to use for each specific compounds, there is controversy as to which method is suitable as SRM for N_2O, since the best available technology (and hence the most accurate instrument) is the actual online instrument which is the subject of calibration by this method.

The AMS unit at Fosfertil Cubatão NAP 4 was installed by qualified contractors under the direct supervision of the equipment manufacturers, considering both relevant Brazilian and international standards. The Plant Manager, as well as members of Fosfertil Technology Engineering Support Group, actively supervised all phases of installation, from system design to commissioning.

QAL3: Ongoing quality assurance during operation.

Procedures described at QAL3 of EN 14181: 2004 check for drift and precision, in order to demonstrate that the AMS is in control during its operations so that it continues to function within the required specification for uncertainty. This is achieved by conducting periodic zero and span checks on the AMS, and evaluating results obtained using control charts.
Zero and span adjustments or maintenance of the AMS may be implemented, as result of such evaluation. The implementation and performance of the QAL3 procedures given in this standard are the responsibility of the plant (or AMS) owner.
The standard deviation according to QAL3 has been calculated by the equipment manufacturer based on equipment performance characteristics and field conditions for Fosfertil Cubatão NAP 4. Calculation spreadsheets from the suppliers are available for validation. The data is used to monitor that the difference between measured values and true values of zero and span reference materials are equal or smaller than the combined drift and precision value of the AMS multiplied by a coverage factor of 2 (2 times standard deviation of AMS, as described in QAL3 section of EN14181) on a weekly basis, with the aid of Shewart charts.
The purpose of the procedure is correcting the data when the off set of zero and span is too high. For instance when the offset (drift) is within 2% of the full scale no action is taken. When the offset (drift) is more than 4% of the full scale the data is corrected linear in the time and the action should be to increase the calibration frequency, i.e. instead of doing it on a weekly basis, it will be made more than once a week.
Documented calibration procedure for weekly zero and span checks as well as resulting Shewart charts will be available on site for validation and future verifications
All monitoring equipment is serviced and maintained according to the manufacturer’s instructions and international standards by qualified personnel (Fosfertil Cubatão NAP 4 resources and the third parties involved during such activities). Maintenance and service logs are well kept at Fosfertil Cubatão NAP 4 and available for auditing purposes.

AST: Annual Surveillance Test (ongoing quality assurance).

The AST is a procedure to evaluate whether the measured values obtained from the AMS still meet the required uncertainty criteria, as evaluated during the QAL2 test. As the QAL2, it also requires a limited number of parallel measurements using an appropriate Standard Reference Method. An AST should be performed to the plant’s AMS at least once every 3 years; its frequency depends on the relation between the total expected uncertainty of the AMS and the selected required uncertainty.

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