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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

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Petrobras FAFEN-BA Nitrous Oxide Abatement Project
Version 3
26 September 2008

A.2. Description of the project activity:

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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 once it is formed inside the ammonia oxidation reactor of FAFEN-BA's[1] Nitric Acid Plant. FAFEN-BA, *Fábrica de Fertilizantes Nitrogenados da Bahia, is a unit of* PETROBRAS and produces nitrogenous fertilisers and raw materials for petrochemical plants. The nameplate capacity of the nitric acid plant is 110 ton 100% HNO3/ day.

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 (kg N_2O/tonnne 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", approved by the CDM Executive Board.

[1] For a complete description of FAFEN-BA please see item A.3 of this PDD.

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 FAFEN-BA's plants.
Petrobras will invest part of the incomes in programs aimed to educate the community in environmental matters.

FAFEN-BA 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:

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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)	PETROBRAS	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.		

FAFEN-BA is a Business Unit of Petrobras, one of the fifteenth largest oil companies in the world today. Petrobras is leader in oil and natural gas production and ranks 15th among the world's oil majors, with 48,558 direct employees. It operates in some countries in North America, South America and Africa. In Brazil, Petrobras has a net of more than 7,200 gas stations, 16,000 km of pipelines all over the country and, as a consequence of its growth; the became self-sufficient in oil in 2006. Over more than four decades the company has become the Country's leader in the distribution of oil products and natural gas; an activity not covered by the Government monopoly, Leading the sector in the development of the most advanced deepwater and ultra-deep water technology for oil production, it was awarded twice by the Offshore Technology Conference prize in 1992 and 2001, the most important award in the sector.

The project activity takes place in Camaçari City, where FAFEN-BA started the production in 1971 with one ammonia plant, one urea plant and utilities, producing nitrogenous fertilizers from the natural gas produced by PETROBRAS in oil fields from Bahia and Sergipe states. The complex was a forerunner to the installation of a petrochemical complex.in Camaçari in 1978 using the industrial structure of gas lines, utilities and maintenance developed by PETROBRAS. In the same year, two new and larger urea and ammonia plants were started up by FAFEN-BA. In 1981 a nitric acid plant was started up and this is the plant where the project activity takes place.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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A.4.1.1. Host Party(ies):

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Brazil

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

>>
Bahia

A.4.1.3. City/Town/Community etc:

>>
Camaçari

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

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The project activity is located at Camaçari Nitric Acid Plant of FAFEN-BA, Rua Eteno, 2198, Bahia, Brazil.
The FAFEN-BA is installed in the industrial center of the city of Camaçari (12 ° 41'52 "S and 38 ° 19'26"W) since 1978. The city is located only 42 km from the capital of the largest Brazilian northeast region.

Figure 1. Location of FAFEN-BA's Plant

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

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

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

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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 the efficiency of the desired reaction (affecting nitric production); then, an optimal point is found between 850-950 °C, affected by other process conditions and catalyst chemical composition (figure 2)[2]. Reactions 2 and 3 are favored by higher pressure and lower temperatures.

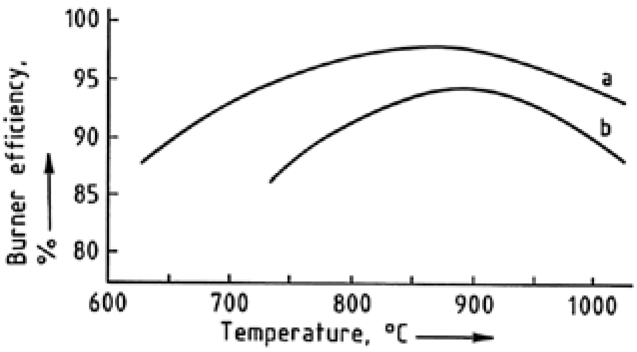

Figure 2. Conversion of Ammonia to Nitrogen Monoxide on Platinum Gauze as a function of temperature a) 100 kPa; (b) 400 kPa [1]

[2] 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.

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

(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 in 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 into N_2 and O_2; 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.

The selected technology has been developed by several catalyst suppliers; f.e. W.C. Heraeus, Johnson Matthey/Yara, Umicore and BASF. All of them have developed a secondary catalyst that decomposes N_2O gases without affecting the Nitric Acid Production either in efficiency or in quality. Typically the secondary catalyst has a very high activity; the suppliers assure at least 80% of conversion efficiency.

FAFEN-BA is going to install a secondary catalyst system (upon successful registration as a CDM project).
The secondary abatement technology has been tested in several industrial trials in which it has been proven to be reliable in reducing N_2O and environmentally safe. Especially, its implementation does not lead to increase NO_X emissions. Neither is the environment directly or indirectly harmed in any other way.

FAFEN-BA will ensure that the chosen N_2O abatement catalyst vendor will take back the catalyst at the end of its useful life and refine, recycle or disposed of it, according to the prevailing EU standards.
Once installed, the catalyst itself and the AMS will be operated by the local FAFEN-BA employees. FAFEN-BA workers will be trained 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 57,366 tonnes CO_2e/year for the first seven-year crediting period, which may be renewed. Note that actual emissions reductions will be based on monitored data and may differ from this estimation.

Year	**Annual estimation of emission reduction in tonnes of CO_2e**
2009[3]	52,586
2010	57,366
2011	57,366
2012	57,366
2013	57,366
2014	57,366
2015	57,366
2016[4]	4,781
Total estimated reductions (tonnes of CO_2e)	**401,562**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	57,366

[3] Year 2009 includes 11 months (from February to December).

[4] Year 2016 includes 1 month, January.

A.4.5. Public funding of the project activity:

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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:

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The selected methodology is AM0034 "Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants" version 03.1. (EB 41)
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 05.2 (EB 39) is used to demonstrate additionality.

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

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The proposed project activity would reduce N_2O emissions from FAFEN-BA Nitric Acid Plant meeting all the conditions specified in the selected approved methodology (AM0034):

- FAFEN-BA plant limits the application of this project activity to existing nitric acid production capacity measured in tons of HNO_3 installed before December, 31st 2005. The plant started its operation on 1982 with a nameplate capacity of 100 ton 100% HNO_3/day. That capacity was increased to 110 ton 100% HNO3/day as result of improvements made before December 2005.
- Currently FAFEN-BA plant doesn't has 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.
- 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.
- FAFEN BA plant doesn't have installed any NOx abatement catalyst system.
- 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

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The project boundary encompasses the physical, geographical site of FAFEN-BA Nitric Acid Plant 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	The main GHG emission of the nitric acid plant.
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	The main GHG emission of the nitric acid plant.
	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	

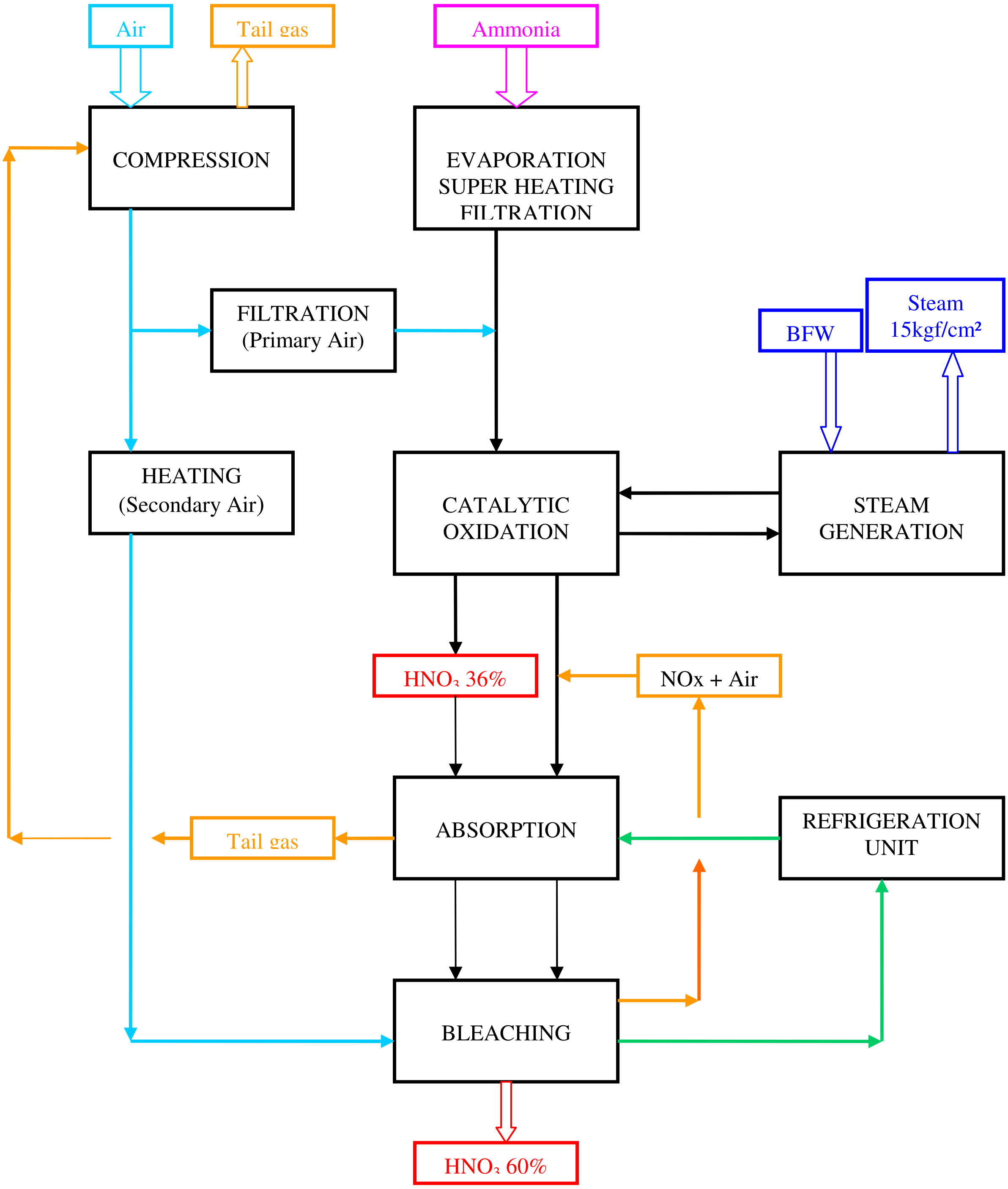

Figure 5. Project boundary

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

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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 03.1. 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:
    - o Recycling N_2O as a feedstock
    - o Use of N_2O for external purposes
- The installation of an N_2O destruction or abatement technology:
    - o Primary approach
    - o Secondary approach
    - o Tertiary approach, including Non Selective Catalytic Reduction (or NSCR De NO_X)[5]
    - o 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)

[5] NSCR: 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.

- 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 neither in Brazil nor in other developing country.

There are no regulations or legal obligations in Brazil concerning NO_X emissions for plants which started its operations before 2006, nevertheless FAFEN-BA Nitric Acid Plant controls their NO_X emissions reducing the temperature and absorbing it as condensed iced acid. 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):

Sub-Step 3a: 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 except of Rhodia Poliamida e Especialidades Ltda, which has installed a secondary catalyst to eliminate N_2O emissions, also as a CDM project.

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

- The continuation of the status quo

There is no barrier that would prevent the implementation of this scenario.

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.

- Primary abatement:

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.

- Tertiary abatement:

Available tertiary approaches are the NSCR (Non Selective Catalytic Reduction) and the EnviNOx® process commercialized by Uhde GmbH (Germany); both systems are not selective towards N_2O abatement, and also actuate over acidic species (NOx). 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).

- Quaternary:

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. To our knowledge no full scale installations that uses such technology is in operation.

- Switch to alternative production method not involving ammonia oxidation process:

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.

- Use of N_2O for external purposes:

The use of N_2O for external purposes is technically not feasible at FAFEN-BA Nitric Acid Plant, as the quantity of gas to be treated is enormous compared to the amount of nitrous oxide that could be recovered. Note that N_2O concentration in the tail gas at FAFEN-BA plant is expected to be in the range of 1,500 ppmv. The use of N_2O for external purposes is practiced neither in Brazil nor anywhere else.

- Recycling N_2O as a feedstock:

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
- Switch to an alternative production method
- 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 other benefits than CDM revenue in order to qualify as valid baselines. Furthermore, tertiary technologies have significant running costs since they consume incremental fuel and/or reducing agents (such as Ammonia) to operate.

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 operational and 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).

Therefore the pre-selected baseline scenario can be adopted as the Baseline Scenario.

The following table resumes the analysis presented above:

Summary of the detected barriers

Baseline Scenario Alternatives	Legal/Technical preclusion	Identified Barriers		
		Investment related	Technical	Common practice related
Continuation of the *status quo*	No	No	No	No
Switch to alternative production method not involving ammonia oxidation process	Yes Technical	No	Yes	Yes
Recycling N_2O as a feedstock	Yes Technical	No	Yes	Yes
Use of N_2O for external purposes	Yes Technical	No	Yes	Yes
Installation of a new Selective Catalytic Reduction (SCR) $DeNO_X$ unit	No	Yes	No	Yes

Baseline Scenario Alternatives	Legal/Technical preclusion	Identified Barriers		
		Investment related	Technical	Common practice related
$DeNO_X$ unit				
Installation of a new Non Selective Catalytic Reduction (NSCR) De NO_X unit	Yes Technical	Yes	Yes	No
Installation of a combined NO_X /N_2O abatement unit (e.g. UHDEs Envinox process)	Yes Technical	Yes	Yes	No
Installation of a new end-of-pipe treatment such as chemical (H_2O_2) scrubbing system	Yes Technical	No	Yes	No
Proposed project activity not implemented as a CDM project.	No	Yes	No	Yes
Proposed CDM project activity	No	No (with CERs revenues)	No	Yes

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

The additionality of the project activity is demonstrated and assessed using the latest 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 FAFEN-BA Nitric Acid Plant.

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.

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) currently installed without incentive of the CDM project (although each producer, like Ultrafertil and Rhodia, is taking steps to do so, within individual CDM projects).

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.

FAFEN-BA 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 at least in an 80% below what they would otherwise be without the catalyst technology installed.

The proposed CDM project activity is undoubtedly additional, since it passes all the selected steps of the "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 registration of the project activity as a CDM Project and corresponding CER revenues are the single source of project revenues. CDM registration is therefore the decisive factor for the realization of the proposed project activity.

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 FAFEN BA is willing to finance the project activity under the condition of the registration of the project activity.

B.6. Emission reductions:

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B.6.1. Explanation of methodological choices:

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FAFEN-BA Nitrous Oxide 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

Thus, baseline emissions are calculated from an emission factor measured before the implementation of the project activity, considering that it is physically very difficult to measure N_2O concentration upstream and downstream of the abatement system accurately.

Then, baseline will be determined by measuring N_2O baseline emission factor (kg 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 monitoring and compared to limits or ranges called "Normal operating conditions".

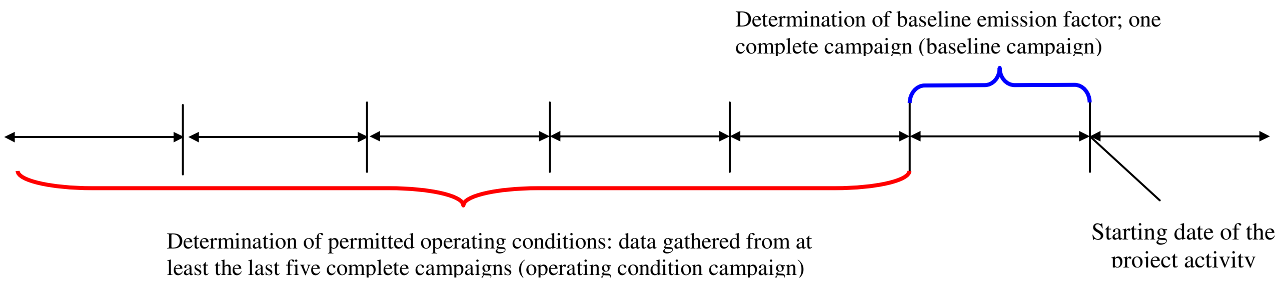
Normal operating conditions are defined based on plant historical operating conditions, and or plant design data. A range or maximum value for any given parameter has been established considering specific control capabilities of FAFEN BA plant. In order to properly characterize baseline emission rates, 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.

FAFEN-BA was planning to start their initial campaign for baseline emission factor determination in May 2008, but the date has been postponed due to delays on deliveries of equipment and materials needed for the AMS installation. Baseline campaign will start in October 2008.
The emissions factor determined from such measurements will be presented for crediting of emission reductions.

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

The "permitted range" for oxidation temperature and pressure is determined using historical data for the operating range of temperature and pressure from the previous five campaigns.

Then, the permitted range is determined through a statistical analysis of the historical data in which the time series data is to be interpreted as a sample for a stochastic variable. All data that falls within the upper and lower 2.5% percentiles of the sample distribution is defined as abnormal and shall be eliminated. The permitted range of operating temperature and pressure is then assigned as the historical minimum (value of parameter below which 2.5% of the observation lie) and maximum operating conditions (value of parameter exceeded by 2.5% of observations).

Statistical analysis of historical data, to define "permitted 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 are determined using historical data of ammonia flow rate and ammonia flow to air flow ratio from the previous five campaigns.

Historical data and its analysis will be available during 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 automatically eliminated from the output data series by the monitoring system.

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}	Total operating hours of the baseline campaign, 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.

The overall measurement uncertainty of the monitoring system shall also be determined and the measurement error will be expressed as a percentage (*UNC*). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) shall then be reduced by the estimated percentage error as follows:

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

where:

EF_{BL}	Baseline emission factor, in $tN_2O/ tHNO_3$
NAP_{BC}	Total 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 the nitric acid plant (Bahia), 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 that were 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 automatically eliminated from the output data series by the monitoring system. 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:

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

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

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

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

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

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 emissions reduction of the project activity, *ER*, expressed in tonnes of CO_2 equivalent per year (tCO_2e/yr), is 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 (IPCC default value)

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 should be available for the validation process of the project activity.[6]

[6] By nameplate (design) implies the total yearly capacity (considering 365 days of operation per year) as per the documentation of

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

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:	Calculated from historical process data.
Value applied:	866 ºC- 894 ºC
Justification of the choice of data or description of measurement methods and procedures actually applied :	FAFEN-BA Plant has completed historical registers for oxidation temperature; then, historical data is used to determine normal oxidation temperature.
Any comment:	This information will be available in electronic records and paper for at least 2 years.

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:	Calculated from historical process data.
Value applied:	500,000 Pa – 520,000 Pa
Justification of the choice of data or description of measurement methods and procedures actually applied :	FAFEN-BA Plant has completed historical registers for oxidation pressure; then, historical data is used to determine normal oxidation pressure.
Any comment:	This information will be available in electronic records and paper for at least 2 years.

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:	Calculated from historical process data
Value applied:	1,384 kg NH_3/hour
Justification of the choice of data or	FAFEN-BA Plant has completed historical registers of ammonia gas flow rate; then, historical data is used to determine maximum ammonia flow rate.

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.).

description of measurement methods and procedures actually applied :	
Any comment:	This information will be available in electronic records and paper for at least 2 years.

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:	Calculated from historical process data
Value applied:	0.0782 kg NH_3/kg air
Justification of the choice of data or description of measurement methods and procedures actually applied :	FAFEN-BA Plant has completed historical registers of ammonia gas flow rate and air flow rate; then, historical data is used to determine maximum ammonia to air flow rate.
Any comment:	This information will be available in electronic records and paper for at least 2 years.

Data / Parameter:	**Normal Campaign Length, CL_{normal}**
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.
Source of data used:	Calculated from historical process data.
Value applied:	11,990 ton 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.
Any comment:	None

Data / Parameter:	**Normal Gauze Supplier, GS_{normal}**
Data unit:	Company name
Description:	Gauze supplier for the operation condition campaigns (the previous five campaigns).
Source of data used:	From historical process data.
Value applied:	Umicore
Justification of the choice of data or	Umicore supplies primary catalyst package to Fafen BA on a contract basis for commercial/economic reasons.

description of measurement methods and procedures actually applied :	
Any comment:	The information will be stored in electronic records and paper for the crediting period.

Data / Parameter:	**Normal Gauze Composition, GC_{normal}**
Data unit:	%
Description:	FAFEN-BA Nitric Acid Plant uses primary gauzes that have knitted structure.
Source of data used:	From historical process data.
Value applied:	Pt (95%), Rh (5%)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Current gauze composition delivers acceptable performance.
Any comment:	The information will be stored in electronic records and paper for the crediting period.

B.6.3 Ex-ante calculation of emission reductions:

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For completing this PDD with the estimation of emission reductions the following assumptions are used:

- Nitric acid production is assumed to be constant, so that nitric acid production do not vary from year to year
- An N_2O emission factor from IPCC (7 kg N_2O / ton HNO_3, according to the operating pressure of the plant), affected by the uncertainty of the monitoring system, is used to estimate baseline emissions
- Catalyst suppliers typically assure, at least, 80% of abatement efficiency. In order to present estimative values in this PDD, we consider project emission factor to be equal to the 20% of baseline emission factor ($EF_P = 0.20 * EF_{BL}$)

Then, *ex-ante* estimations of emission reduction are determined using the following formula:

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

$$EF_{BL} = \frac{BE_{BC}}{NAP_{BC}}\left(1 - \frac{UNC}{100}\right) \qquad \text{(Eq. 9)}$$

$$EF_{BL} = 0.00700 \cdot \left(1 - \frac{2.01}{100}\right) = 0.00686\, ton N_2O / ton HNO_3 \qquad \text{(Eq.10)}$$

Using equations 10 and 9 BE_{BC} value can be calculated.

$$BE_{BC} = 0.00686 * 11{,}990 = 82.24\, tN_2O \qquad \text{(Eq.11)}$$

$$VSC_{BC} \cdot NCSG_{BC} \cdot 10^{-9} = 82.24 / 2{,}616 = 0.0314\, tN_2O / h \qquad \text{(Eq.12)}$$

$$PE_n = VSG \cdot NCSG \cdot 10^{-9} \cdot OH \qquad \text{(Eq.13)}$$

$$PE_n = 0.0314 \cdot 0.2 \cdot 3{,}240 = 20.372\, tN_2O \qquad \text{(Eq.14)}$$

$$EF_p = \frac{PE_n}{NAP_n} \qquad \text{(Eq.15)}$$

$$EF_p = \frac{20.372}{14{,}850} = 0.00137\, tN_2O / tHNO_3 \qquad \text{(Eq.16)}$$

$$ER_n = (EF_{BC} - EF_p) \cdot NAP \cdot GWP_{N_2O} \qquad \text{(Eq.17)}$$

$$ER_n = (0.00700 - 0.00137) \cdot 33{,}723 \cdot 310 = 57{,}366\, tonCO_2e / year \qquad \text{(Eq.18)}$$

Where

BE_{BC}	Total emissions during baseline campaign, in, tN_2O
VSG_{BC}	Mean stack gas volume flow rate during baseline campaign, in Nm^3/h
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during baseline campaign, in mg N_2O/Nm^3
OH_{BC}	Number of operating hours during baseline campaign, 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 monitoring system, %
PE_n	N_2O emission for the project campaign, tN_2O
VSG	Mean stack gas volume flow rate for the project campaign, in Nm^3/h
$NCSG$	Mean concentration of N_2O in the stack gas for the project campaign, in mg N_2O/Nm^3
OH	Number of operating hours in the project campaign, in h
EF_p	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	FAFEN-BA Plant
EF_{BL}, $t\ N_2O\ /t\ HNO_3$	0.00686
NAP_{BC} $t\ HNO_3$	11,990
UNC, %	2.01
$OH_{BC,}$,*h*	2,616
OH,h	3,240
NAP_n	14,850
NAP, $t\ HNO_3/yr$	33,723
GWP_{N_2O} tCO_2e/tN_2O	310

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:

Year	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)
2009[7]	13,147	65,732	-	52,586
2010	14,342	71,708	-	57,366
2011	14,342	71,708	-	57,366
2012	14,342	71,708	-	57,366
2013	14,342	71,708	-	57,366
2014	14,342	71,708	-	57,366
2015	14,342	71,708	-	57,366
2016[8]	1,195	5,976	-	4,781
Total (tonnes of CO_2e)	**100,394**	**501,956**	**-**	**401,562**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**Volume Flow Rate of the Stack Gas, VSG_{BC}**
Data unit:	m^3/hour
Description:	Volume flow rate of the stack gas, expressed in normal conditions
Source of data to be used:	AMS (Flow meter) at FAFEN-BA plant.
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 to be measured by ANNUBAR. Automatic acquisition of actual stack pressure and temperature will also be considered in order to normalize output data.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN14181). Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.

[7] Year 2009 includes 11 months (from February to December).

[8] Year 2016 includes 1 month, January.

Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds. The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Baseline Temperature of the Stack Gas, TSG**
Data unit:	ºC
Description:	Temperature of the gas in the stack gas
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:	The ANNUBAR device measures temperature and pressure and send the signal to the Data Acquisition System (DAS).
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN14181). 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. The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Baseline Pressure of the Stack Gas, PSG**
Data unit:	Pa
Description:	Pressure in the stack gas
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:	The ANNUBAR device measures temperature and pressure and send the signal to the Data Acquisition System (DAS).
QA/QC procedures to be	Regular calibrations according to vendor specifications and recognised industry

be applied:	industry standards (EN14181). Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.
Any comment:	Recorded every two seconds. The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Baseline N_2O Concentration in the Stack Gas, $NCSG_{BC}$**
Data unit:	mg N_2O/ m^3 at normal conditions (101.325 kPa, 0 deg C).(converted from ppm if necessary)
Description:	N_2O concentration in the stack gas at normal conditions.
Source of data to be used:	AMS (Infrared gas analyzer) at FAFEN-BA plant.
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:	N_2O concentration to be measured by on-line analyzer (Non Dispersive Infra Red principle or equivalent). A gas stream will be continuously drawn from the stack by the sampling system under proper conditions and conveyed to the infrared (or equivalent) cell. The device will be set up to measure concentration and record the output electronically at periodic time intervals
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN14181). 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. The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Baseline Operating Hours, OH_{BC}**
Data unit:	hours
Description:	Operating hours.
Source of data to be used:	Process control system of FAFEN-BA plant. For the purpose of estimating emission reductions an estimated number of hours was used, it was obtained dividing the normal campaign length with the daily capacity of 110 ton 100% HNO_3/day and considering 24 operating hours per day.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2616 hours
Description of	The Data Acquisition System will record plant effective operating hours by

measurement methods and procedures to be applied:	monitoring the time when ammonia flow signals (coming from the devices installed to measure flow of the parameters) reach their normal operational level, 700 kg/h. Values of ammonia flow below 700 kg/h indicate the plant is off-line.
QA/QC procedures to be applied:	Operating up time of the plant will be cross check against production logbook data. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant.
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Daily recorded, compiled for entire campaign The information will be stored in electronic records and paper for the entire crediting period

Data / Parameter:	**Uncertainty of the monitoring system, UNC**
Data unit:	%
Description:	Overall measurement uncertainty of the monitoring system.
Source of data to be used:	QAL1 supplied by the equipment manufacturer. For future calculations the uncertainty obtained from QAL2 test will be used. The mentioned value has to be verified by the verifying DOE.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2.01 %
Description of measurement methods and procedures to be applied:	The overall uncertainty was calculated as the combined uncertainty of the flow Meter, the uncertainty of the N_2O concentration measurements, and the uncertainty of the nitric acid flow measurement, using the law of propagation of uncertainty.
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	Calculated once after monitoring system is commissioned. The information will be stored in electronic and paper for the duration of the project activity.

Data / Parameter:	**Nitric Acid Over Baseline Campaign, NAP_{BC}**
Data unit:	ton 100% HNO_3
Description:	Nitric acid (100% concentrated) over baseline campaign
Source of data to be used:	Process control system of FAFEN-BA plant.
Value of data applied for the purpose of calculating expected emission reductions in	11,990 ton 100% HNO_3.

section B.5	
Description of measurement methods and procedures to be applied:	Daily production will be measured by using an accurate mass flow meter (Coriolis principle), and correcting by the average of several concentration checkups performed in analytical lab. Nitric acid concentration is measured following the procedure number PE-4AF-00069 – "Acidez total ácido nítrico diluido e concentrado", available at Petrobras Quality Assurance System (SINPEP).
QA/QC procedures to be applied:	Cross checking of production measured by mass balance vs direct flow measurement is performed routinely. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant.
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Daily recorded, compiled for entire campaign The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Baseline Emission Factor, EF_{BL}**
Data unit:	ton N_2O / ton 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	An N_2O emission factor from IPCC (0.007 ton N_2O / ton HNO_3, according to the operating pressure of the plant), affected by the uncertainty of the monitoring system, is used to estimate baseline emissions. Therefore, the value used in the estimations is: 0.00686 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:	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 after baseline campaign.

Data / Parameter:	**Oxidation Temperature for each hour, OT_h**
Data unit:	ºC
Description:	Oxidation temperature for each hour
Source of data to be	Process control system of FAFEN-BA plant.

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:	Reactor temperature is measured by a thermocouple installed through the reactor wall, near the oxidation catalyst; the signal from such device is acquired by the Data Acquisition System (DAS) and stored electronically at a given time interval.
QA/QC procedures to be applied:	New thermocouples are installed on a routine basis when required (off or open signal – meaning the unit is broken).
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. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	**Oxidation Pressure for each hour, OP_h**
Data unit:	Bar
Description:	Oxidation pressure for each hour
Source of data to be used:	Process control system of FAFEN-BA plant.
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:	Oxidation pressure is tracked by an electronic pressure transducer located at the reactor's pipe inlet. The signal is acquired by the Data Acquisition System (DAS) 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.
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. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	**Ammonia Gas Flow Rate, AFR**
Data unit:	kg NH_3/hour
Description:	Ammonia gas flow rate to the ammonia oxidation reactor.

Source of data to be used:	Process control system of FAFEN-BA plant.
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:	Ammonia flow to oxidation reactor is tracked by a mass flow measuring device (orifice plate principle); the signal from the transmitter device is acquired by the Data Acquisition System (DAS) 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.
Any comment:	Monitored during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation. Monitored continuously. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	**Ammonia to Air Ratio, AIFR**
Data unit:	kg NH_3/hour
Description:	Ammonia to air ratio
Source of data to be used:	Process control system of FAFEN-BA plant.
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:	Air flow to oxidation reactor is tracked by mass flow measuring device (Venturi principle); the signal from the transmitter device is acquired by the Data Acquisition System (DAS) 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:	Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant.
Any comment:	Monitored during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation. Recorded every hour. The information will be stored in electronic records and paper for at least 2 years.

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:	Process control system of FAFEN-BA plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The normal campaign length has been set as 11,990 ton 100% HNO_3. If baseline campaign length is lower than normal (CL_{Normal}), all N2O values measured during the baseline campaign can be used for the baseline emission factor calculation
Description of measurement methods and procedures to be applied:	Daily production will be measured by using an accurate mass flow meter (Coriolis principle), and correcting by the average of several concentration checkups performed in analytical lab. Nitric acid concentration is measured following the procedure number PE-4AF-00069 – "Acidez total ácido nítrico diluido e concentrado", available at Petrobras Quality Assurance System (SINPEP).
QA/QC procedures to be applied:	Cross checking of production measured by mass balance vs direct flow measurement is performed routinely on both plants. Critical instruments are calibrated on a routine basis according to the quality assurance system of the plant.
Any comment:	Calculated after the end of each campaign. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	**Baseline Gauze Supplier, GS_L**
Data unit:	ton 100% HNO_3
Description:	Gauze supplier for the baseline campaign
Source of data to be used:	Procurement offices of FAFEN-BA Nitric Acid Plant
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:	Cover of supply contract or bill for gauzes for baseline campaign, or equivalent document to prove commercial transaction.
QA/QC procedures to be applied:	None

Any comment:	Recording once. The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Baseline Gauze Composition, GC_{BL}**
Data unit:	%
Description:	Gauze composition during the baseline 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 (95%) Rd (5%)
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. The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Project Volume Flow in the Stack Gas, VSG**
Data unit:	m^3 / hour
Description:	Volume flow rate in the stack gas for the project campaign, expressed in normal conditions.
Source of data to be used:	AMS (Flow meter) of the monitoring system of FAFEN-BA plant.
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 to be measured by ANNUBAR. Automatic acquisition of actual stack pressure and temperature will also be considered in order to normalize output data.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN14181). 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. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	Project Temperature of the Stack Gas, TSG
Data unit:	ºC
Description:	Temperature of the stack gas
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:	The ANNUBAR device measures temperature and pressure and send the signal to the Data Acquisition System (DAS).
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN14181). 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. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	Project Pressure of the Stack Gas, PSG
Data unit:	Pa
Description:	Pressure of stack gas
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:	The ANNUBAR device measures temperature and pressure and send the signal to the Data Acquisition System (DAS).
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN14181). 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. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	Project N_2O Concentration in the Stack Gas, NCSG

Data unit:	mg N_2O/ m^3 at normal conditions (101.325 kPa, 0 deg C). (converted from ppm if necessary)
Description:	N_2O concentration in the stack gas
Source of data to be used:	AMS (Infrared gas analyzer) of the monitoring system of FAFEN-BA plant.
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:	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 (EN14181). 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. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	**Project Operating Hours, OH**
Data unit:	Hours
Description:	Operating hours
Source of data to be used:	Process control system of FAFEN-BA plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,240 hours
Description of measurement methods and procedures to be applied:	The Data Acquisition System will record plant effective operating hours by monitoring the time when ammonia flow signals (coming from the devices installed to measure flow of the parameters) reach their normal operational level, 700kg/h. Values of ammonia flow below 700 kg/h indicate the plant is off-line.
QA/QC procedures to be applied:	Operating up time of the plant will be cross check against production logbook data. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant.
Any comment:	Measured during the complete lifetime of the project activity. Daily recorded, compiled for entire campaign. The information will be stored in electronic records and paper for at least 2 years.

Data / Parameter:	Project Nitric Acid Production, NAP
Data unit:	ton 100% HNO_3
Description:	Nitric acid production (100% concentrate)
Source of data to be used:	Process control system of FAFEN-BA plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	14,850 ton 100% HNO_3.
Description of measurement methods and procedures to be applied:	Daily production will be measured by using an accurate mass flow meter (Coriolis principle), and correcting by the average of several concentration checkups performed in analytical lab. Nitric acid concentration is measured following the procedure number PE-4AF-00069 – "Acidez total ácido nítrico diluido e concentrado", available at Petrobras Quality Assurance System (SINPEP).
QA/QC procedures to be applied:	Cross checking of production measured by mass balance vs direct flow measurement is performed routinely. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant.
Any comment:	Measured during the complete lifetime of the project activity. Daily recorded, compiled for entire campaign. The information will be stored in electronic records and paper for at least 2 years.

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	0.00137 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, 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 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:	Process control system of FAFEN-BA plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The normal campaign length has been set as 11,990 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 an accurate mass flow meter (Coriolis principle), and correcting by the average of several concentration checkups performed in analytical lab. Nitric acid concentration is measured following the procedure number PE-4AF-00069 – "Acidez total ácido nítrico diluido e concentrado", available at Petrobras Quality Assurance System (SINPEP).
QA/QC procedures to be applied:	Cross checking of production measured by mass balance vs direct flow measurement is performed routinely. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant.
Any comment:	Calculated once at the end of the project campaign. The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Project Gauze Supplier, $GS_{project}$**
Data unit:	Company name
Description:	Gauze supplier for project campaigns
Source of data to be used:	Procurement office of FAFEN-BA Nitric Acid Plant.
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:	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. The information will be stored in electronic records and paper for the entire crediting period.

Data / Parameter:	**Project Gauze Composition,, $GC_{project}$**
Data unit:	%
Description:	Gauze composition for project campaigns
Source of data to be used:	Procurement office of FAFEN-BA Nitric Acid Plant
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:	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. The information will be stored in electronic records and paper for the entire crediting period.

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:	Petrobras has a SMSNet system that verifies changes in the Brazilian Legislation.
QA/QC procedures to be applied:	None
Any comment:	None

Data / Parameter:	**Moving average emission factor, $EF_{ma,n}$**
Data unit:	ton 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:	ton 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

Data / Parameter:	**Emission factor used to determine emission reductions, EF_p**
Data unit:	ton N_2O / ton 100% HNO_3
Description:	Emission factor used to calculate the emission from the particular campaign
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	0.00137 ton N_2O / ton 100% HNO_3
Description of	Calculated using campaign emission factors. EF_p will be determined as the

measurement methods and procedures to be applied:	higher of $EF_{mn,a}$ and EF_n.
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	Determined from campaign emission factors. Calculated after the end of each project campaign.

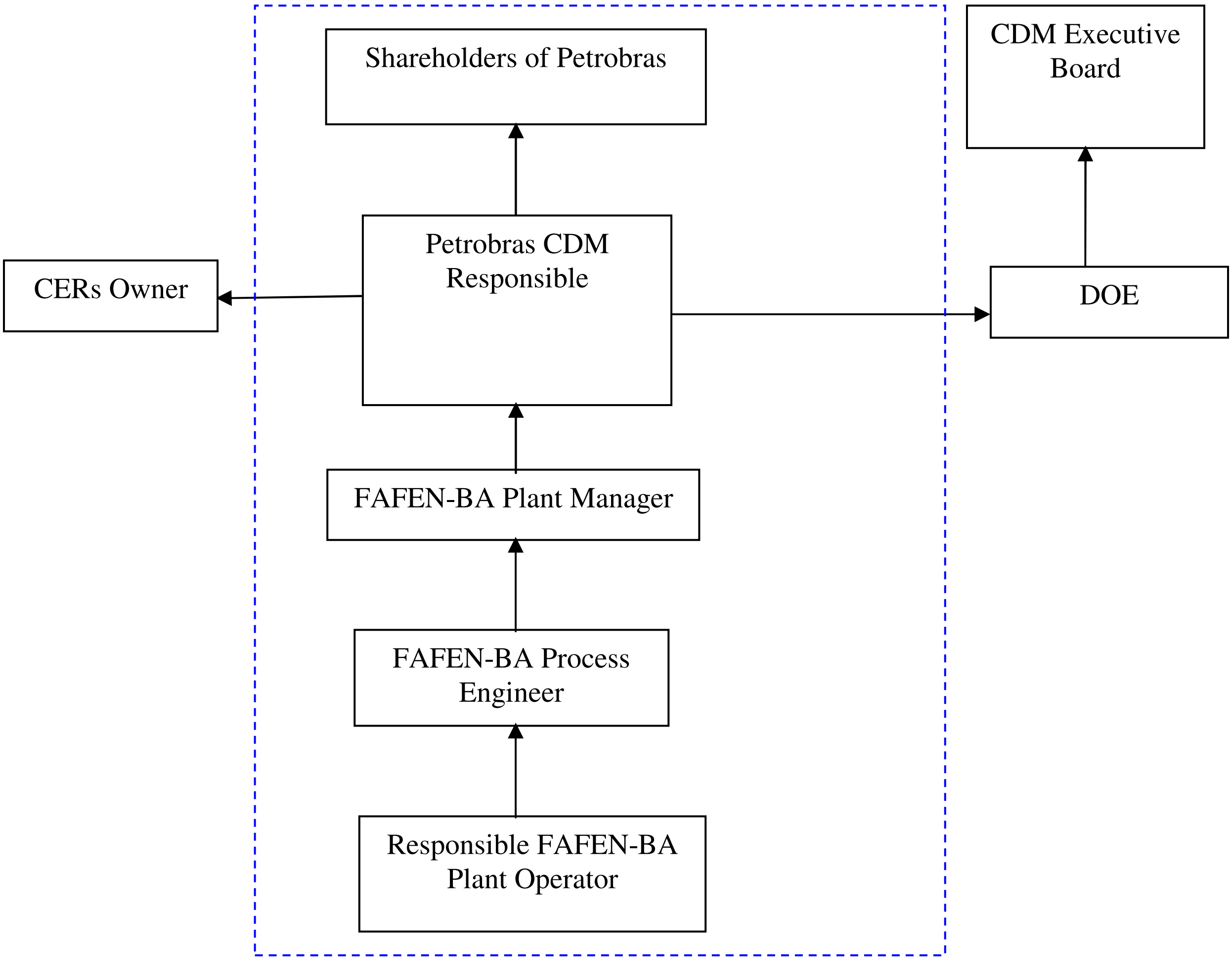
B.7.2 Description of the monitoring plan:

FAFEN-BA Nitric Acid Plant is operated by a centralized automated control system, so staff is qualified and experienced at operating technical equipment to a high level of quality standards.

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).

The proposed CDM project will be closely monitored, metered and recorded. The management and operation of the proposed nitrous oxide abatement project at the plant will be the responsibility of the plant. The emission reductions will be 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 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 FAFEN-BA Process Engineer.

- The FAFEN-BA Process Engineer is in charge of programming all formulae in the spreadsheets which are used. The Plant Operations Technician processes the data, checks the data for consistency, validates them, and records them every day as an electronic file. In case of failure of an instrument, or non-consistency of the data, he adjusts the data according to a procedure that will be written during the project implementation. In case the failure is not covered by the procedure, the FAFEN-BA Process Engineer makes the decision to correct the figures or to abandon the data. FAFEN-BA Process Engineer is responsible for archiving the data. Once validated, the data are input in an electronic folder and protected against any modification. A backup of all the data is made every day on the plant server. Both original document and the backup file are kept for the project crediting period.

- FAFEN-BA Plant Manager will be responsible to ensure that the CDM project activity at plant level is implemented in compliance with this PDD and other relevant standards.

- The Petrobras CDM Responsible will send a report which will basically be the monitoring plan spreadsheet to the CERs owner, as well as to the corresponding DOE. The Petrobras CDM Responsible is responsible for the declaration of the Emission Reductions, at a frequency to be fixed later in the project implementation.

- The calculation of the Emission Reductions is done after each campaign by the FAFEN-BA Process Engineer, based on the campaign data, and validated by the Plant Manager.

- 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 Petrobras will receive from the Petrobras CDM Responsible, the same report sent to the DOE.

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)

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Date of completion of the application of this baseline and monitoring methodology to this project activity is: 18/02/2008 (reported here). Emissions factors, determined from measurements, would be used for actual emission reductions determination.

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:

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23/11/2007, This is the date when Petrobras signed the contract with ABB, supplier of the AMS.

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:

>>
1/02/2009
The start of the crediting period is the latest date of either registration or the date of the completion of a baseline campaign, which is signed-off by the verifying DOE during the first periodic verification

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

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

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FAFEN-BA Nitrous Oxide Abatement Project 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. FAFEN-BA nitric acid plant is in compliance with the Atmospheric Emission Regulation as indicated in the environmental licence (Licença Ambiental)**.**

Moreover, the project was submitted to internal evaluation in accordance with Petrobras's norm "Sistema de Gestão de Mudanças – PE-2AT-00027" that automatically evaluates the potential environmental impacts of each new project. The evaluation revealed that an EIA was not necessary for the project implementation.

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:

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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

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

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This process was conducted according to the rules stated in Resolution number 1 of the CIMGC, which is the Brazilian DNA, DNA because it was carried out at the end of 2007 and its validation started on March 8th. 2008, before this Resolution, was superseded by the resolution 7 which was published on March 31st. 2008.

The "Petrobras FAFEN-BA Nitrous Oxide Abatement Project" local Stakeholder consultation process was carried out as described below.

The invitation letters were sent to the main stakeholders on November 26th and 27th. 2007. The letters communicated FAFEN-BA'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. The letters were addressed to the main representatives of the below mentioned entities and the acknowledgements of receipt are available upon request and for validation purposes:

- Camaçari City Hall
- Public Ministry of Bahia State.
- Secretary of Planning, Urban design, Environment and Management development of Municipality of Camaçari- SEPLAN.
- Municipal Chamber of Camaçari

- Common Advisory Council of Industrial Centre of Camaçari.
- Centre of environmental resources- CRA
- Chemical and tankers Syndicate of Bahia
- Committee of Industrial development of Camaçari-COFIC
- Superintendence of IBAMA at Salvador- BA.
- Social environment Organization "Jogue Limpo".
- Brazilian Forum of NGO and social movements for environment and development (FBOMS).

E.2. Summary of the comments received:

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Comments from two Stakeholders were received. Stakeholders who gave their opinion are: COFIC and FBOMS.

COFIC gave support to the project, stating that the project contributes to social and economical development of the region by the prevision of investment on environmental education and environmental training. COFIC also commented that the project will contribute helping the environment by means of GHG emission reductions.

FBOMS sent a letter to Petrobras dated 18 of December of 2007 with the following points:

- Confirmation of the act of receiving the PDD and the letter of request of commentaries;
- Description of FBOMS expectations on its role in the evaluation of the PDD and its relationship with the Brazilian DNA;
- Suggestion for the project participants to adopt criteria of sustainability evaluation such as the "Standard Golden";

FBOMS did not supply an analysis of the project activity, despite they declared their intention to do it. They also observed that lack of their technical analysis in the given stated period (30 days) did not imply their approval.

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

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FAFEN- BA answered to FBOMS sending a letter thanking them for the comments and stating that FAFEN agrees with their opinion.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	PETROBRAS
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funds are available for the financing of the project activity. Therefore, Petrobras 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)	33,723
N_2O baseline emission factor (kg N_2O / ton 100% HNO_3)	7
Expected N_2O destruction factor (%) provided by the technology supplier	80
Operating days	320

Annex 4

MONITORING INFORMATION

The current CDM project "Nitrous Oxide Abatement Project at FAFEN-BA" 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".

The monitoring procedures (deployed as per the current monitoring plan and being an integral part of it), will be fully integrated into Petrobras's Quality Management System.

Before beginning the baseline campaign all the people involved in the operation and maintenance of the AMS will be trained to deal with the new technology installed as consequence of the project activity. Those trainings will be developed according to Petrobras's Quality Management System; registers of those trainings will be available on site for future audits.

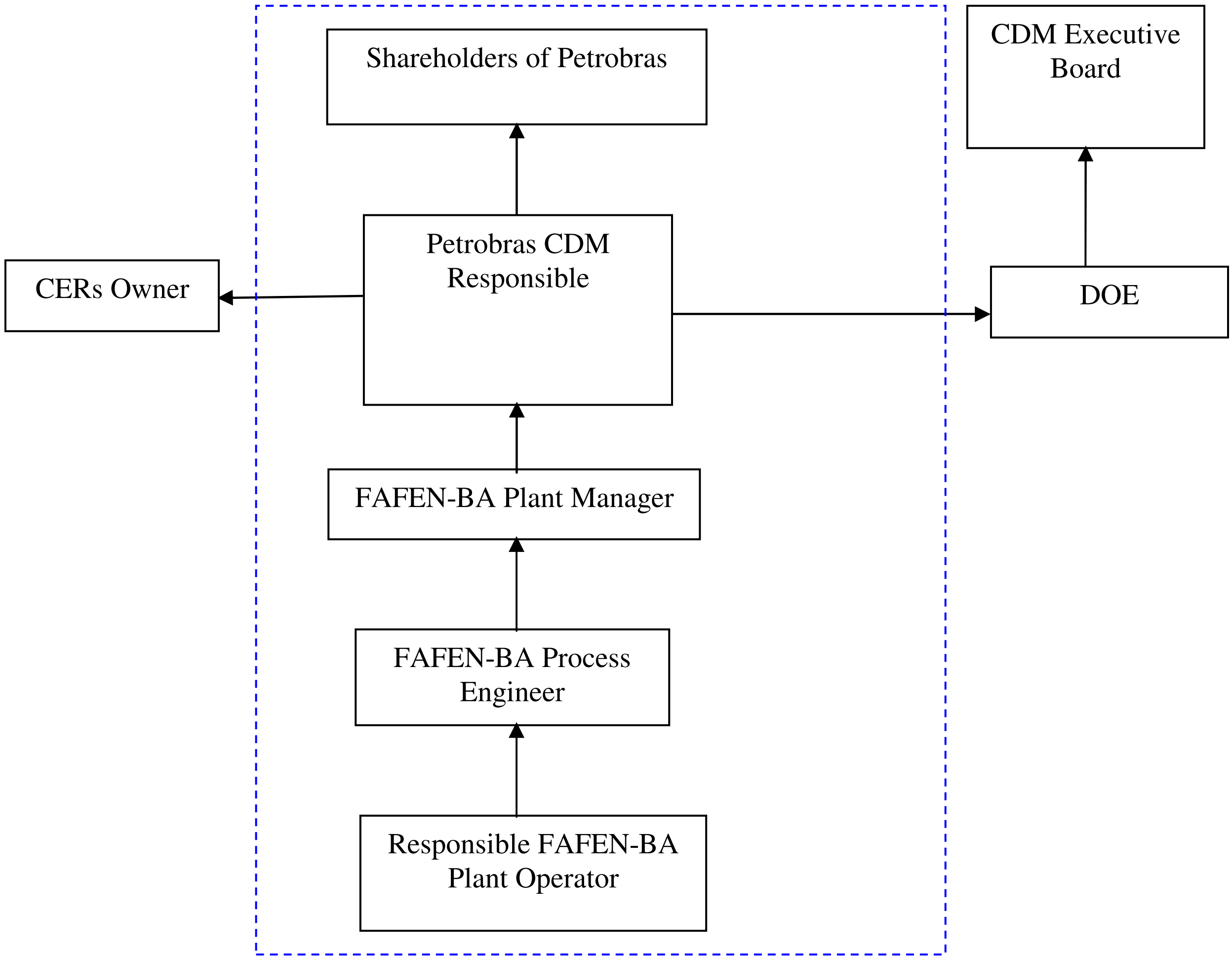
The plant manager will be responsible for the ongoing operation and maintenance of the N_2O monitoring system. Operation, maintenance, calibration and service intervals will be according to the manufacturer

[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.

specifications and international standards (see QA/QC section below), and incorporated into the management structure procedures.

The proposed CDM project will be closely monitored, metered and recorded. The management and operation of the proposed nitrous oxide abatement project at FAFEN-BA plant 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 FAFEN-BA 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 FAFEN-BA Plant Operator will report the relevant data to the FAFEN-BA Process Engineer.

- The FAFEN-BA Process Engineer is in charge of programming all formulae in the spreadsheets which are used. The Plant Operations Technician processes the data, checks the data for consistency, validates them, and records them every day as an electronic file. In case of failure of an instrument, or non-consistency of the data, he adjusts the data according to a procedure that will be written during the project implementation. In case the failure is not covered by the procedure, FAFEN-BA Process Engineer makes the decision to correct the figures or to abandon the data. The FAFEN-BA Process Engineer is responsible for archiving the data. Once validated, the data are input in an electronic folder and protected against any modification. A backup of all the data is made every day on the plant server. Both original document and the backup file are kept for the project crediting period.

- FAFEN-BA Plant Manager will be responsible to ensure that the CDM project activity at plant level is implemented in compliance with this PDD and other relevant standards.

- The Petrobras CDM Responsible will send a report which will basically be the monitoring plan spreadsheet to the CERs owner, as well as to the corresponding DOE. The Petrobras CDM Responsible is responsible for the declaration of the Emission Reductions, at a frequency to be fixed later in the project implementation.

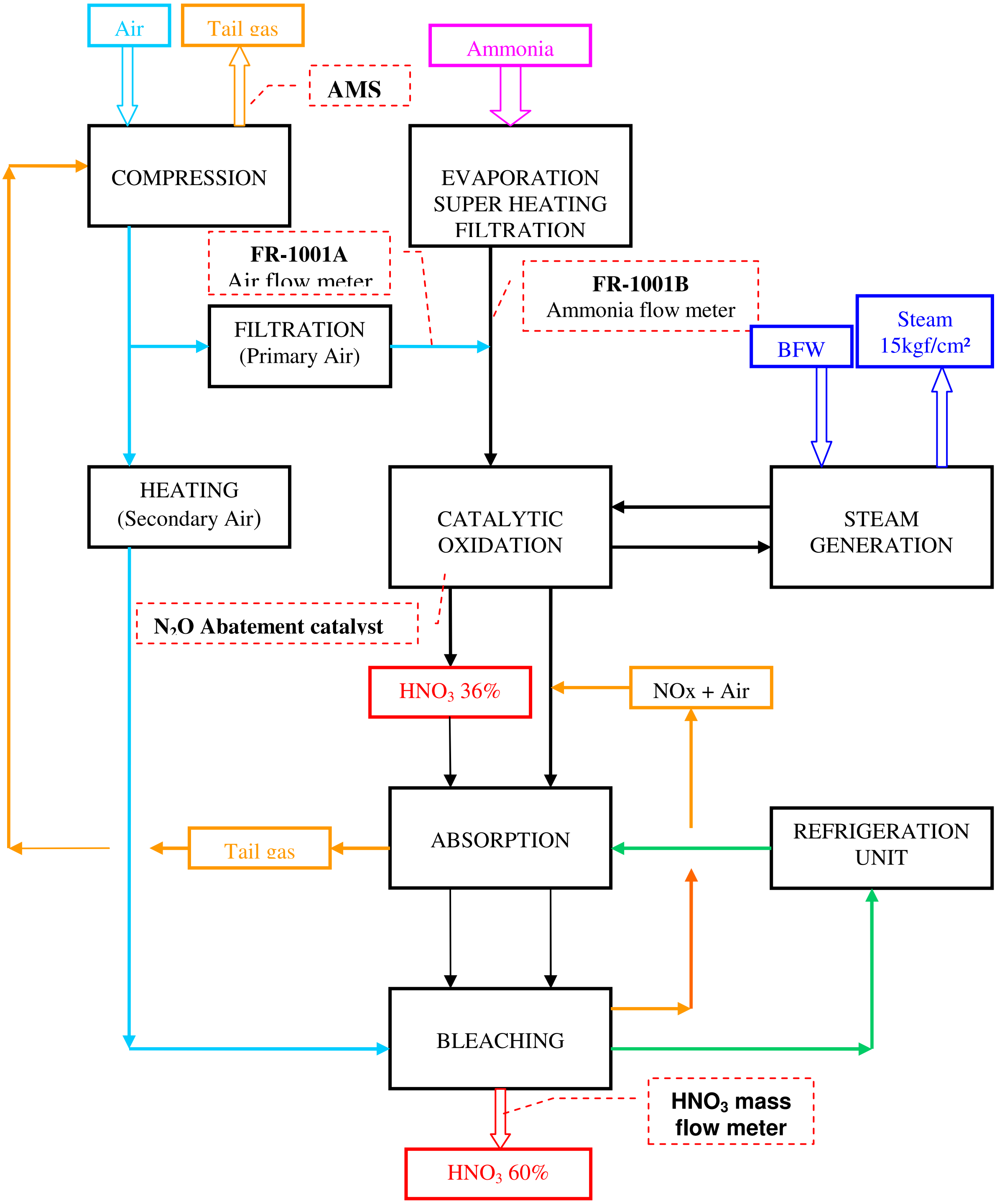
- The calculation of the Emission Reductions is done after each campaign by the FAFEN-BA Process Engineer, based on the campaign data, and validated by the Plant Manager.

- 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 Petrobras will receive from the Petrobras CDM Responsible, the same report sent to the DOE.

Tables on section B.7.1 of the PDD describe the parameters to be acquired and recorded as per the current monitoring plan, for 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.

The following flow diagram shows the monitoring points of relevant parameters



Fafen- BA nitric acid plant has procedures for emergency preparedness including into the Petrobras Quality Assurance System.

All the relevant instrumentation to measure process parameters are calibrated on a routinely basis as per Petrobras Quality Assurance System. The signals generated by these instruments are acquired and logged electronically by the Data Acquisition System (DAS) 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 automatically 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 after the ending of the crediting period.

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}	Total operating hours of the baseline campaign, 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}	Total 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 specific monitoring period, 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 1^{st} 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 N2O 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:

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

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

FAFEN-BA has selected 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:

Measuring Components and Measuring Ranges

Measuring Component	Smallest Range	Largest Range
Uras CO	0 – 75 mg/m³	0 – 750 mg/m³
Uras NO	0 – 100 mg/m³	0 – 1000 mg/m³
Uras SO_2	0 – 75 mg/m³	0 – 3600 mg/m³
Uras N_2O	0 – 100 mg/m³	0 – 3000 mg/m³
Uras CO_2	0 – 20 Vol%	
Magnos O_2	0 – 10 Vol%	0 – 25 Vol%
Sensor O_2	0 – 10 Vol%	0 – 25 Vol%

There can be measured up to 4 IR - components additionally one oxygen measurement.

Availability

> 98% over a 3 month period for two independent systems including sample conditioning.

Maintenance Interval / Auto - Adjustment

The ascertained maintenance interval concerning adjustment of the AMS will be 3 weeks. Using internal operating auto-adjustment facilities the maintenance interval will be 1 year for verification with test gas.

Uras26 If the analyzer is equipped with a internal auto-adjustment facility, operating with gas filled adjustment cells, a verification is required only once a year (AST) with external flowing reference gas.

Magnos206 and Oxygen Sensor
With automatically single-point adjustment during the maintenance interval, using ambient air .
A verification of the analyzer at the zero-point has to be carried out once a year (AST) .

The flow measurement system consists of a primary element of Annubar's measurement principle , a primary element for absolute pressure, a sensor of temperature PT100, all installed in the same pipe near the gas sampling point . A transmitter multi-variable, installed next to the primary elements, processes the three data and transforms them into an outflow.

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.
Table below indicates such characteristics as per the corresponding QAL1 report

Specific performance characteristics for N_2O analyzer (ABB AO 2000-Uras 26):

Contributing partial standard uncertainties and reference to their origins

Selectivity H2O	0,00	ppm
Selectivity others (largest sum)	0,04	ppm
Lack of fit	0,47	ppm
Drift	7,97	ppm
Pressure dependence	0,00	ppm
Temperature dependence	18,71	ppm
Flow dependence	0,07	ppm
Voltage dependence	0,09	ppm
Repeatability	0,10	ppm
Uncertainty of response factors	0,00	ppm
Uncertainty of converter efficiency (SCC-K NOx converter)	0,00	ppm
Response time	44	seconds
Origin of data	*TÜV-Report no. 821029 (2006)*	
Long-term drift of calibration cell	3,12	ppm
Origin of data	*Article in UmweltMagazin, 2001*	

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 = $((N_2O \text{ Analyzer uncertainty})^2 + (\text{Flow meter uncertainty})^2)^{1/2}$). The overall measurement uncertainty will be available for auditing purposes once the AMS is installed.

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.
Fafen BA is in the process of selecting a suitable testing laboratory to conduct the QAL2 tests.
Any data collected previous to the reception of the QAL2 lab report will be corrected through proper application of the calibration function. The UNC calculated during the QAL2 test will be deducted from the baseline emission factor according to the equation giving by the methodology. The mentioned value has to be verified by verifying DOE.

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. The AMS unit at FAFEN BA plant will be installed by qualified contractors under the direct supervision of the equipment manufacturers, considering both relevant Brazilian and international standards. Plant Manager, will actively supervise 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

[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.

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 will be calculated by the equipment manufacturer based on equipment performance characteristics and field conditions for Fafen BA's nitric acid plant. Calculation spreadsheets from the suppliers will be available for future verification. 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. Documented calibration procedure for weekly zero and span checks as well as resulting Shewart charts will be available on site for future verifications.

All monitoring equipment will be serviced and maintained according to the manufacturer's instructions and international standards by qualified personnel (both Fafen BA resources and the third parties involved during such activities). Maintenance and service logs will be well kept at Fafen BA's plant 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 AMS at least once every 3 years, depending on the QAL3 results.

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