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

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

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Monomeros Nitrous Oxide Abatement Project
Version 3
20 September 2007

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 inside the reactor once it is formed.

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

Baseline emissions rate will be determined by measuring N_2O emission factor (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.

The project activity will contribute to the sustainable development of the country through industrial technology transfer (catalyst technology from a developed country to Colombia). 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 Monomeros' plant. Monomeros 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)
Colombia (host)	Monomeros Colombo Venezolanos S.A. Private entity. Project Developer.	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.		

Monomeros Colombo Venezolanos S.A. is a Company established in Colombia to provide chemical products to the manufacture industry and fertilizers to the agri-business, its production volume become one of the most important petrochemical company in the countries of the Andino Group.

In December 1967, the setting-up of Monomeros of Colombia as a limited-liability company was executed by deed, with the initial participation of the Industrial Promotion Institute (IFI), the Colombian Oil Company (ECOPETROL) and the Venezuelan Petrochemical Institute (IVP).
In 1968, the Dutch firm holding the license for the Stamicarbon process became a stockholder, in 2007 the Venezuelan Petrochemical S.A. Pequiven bought Monomeros and currently this is the main stakeholder with 86.21%.

Currently, Monomeros manufactures three types of products: compound fertilizers, tricalcium phosphates and industrial chemicals, among these, nitric acid, sulphuric acid, and others.

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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Colombia

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

>>
Atlántico

A.4.1.3. City/Town/Community etc:

>>
Barranquilla

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 takes place at Monomeros Colombo Venezolanos (MCV) nitric acid plant located in Vía 40 Las Flores/P.O. Box 3205, Barranquilla, state of Atlántico, Colombia.

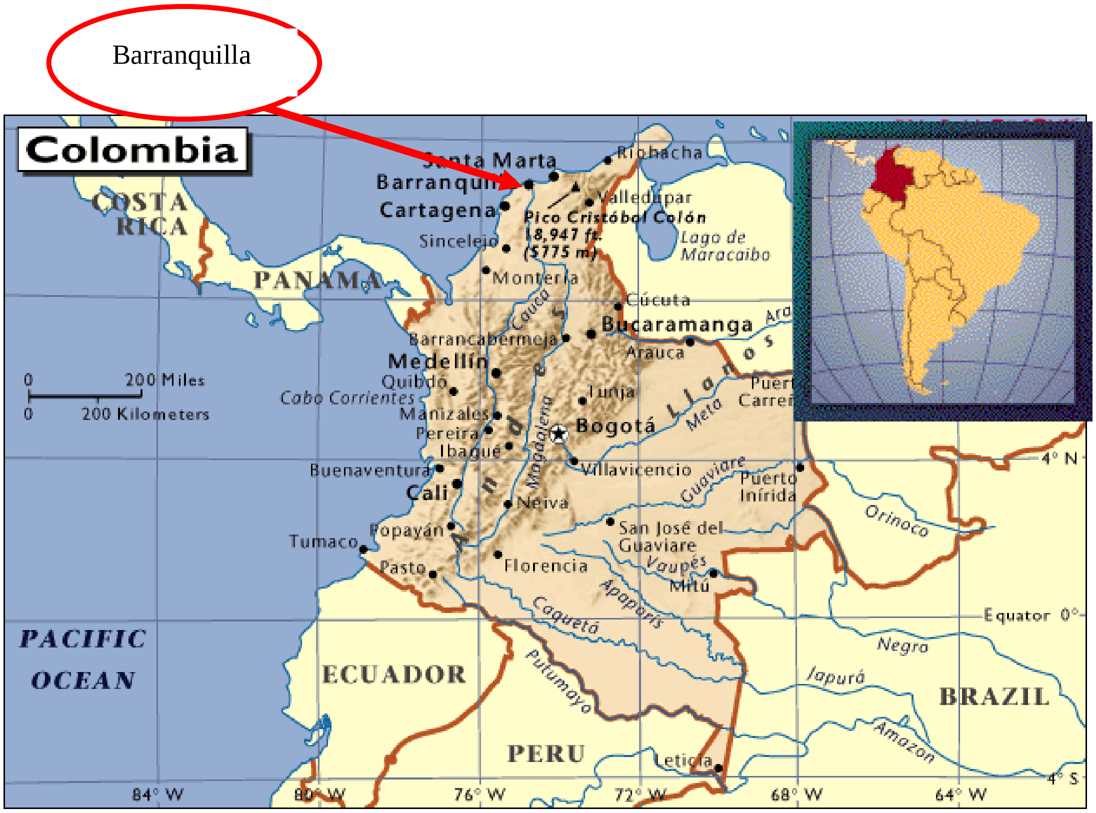

Figure 1. Location of MCV's Plant

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 yield (affecting nitric production); then, an optimal is found between 850-950 C, affected by other process conditions and catalyst chemical composition (figure 2)[1]. Reactions 2 and 3 are favored by higher pressure and lower temperatures.

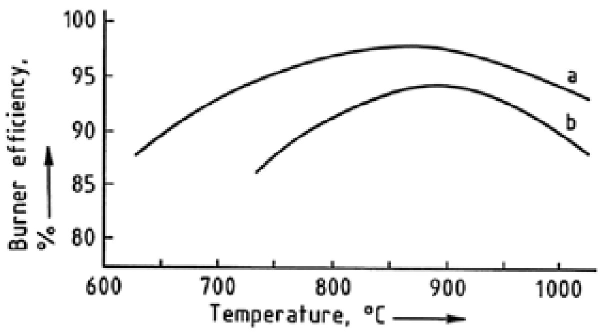

Figure 2. Conversion of Ammonia to Nitrogen Monoxide on Platinum Gauze as a function of temperature a) 100 kPa; (b) 400 kPa [1]

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

Monomeros has a mono pressure plant.

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).

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

(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 at the tail gas, after the absorption tower and previous to the expansion turbine.
Quaternary: N_2O is removed following the expansion turbine, and before the stack.

Selected technology for the project activity

General description

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

- The catalyst does not consume electricity, steam, fuels or reducing agents (all sources of leakage) to eliminate N_2O emissions; thus, operating costs are negligible and the overall energy balance of the plant is not affected.
- Installation is relatively simple and in most cases does not require any new process unit or re-design of existing ones (in some cases, the reactor basket needs some re-design / modifications in order 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 nor in efficiency neither in quality. Typically the secondary catalyst has a very high activity; about 85% of N_2O gases are converted to N_2 and O_2. MCV is currently on final phase of evaluation of the several commercial options offered for secondary catalyst technology, and will make a final decision in the short term.

Effect of catalyst thickness on N_2O abatement

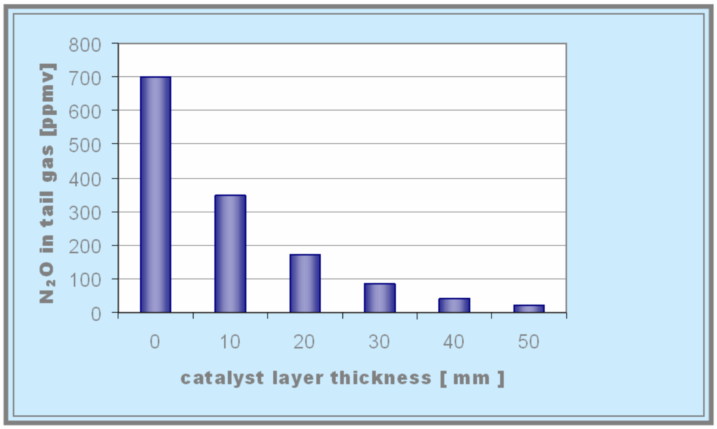

Figure 3. Effect of catalyst thickness on N_2O abatement
(Courtesy of W.C. Heraeus)

Some advantages MCV was looking for to select the specific secondary catalyst are:

- No measurable effect on ammonia to nitric oxide yield.
- Low level of N_2O in tail gas to be achieved by adjusting the catalyst bed thickness.
- Proven risk profile. The catalyst must have a proven safe record of operation during several years in other nitric acid plants.
- Proven performance. Several successful industrial-scale installations should be demonstrated with acceptably low N_2O emissions.

The project activity consists on the installation of a new catalyst (secondary catalyst), below the oxidation gauzes, which has the sole purpose of reducing N_2O emissions without the formation of a potential product or by product.

Currently, there are no national regulations or legal obligations in Colombia 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 Colombia that has ratified the Kyoto Protocol and actively participates in CDM

Monomeros Colombo Venezolanos 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.

Then, the project activity is not common practice.

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

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Total *ex-ante* emissions reductions are estimated to be 122,050 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 estimate.

Year	Annual estimation of emission reduction in tonnes of CO_2e
2008	111,879
2009	122,050
2010	122,050
2011	122,050
2012	122,050
2013	122,050
2014	122,050
2015	10,171
Total estimated reductions (tonnes of CO_2e)	**854,350**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	122,050

Note: Year 2008 includes eleven months, from February to December.
Year 2015 includes one 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 02. (EB 27)
AM0028 "Catalytic reduction of N_2O in the tail gas of Nitric Acid or Caprolactam Productions Plants" version 04.1 (EB 28) is used to select the baseline scenario".
The "Tool for the demonstration and assessment of additionality" version 03 (EB 29) 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 MCV's Nitric Acid Plant meeting all the conditions specified in the selected approved methodology (AM0034):

- MCV's plant limits the application of this project activity to its existing nitric acid production capacity, 275 ton HNO_3/day installed in 1970

- Currently MCV's plant doesn't have any N_2O destruction or abatement facility or equipment that could be affected by the project activity.
- The project activity will not affect the level of nitric acid production
- There are currently no regulatory requirements or incentives to reduce levels of N_2O emissions from nitric acid plants in Colombia.
- As it was explained above, no N_2O abatement technology is currently installed in MCV's plant.
- The secondary catalyst technology to be installed as project activity has been tested in several industrial trials and has been demonstrated that its installation does not increase NO_X emissions.
- NO_X abatement catalyst installed, prior to the start of the project activity is a Selective Catalytic Reduction (SCR, Vanadium Pentoxide, by Monsanto) $DeNO_X$ unit.
- As it was explained before, the secondary catalyst technology to be installed as project activity has been tested in several industrial trials and has been demonstrated that its operation does not lead to any process emissions of greenhouse gases, directly or indirectly.
- Continuous real-time measurements of N_2O concentration and total gas volume flow are carried out in the stack during the current campaign (baseline campaign), prior the installation of the secondary catalyst, and will be carried out 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 MCV's 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	
Project Activity	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	Excluded	The project does not lead to any change in CO_2 or CH_4 emissions
		CH_4	Excluded	
		N_2O	Included	
	Leakage emissions from production, transport, operation and decommissioning of the catalyst.	CO_2	Excluded	No leakage emissions are expected.
		CH_4	Excluded	
		N_2O	Excluded	

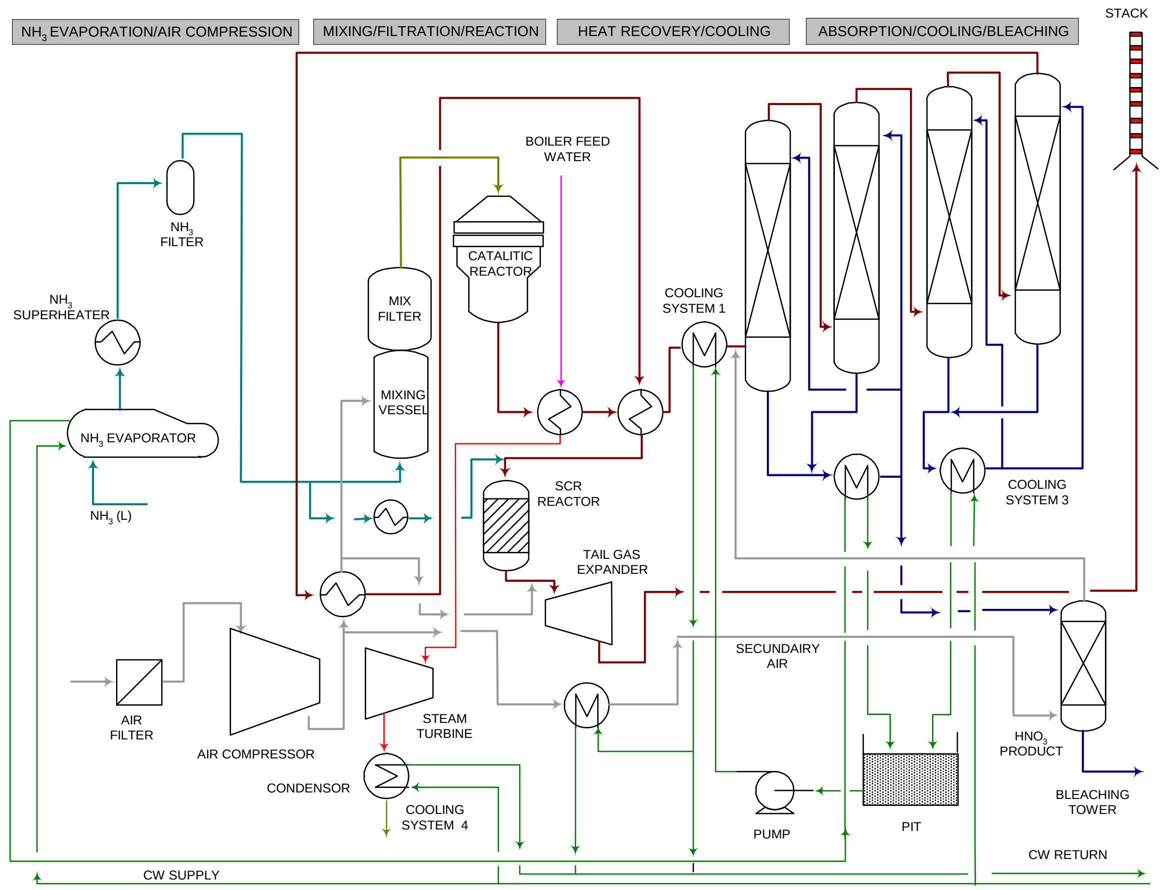

Figure 5. Project boundary

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 Productions Plants" Version 04.1 as it is specified in selected AM0034 version 02. The analysis of baseline scenarios involves six steps:

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

The first step in determining the baseline scenario is to analyse all options available to project participants. These include the business-as-usual case, considering sectoral policies and circumstances to

determine whether this case corresponds to the continuation or not of the current operation of the nitric acid industry, the project scenario, and any other scenarios that might be applicable. This *first step* can be further broken down into two sub-steps:

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

- Continuation of *status quo.* The continuation of the current situation, where there will be no installation of technology for the destruction or abatement of N_2O.
- Switch to alternative production method not involving ammonia oxidation process
- Alternative use of N_2O, such as:
  - Recycling N_2O as a feedstock
  - Use of N_2O for external purposes
- The installation of an N_2O destruction or abatement technology:
  - Primary approach
  - Secondary approach
  - Tertiary approach, including Non Selective Catalytic Reduction (or NSCR De NO_X)[2]
  - Quaternary (or end of pipe) approach.

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

Step 1b: In addition to the baseline scenario alternatives of Step 1a, all possible options that are technically feasible to handle NO_X emissions should be considered, since some NO_X technical solutions could also have an effect on N_2O emissions. The alternatives include:

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

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

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

Monomeros Colombo Venezolanos nitric acid plant is in compliance with the Atmospheric Emission Regulation of Colombia, which covers NO_X regulations, as indicated in the Resolution 1027/2004. Therefore the continuation of the status quo is a valid baseline alternative.

[2] NSCR: A NSCR $DeNO_X$-unit will reduce N_2O emissions as a side reaction to the NO_X--reduction. Consequently, new NSCR installation may be considered as an alternative N_2O reduction technology.

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):

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.

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

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

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

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

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

The use of N_2O for external purposes is technically not feasible at MCV Nitric Acid Plant, as the quantity of gas to be treated is extremely high compared to the amount of nitrous oxide that could be recovered. Note, N_2O concentration in the tail gas at MCV's plant is expected to be in the range of 1,000 ppmv to 1,300 ppmv. The use of N_2O for external purposes is practiced neither in Colombia nor anywhere else.

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

Therefore the following baseline alternatives are eliminated in this step:

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

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

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

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

Sub-step 4a: Determine appropriate analysis method:

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

Sub-step 4b: Apply simple cost analysis:

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

No income from any kind of potential product or by-product except CERs are able to pay back investment costs as well as running costs for the installation of any available secondary or tertiary

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

According to the baseline methodology,

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

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

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

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

Sub-step 4d: Sensitivity analysis

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

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

At the start of a crediting period, a re-assessment of the baseline scenario due to new or modified NO_X or N_2O emission regulations in Colombia, will be executed as follows

Sub-step 5a: New or modified NO_X-emission regulations

If new or modified NO_X emission regulations are introduced after the project start, determination of the baseline scenario will be re-assessed at the start of a crediting period. Baseline scenario alternatives to be analyzed will include, inter alia:
- Selective Catalytic Reduction (SCR);
- Non-Selective Catalytic Reduction (NSCR);
- Tertiary measures incorporating a selective catalyst for destroying N_2O and NO_X emissions;
- Continuation of baseline scenario.

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

Sub Step 5b: New or modified N_2O –regulation

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

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

Monomeros 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 plant:

Baseline emissions are calculated from an emission factor measured before the implementation of the project activity (the installation of a secondary catalyst). Then, baseline will be determined by measuring N_2O baseline emission factor (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 which 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 plant design data. A range or maximum value for any given parameter has been established considering specific control capabilities of MCV's nitric acid plant. In order to properly characterize baseline emission rates, operation during such initial campaign is controlled during the specified limit (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.

At the moment of presenting this PDD Monomeros Colombo Venezolanos plant is carrying out their initial campaign for baseline emission factor determination.
The baseline campaign began on February, 16th, 2007 and will be finished at the end of January, 2008.
The emissions factor determined from such measurements will be used for crediting of emission reductions.

The additionality of the project activity is demonstrated and assessed using the third 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 MCV's 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 Colombia. 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 Colombia has a secondary catalyst (or any other type of N_2O abatement technology) currently installed, except for Abonos Colombianos SA (Abocol), state of Bolivar, which has installed a secondary catalyst, also as CDM project activity.

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

Conclusion:

Currently, there are no national regulations or legal obligations in Colombia 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 Colombia that has ratified the Kyoto Protocol and actively participates in CDM.

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

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

The proposed CDM project activity is undoubtedly additional, since it passes all the steps of the Version 3 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 approval and registration of the project activity as a CDM activity, and the attendant benefits and incentives derived from the project activity, will offset the substantial cost of the catalyst and any plant modifications and will enable the project activity to be undertaken.

Based on the *ex-ante* estimation of N_2O emission reductions over the first crediting period, it is expected that the income from selling of CERs of the registered CDM project activity is at least as high as the investment, financing and running costs. Therefore MCV 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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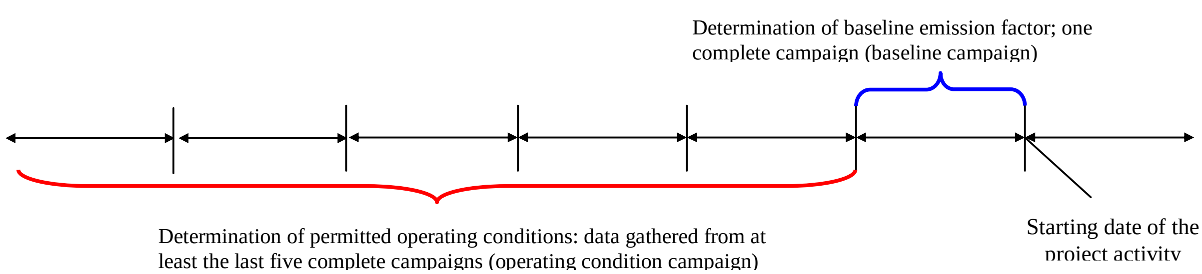
Baseline emissions procedure

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" is determined based on historical data from the previous five campaigns.
When historical data is used to calculate the "permitted range of operating conditions", this range is determined through a statistical analysis 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 range for oxidation temperature" will be available for the validation process of the project activity

The range of oxidation pressure as indicated in the operating manual for the existing equipment is used to determine "permitted range for oxidation pressure, due to lack of sufficient historical data.

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

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

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

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

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

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

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is to be applied to the complete data series of N_2O

concentration as well as to the data series for gas volume flow. The statistical procedure will be applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

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

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

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

where:

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

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

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

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

where:

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

<u>Impact of regulations</u>

Should N_2O emissions regulations that apply to nitric acid plants be introduced in the Colombia or jurisdiction covering the location of the nitric acid plant (Baranquilla), 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.

<u>Composition of the ammonia oxidation catalyst</u>

There has been a change in the composition of the ammonia oxidation catalyst for the current (baseline) campaign compared to the previous historical five campaigns. The standard 90/10 (Pt/Rh) gauze pack system was replaced by a combined Pt/Rh/Pd pack, which has better performance (f.e. in terms of precious metal losses) than the previous gauze set and specifications. Then, the change is justified by the performance as it is stated in page 7 of AM0034:

"The change in the catalyst composition is justified by its availability, performance, relevant literature, etc."

<u>Campaign Length</u>

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.

<u>Historic Campaign Length</u>

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

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

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

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

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

Project emission procedure

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

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

<u>Estimation of campaign-specific project emissions</u>

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

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

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

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

where:

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

OH_n Number of operating hours in the project campaign, in h

Derivation of a moving average emission factor

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

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

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

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

where:

EF_n Emission factor calculated for the *nth* campaign, in 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:

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

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

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

If $EF_{ma,n} > EF_{,n}$, then $EF_{,p} = EF_{ma,n}$

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

Minimum project emission factor

A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum (EF_{min}). If any of the later project campaigns results in an EF_n that is lower

than EF_{min}, the calculation of the emission reductions for that particular campaign shall used EF_{min} and not EF_n.

<u>Project Campaign Length</u>

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

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

Where

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

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

Documentation to prove design capacity (nameplate) of the nitric acid plant will be available for the validation process of the project activity.[3]

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

(Copy this table for each data and parameter)

Data / Parameter:	**Normal Operating Temperature OT_{normal} (range of temperature)**
Data unit:	ºC
Description:	Range of oxidation temperature of the ammonia reactor
Source of data used:	Calculated from historical process data.
Value applied:	832ºC-872ºC
Justification of the choice of data or description of measurement methods and procedures actually applied :	Monomeros Plant has complete historical registers for oxidation temperature (five historical campaigns); then, historical data is used to determine normal oxidation temperature. Reactor temperature was measured by a thermocouple installed through the reactor wall, near the oxidation catalyst; the signal from such device is acquired by the Distributed Control System (DCS) and stored electronically at a given time interval.
Any comment:	None

Data / Parameter:	**Normal Operating Pressure, OP_{normal} (range of pressure)**
Data unit:	Pa
Description:	Range of oxidation pressure of the ammonia reactor.
Source of data used:	Based on design data.
Value applied:	303,948 Pa- 384,890 Pa

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

Justification of the choice of data or description of measurement methods and procedures actually applied :	Complete historical registers for oxidation pressure (five historical campaigns) are not available; then, plant design data was used to determine normal oxidation pressure.
Any comment:	None

Data / Parameter:	**Maximum Ammonia Flow Rate, AFR_{max}**
Data unit:	kg NH_3/hour
Description:	Ammonia flow rate to the ammonia oxidation reactor.
Source of data used:	Defined as specified by the ammonia oxidation catalyst manufacturer.
Value applied:	3,282 kg NH_3/hour
Justification of the choice of data or description of measurement methods and procedures actually applied :	Complete historical registers for ammonia flow to reactor (five historical campaigns) are not available; then, maximum ammonia load as specified by the primary catalyst manufacturer was used to determine maximum ammonia flow rate.
Any comment:	None

Data / Parameter:	**Maximum Ammonia to Air Flow Rate, $AIFR_{max}$**
Data unit:	Kg NH_3/kg air
Description:	Ammonia to air flow rate to the ammonia oxidation reactor.
Source of data used:	Defined as specified by the ammonia oxidation catalyst manufacturer.
Value applied:	0.066 (Kg NH_3/kg air)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Complete historical registers for ammonia flow rate to reactor (five historical campaigns) are not available; then, maximum load as specified by the primary catalyst manufacturer was used to determine maximum ammonia to air flow rate.
Any comment:	None

Data / Parameter:	**Normal Campaign Length, CL_{normal}**
Data unit:	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:	75,398 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. Four immediate historical campaigns (128 to 131, current baseline campaign is 132) plus historical campaign 123 were used for calculating normal campaign length. Two intermediate campaigns (124/125 and 126/127) were ignored for not being representative of normal operation (campaigns were cut short due to low conversion efficiency with such gauze supplier/specification, which was modified on next campaign) Daily production was measured directly by a mass flow meter (Coriolis principle) that records the combined Nitric acid produced by both the Nitric Acid Plant and the NO_X Plant; those measurements were adjusted with the average of three concentration measurements done in laboratory. The specific NO_X Plant production was measured by a second device of the vortex type and adjusted by the concentration measured in laboratory. The nitric acid plant daily production was reported as the difference between the first (Coriolis) and second (Vortex) device measurements.
Any comment:	None

Data / Parameter:	**Normal Gauze Supplier, GS_{normal}**
Data unit:	Johnson Matthey PLC
Description:	Gauze supplier during operating condition campaigns (the previous five campaigns).
Source of data used:	From historical process data
Value applied:	Johnson Matthey PLC
Justification of the choice of data or description of measurement methods and procedures actually applied :	Johnson Matthey supplied primary catalyst for the previous four campaigns. Umicore supplied catalyst for fifth representative historical campaign.
Any comment:	None

Data / Parameter:	**Normal Gauze Composition, GC_{normal}**
Data unit:	%
Description:	Standard knitted 90/10 gauzes.
Source of data used:	From historical process data.
Value applied:	90.0 % Pt, 10.0 % Rh.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Such gauze composition delivered acceptable performance (as per contractual basis considering commercial/economic issues)
Any comment:	None

B.6.3 Ex-ante calculation of emission reductions:

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

- Nitric acid production is assumed to be constant, so that project emissions do not vary from year to year
- An N_2O emission factor (EF_{BL}) calculated from monitored data available at the moment of submitting this PDD. The final baseline emission factor will be calculated after the completion of baseline campaign measurements.
- All the technology providers indicate that the estimated reduction efficiency to be achieved as a consequence of project implementation is at least 85%. Then, in order to present estimative values in this PDD, we consider N_2O concentration in the stack gas during the project campaign equal to 15% of the N_2O concentration in the stack gas during the baseline campaign (NCSG = 0.15 * $NSCG_{BC}$)

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

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

$$BE_{BC} = 35{,}026 \cdot 1{,}579 \cdot 3{,}392 \cdot 10^{-9} = 187.6\, tN_2O \quad \text{(Eq. 9)}$$

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

$$EF_{BL} = \frac{187.6}{32{,}739} \cdot (1 - \frac{2.94}{100}) = 0.00556\, tN_2O / tHNO_3 \quad \text{(Eq. 11)}$$

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

$$PE_n = 35{,}026 \cdot 0.15 \cdot 1{,}579 \cdot 10^{-9} \cdot 7{,}704 = 63.9\, tN_2O \quad \text{(Eq. 13)}$$

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

$$EF_p = \frac{63.9}{75{,}398} = 0.00085\, tN_2O / tHNO_3 \quad \text{(Eq. 15)}$$

Then,

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

$$ER_n = (0.00556 - 0.00085) \cdot 83{,}530 \cdot 310 = 122{,}050\, tonCO_2e / year \quad \text{(Eq. 17)}$$

where

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

The assumptions parameters are specified in the following table:

Estimated values	**MCV's Plant**
NAP, t HNO_3/yr	83,530
OH, h	7,704
GWP_{N_2O} tCO_2e/tN_2O	310

Note: In order to follow the calculations see Spreadsheet "Baseline Campaign-Monomeros 20Sept 2007¨.xls"

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

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

Years	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of emission reduction (tonnes of CO_2e)
2008	20,114	125,994	-	111,879
2009	21,943	143,993	-	122,050
2010	21,943	143,993	-	122,050
2011	21,943	143,993	-	122,050
2012	21,943	143,993	-	122,050
2013	21,943	143,993	-	122,050
2014	21,943	143,993	-	122,050
2015	1,829	17,999	-	10,171
Total (tonnes of CO_2e)	**153,601**	**1,007,951**	**-**	**854,350**

Note: Year 2008 includes eleven months, From February to December.
Year 2015 includes one month, January.

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

B.7.1 Data and parameters monitored:

(Copy this table for each data and parameter)

Data / Parameter:	**Baseline Volume Flow in the Stack Gas, VSG_{BC}**
Data unit:	Nm^3 / hour
Description:	Mean gas volume flow rate in the stack gas during baseline campaign
Source of data to be used:	AMS (Flow meter) at MCV's plant
Value of data applied for the purpose of calculating expected emission reductions in section B.5	35,026 Nm^3/ hour
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181) as reference method. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will set up.

Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds

Data / Parameter:	**Baseline Temperature of the Stack Gas, TSG_{BC}**
Data unit:	ºC
Description:	Temperature of the gas in the stack gas during baseline campaign
Source of data to be used:	AMS (Flow meter).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Stack flow is measured by an ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data. This device also measure temperature and pressure and send the signal 4-20 mA to the DCS trough a digital signal converter (Hart protocol).
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds.

Data / Parameter:	**Baseline Pressure of the Stack Gas, PSG_{BC}**
Data unit:	kg/cm^2
Description:	Pressure in the stack gas during baseline campaign
Source of data to be used:	AMS (Flow meter)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) with automatically compensates for actual stack pressure and temperature in order to normalize output data. This device also measure temperature and pressure and send the signal 4-20 mA to the DCS trough a digital signal converter (Hart protocol).
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.

Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds.

Data / Parameter:	**Baseline N_2O Concentration in the Stack Gas, $NCSG_{BC}$**
Data unit:	mg N_2O/ m^3 (converted from ppm if necessary)
Description:	Mean concentration of N_2O in the stack gas for the baseline campaign
Source of data to be used:	AMS (Infrared gas analyzer) at MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,579 mg N_2O/ m^3
Description of measurement methods and procedures to be applied:	N_2O concentration is measured by on-line analyzer (Non Dispersive Infra Red principle). A gas stream is continuously drawn from the stack by the sampling system under proper conditions (line is heat traced to avoid condensation), and driven to the infrared cell. The device is set up to measure concentration and record the output electronically every 2 seconds in the DCS.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181) as reference method. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will set up.
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor. Recorded every two seconds.

Data / Parameter:	**Baseline Operating Hours, OH_{BC}**
Data unit:	Hours
Description:	Total operating hours for the baseline campaign
Source of data to be used:	Process control system at MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,392 hours
Description of measurement methods and procedures to be applied:	The distributed control system of the plant will record effective operating time of the plant by monitoring periods when the value registered for the hourly average of the oxidation reactor temperature reaches a value of 650ºC or higher.

QA/QC procedures to be applied:	This Thermocouple is changed every campaign. In the reactor at the same distance of the gauzes is installed another temperature meter which can be used to compare the data of the first in case of a failure
Any comment:	Measured daily during a complete campaign before project implementation to properly characterize baseline emissions factor.

Data / Parameter:	**Uncertainty of the monitoring system, UNC**
Data unit:	%
Description:	Overall uncertainty of the monitoring system, calculated as the combined uncertainty of the applied monitoring equipment
Source of data to be used:	The value used was obtained as result of the QAL2 test.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2.94%
Description of measurement methods and procedures to be applied:	The overall uncertainty was calculated as the combined uncertainty of the flow meter and the uncertainty of the N_2O concentrations measurements, using the law of propagation of uncertainty.
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	Calculated once

Data / Parameter:	**Nitric Acid Production, NAP_{BC}**
Data unit:	ton 100% HNO_3
Description:	Total nitric acid production for the baseline campaign
Source of data to be used:	Production logs of MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Nitric acid production is assumed to be constant, so that project emissions do not vary from year to year. The value of the nitric acid production used for the calculation of expected emission reductions is: 83,530 ton HNO_3/year (based on historical data).
Description of measurement methods and procedures to be applied:	Daily production is measured directly by a mass flow meter (Coriolis principle) that records the combined Nitric acid produced by both the Nitric Acid Plant and the Caprolactam Plant; the device also measures density and temperature, so concentration correction is done automatically with the help of the DCS. The specific Caprolactam Plant production is measured by a second device of the vortex type. The DCS calculates the daily production of the nitric acid plant as the difference between the first (Coriolis) and second (Vortex) device

	measurements.
QA/QC procedures to be applied:	The Coriolis flow meter is calibrated every campaign according to metrology procedures.
Any comment:	Measured daily during a complete campaign before project implementation to properly characterize baseline emissions factor.

Data / Parameter:	**Baseline Emission Factor, EF_{BL}**
Data unit:	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	For the purpose of calculating expected emission reductions, an N_2O emission factor (EF_{BL}) calculated from monitored data available at the moment of submitting this PDD is used. The final baseline emission factor will be calculated after the completion of the baseline campaign measurements. It is expected that the final emission factor will be higher than the emission factor used in this PDD since the emission factor increases during the campaign. The N_2O emission factor used for ex ante calculation is: 0.00556 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 at the end of the baseline campaign

Data / Parameter:	**Baseline Oxidation Temperature, OT_{BC}**
Data unit:	ºC
Description:	Oxidation temperature of the ammonia reactor for the baseline campaign
Source of data to be used:	Distributed Control System of MCV’s plant.

Value of data applied for the purpose of calculating expected emission reductions in section B.5	For the purpose of estimating emission reductions all values that are measured when the oxidation temperature is outside the following range, 832ºC-872ºC, are eliminated from the calculation.
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 Distributed Control System (DCS) and stored electronically at a given time interval.
QA/QC procedures to be applied:	This Thermocouple is replaced every campaign. In the event of a failure during the campaign the plant is shut down and the thermocouple is replaced for a new one.
Any comment:	Monitored continuously during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation.

Data / Parameter:	**Baseline Oxidation Pressure, OP_{BC}**
Data unit:	Pa
Description:	Oxidation pressure of the ammonia reactor for the baseline campaign
Source of data to be used:	Distributed Control System of MCV’s plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For the purpose of estimating emission reductions all values that are measured when the oxidation pressure is outside the following range, 303,948 Pa-384,890 Pa, are eliminated from the calculation.
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 Distributed Control System and stored electronically at a given time interval.
QA/QC procedures to be applied:	Critical instruments are calibrated on a routinely basis every campaign
Any comment:	Monitored continuously during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation.

Data / Parameter:	**Baseline Ammonia Flow Rate, AFR_{BC}**
Data unit:	Kg NH_3/hour
Description:	Ammonia flow rate to the ammonia oxidation reactor for the baseline campaign.
Source of data to be used:	Distributed Control System of MCV’s plant.

Value of data applied for the purpose of calculating expected emission reductions in section B.5	For the purpose of estimating emission reductions all values that are measured when the ammonia flow rate is not lower or equal than 3,282 kg NH_3/hour, are eliminated from the calculation.
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 Distributed Control System and stored electronically at a given time interval.
QA/QC procedures to be applied:	Critical instruments are calibrated on a routinely basis every campaign. Additionally the cell that measures the ammonia flow is already calibrated and the ammonia to Air ratio is calculated and recorder with the AMS data
Any comment:	Monitored continuously during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation.

Data / Parameter:	**Baseline Ammonia to Air Flow Rate, $AIFR_{BC}$**
Data unit:	(Kg NH_3/ Kg Air)
Description:	Ammonia to air flow rate to the ammonia oxidation reactor for the baseline campaign.
Source of data to be used:	Distributed Control System of MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For the purpose of estimating emission reductions all values that are measured when ammonia to air flow rate is not lower or equal than 0.066 (Kg NH_3/kg air), are eliminated from the calculation.
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 Distributed Control System and stored electronically with the other data at a given time interval. The Ammonia to Air ratio is calculated based on the actual flow analysis from the individual streams.
QA/QC procedures to be applied:	Critical instruments are calibrated on a routinely basis every campaign. Additionally the cell that measures the ammonia flow is already calibrated and the ammonia to Air ratio is calculated and recorder with the AMS data
Any comment:	Monitored continuously during the initial campaign for baseline emission factor determination, in order to avoid manipulations that could increase baseline N_2O formation.

Data / Parameter:	**Baseline 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:	Distributed Control System of MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	75,398 ton 100% HNO3
Description of measurement methods and procedures to be applied:	Daily production is measured directly by a mass flow meter (Coriolis principle) that records the combined Nitric acid produced by both the Nitric Acid Plant and the Caprolactam Plant; the device also measures density and temperature, so concentration correction is done automatically with the help if the DCS. The specific Caprolactam Plant production is measured by a second device of the vortex type. The DCS calculates the daily production of the nitric acid plant as the difference between the first (Coriolis) and second (Vortex) device measurements.
QA/QC procedures to be applied:	The Coriolis meter is calibrated every campaign according to metrology procedures.
Any comment:	Measured once

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

Data / Parameter:	**Baseline Gauze Composition, GC_{BC}**
Data unit:	% (Pt, Rh, Pd)
Description:	Gauze composition for the baseline campaign

Source of data to be used:	Nitric acid plant procurement office and/or gauze Supplier technical service department.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	58.0 to 60.0 % Pt, 3.4 to 4.4 % Rh, 36.1 to 38.1 % Pd.
Description of measurement methods and procedures to be applied:	Section of supply contract (or equivalent document) for gauzes that specifies the technical characteristics agreed during baseline campaign. If necessary, additional data could be requested to supplier's technical service office in order to provide complete technical profile of gauzes.
QA/QC procedures to be applied:	None
Any comment:	Recording once

Data / Parameter:	**Project Volume Flow in the Stack Gas, $VSG_{project}$**
Data unit:	N m^3 / hour
Description:	Volume flow rate in the stack gas for the project campaign
Source of data to be used:	AMS (Flow meter) at MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	35,026 Nm^3/ hour.
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) which also measures actual stack pressure and temperature in order to normalize output flow data.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181) as reference method. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will set up.
Any comment:	Measured during the complete lifetime of the project activity. Recorded every two seconds.

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

calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Stack flow is measured by an ANNUBAR device (multiple pressure differential principle) which also measures actual stack pressure and temperature in order to normalize output flow data. The temperature and pressure (4-20 mA) signals are sent to the DCS and acquired through a digital signal converter (Hart protocol).
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.
Any comment:	Measured during the complete lifetime of the project activity. Recorded every two seconds.

Data / Parameter:	**Project Pressure of the Stack Gas, $PSG_{project}$**
Data unit:	kg/cm^2
Description:	Pressure in the stack gas during project campaign
Source of data to be used:	AMS (Flow meter).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Stack flow is measured by ANNUBAR device (multiple pressure differential principle) which also measures actual stack pressure and temperature in order to normalize output flow data. The temperature and pressure (4-20 mA) signals are sent to the DCS and acquired through a digital signal converter (Hart protocol).
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.
Any comment:	Measured during the complete lifetime of the project activity Recorded every two seconds.

Data / Parameter:	**Project N_2O Concentration in the Stack Gas, $NCSG_{project}$**
Data unit:	mg N_2O/ m^3 (converted from ppm if necessary)
Description:	N_2O concentration in the stack gas for the project campaign
Source of data to be used:	AMS (Infrared gas analyzer) at MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in	236.78 mg N_2O/m^3

section B.5	
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 in the DCS.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181) as reference method. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will set up.
Any comment:	Measured during the complete lifetime of the project activity Recorded every two seconds.

Data / Parameter:	**Project Operating Hours, $OH_{project}$**
Data unit:	Hours
Description:	Total operating hours for the project campaign
Source of data to be used:	Process control system at MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	7,704 hours
Description of measurement methods and procedures to be applied:	The distributed control system of the plant will record effective operating time of the plant by monitoring periods time when the plant is producing nitric acid
QA/QC procedures to be applied:	This Thermocouple is changed every campaign. In the reactor at the same distance of the gauzes is installed another temperature meter which can be used to compare the data of the first in case of a failure
Any comment:	Measured daily during the complete lifetime of the project activity.

Data / Parameter:	**Project Nitric Acid Production, $NAP_{project}$**
Data unit:	ton 100% HNO_3
Description:	Total nitric acid production for the project campaign
Source of data to be used:	Production logs of MCV's plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Nitric acid production is assumed to be constant, so that project emissions do not vary from year to year. The value of the nitric acid production used for the calculation of expected emission reductions is: 83,530 ton HNO_3/year (based on historical information).
Description of measurement methods	Daily production is measured directly by a mass flow meter (Coriolis principle) that records the combined Nitric acid produced by both the Nitric Acid Plant

and procedures to be applied:	and the Caprolactam Plant; the device also measures density and temperature, so concentration correction is done automatically with the help if the DCS. The specific Caprolactam Plant production is measured by a second device of the vortex type. The DCS calculates the daily production of the nitric acid plant as the difference between the first (Coriolis) and second (Vortex) device measurements.
QA/QC procedures to be applied:	The Coriolis meter is calibrated every campaign according to metrology procedures.
Any comment:	Measured daily during the complete lifetime of the project activity.

Data / Parameter:	**Project Emission Factor, EF_n**
Data unit:	ton N_2O / ton 100% HNO_3
Description:	Project emission factor calculated from monitored data for the project campaign
Source of data to be used:	Calculated from monitoring data.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.00085 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:	Production logs of MCV's plant.
Value of data applied for the purpose of calculating expected	75,398 ton 100% HNO_3.

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Daily production is measured directly by a mass flow meter (Coriolis principle) that records the combined Nitric acid produced by both the Nitric Acid Plant and the Caprolactam Plant; the device also measures density and temperature, so concentration correction is done automatically with the help if the DCS. The specific Caprolactam Plant production is measured by a second device of the vortex type. The DCS calculates the daily production of the nitric acid plant as the difference between the first (Coriolis) and second (Vortex) device measurements.
QA/QC procedures to be applied:	The Coriolis meter is calibrated every campaign according to metrology procedures.
Any comment:	Calculated once at the end of the project campaign

Data / Parameter:	**Project Gauze Supplier, GS_n**
Data unit:	Company name
Description:	Gauze supplier for the project campaign
Source of data to be used:	Procurement offices of MCV plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	No catalyst supplier has yet been selected.
Description of measurement methods and procedures to be applied:	Cover of supply contract or bill for gauzes for project campaigns, or equivalent document to prove commercial transaction.
QA/QC procedures to be applied:	None
Any comment:	Recording each campaign

Data / Parameter:	**Project Gauze Composition, GC_n**
Data unit:	%
Description:	Gauze composition for the project campaign
Source of data to be used:	Procurement office of MCV Plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	No catalyst supplier has yet been selected.
Description of measurement methods	Section of supply contract for gauzes that specifies the technical characteristics agreed during baseline campaign. If necessary, additional data could be

and procedures to be applied:	requested to supplier's technical service office in order to provide complete technical profile of gauzes.
QA/QC procedures to be applied:	None
Any comment:	Recording each campaign

Data / Parameter:	**Emission Factor set by regulation, EF_{reg}**
Data unit:	kg N_2O/ ton HNO_3
Description:	Local and national regulations on N_2O and NO_X emissions
Source of data to be used:	Local and National Regulations
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	At date of introducing or change of regulation.
QA/QC procedures to be applied:	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

B.7.2 Description of the monitoring plan:

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Monomeros Colombo Venezolanos has been operating a NO_X abatement system and NOx online analyzer since 1991. As responsible of the nitric acid plant for a number of years, current MCV's staffs is used to own, operate and maintain technical equipment to a high level of quality standards.
Furthermore, before beginning the baseline campaign all the people in charge of the operation of the AMS were trained to deal with the new technology installed as consequence of the project activity. Registers of those trainings were available during the validation

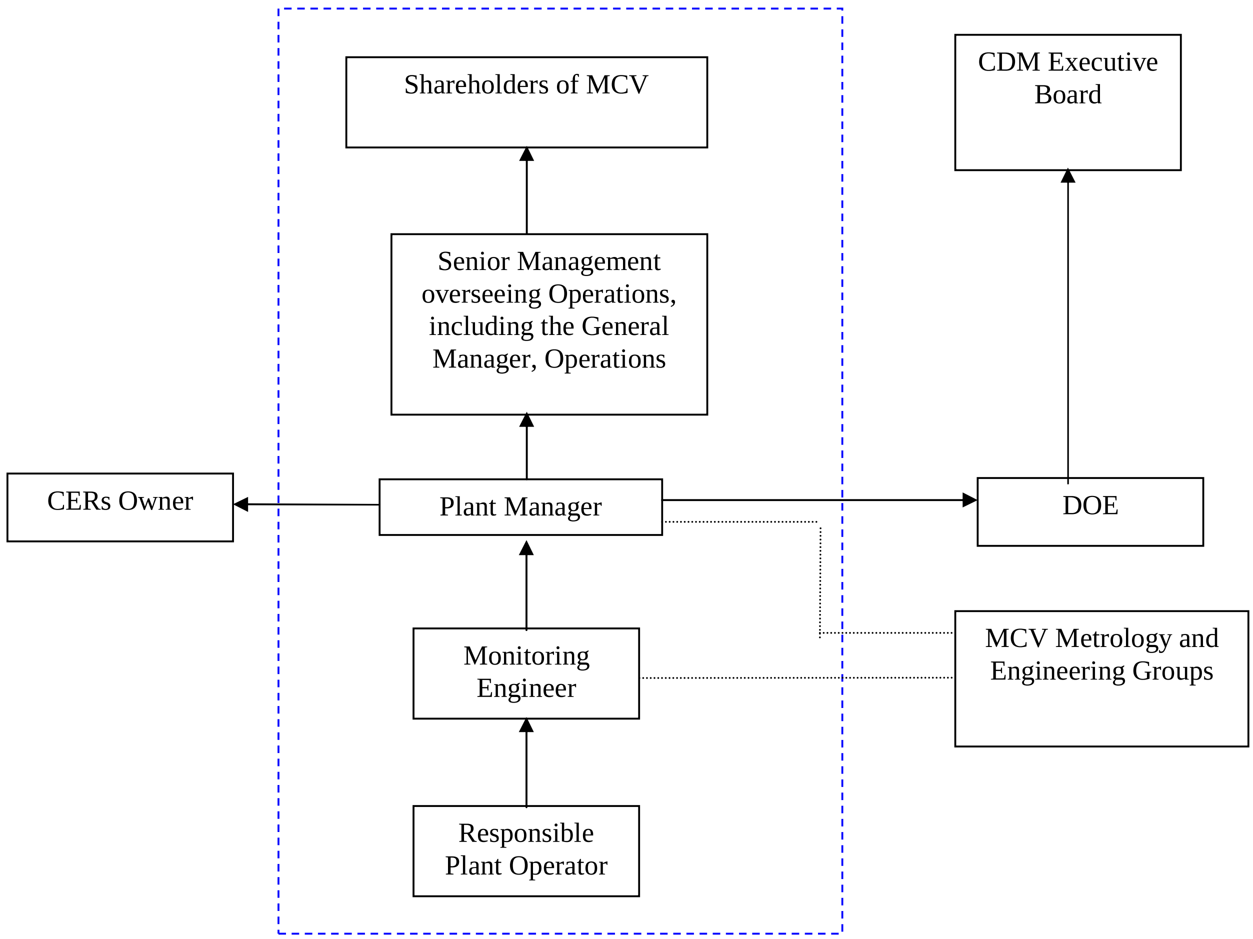
Monomeros baseline campaign began on February, 16th 2007 and will last until end of January, 2008.

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 and assured by Monomeros Internal Norms of Metrology.

Monomeros has written a manual of procedures for the proposed CDM project. This manual of procedures was available during the validation site visit.

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

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



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

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

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

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

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

routinely report to the General Manager Operations as to the overall progress with the CDM project activity. At any time that the Plant Manager wants or needs to follow the implementation of the CDM project activity, he/she will ask for a report from the Monitoring Engineer. For every one year period, the Plant Manager will send a report which will basically be the monitoring plan spreadsheet to the CERs owner, as well as to the corresponding DOE.

- MCV Metrology and Engineering Groups can at any time be used as a support function to the Monitoring Engineer in case of personnel loss or changes. The relevant Plant Manager also has MCV Metrology and Engineering Groups available as resources for assistance when required.

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

- Shareholders of MCV will receive annually from the plant manager, 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: 30/01/2008 (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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01/02/2008, following completion of measurements to establish baseline emissions factor.

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

>>

25 years.

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

>>
01/02/2008

C.2.1.2. Length of the first crediting period:

>>
7 years, 0 months

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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MCV 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 (Decree 1220). N_2O emissions are not regulated in the Colombia air quality regulation. The Colombian Environmental Legislation states that plants which began its operation before year 1993 don't need an operational license for operating; since Monomeros started its operation before year 1993 doesn't need an operational license, it needs the following permissions; water, atmospheric emission and waste water.
Monomeros production plant is under the regulation of the DAMAB and has the permissions numbered above; regarding atmospheric emissions applies the Resolution No. 1027 of November 25/2004 which gives Monomeros the Atmospheric Emissions Permit required under national regulation.

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 Colombian authorities. Adequate management of all possible project impacts are included in the approved Environmental Management Plan (EMP) of the Facility.

However, any possible impacts originated during the secondary catalyst installation (mainly waste management) will be managed normally under the procedures approved by the local environmental authority (Departamento Tecnico Administrativo de Medio Ambiente de Barranquilla - DAMAB) in the general EMP of the Monomeros Colombo Venezolanos Production Facility, and will be reported to the DAMAB in the periodically required reports, the related regulation is:

- Resolution No. 1027 of november 25/2004. Atmospheric Emissions Permit,

- Resolution No. 1748 of november 24/2005. Following and actualization of the Environmental Management Plan.

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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The stakeholders' comments for the "Monomeros Colombo Venezolanos Nitrous Oxide Abatement Project" were carried out as follows:

Initially, the project was presented before the Environmental Committee of the ANDI (National Association of Colombian Entrepreneurs) of the Barranquilla area, in a meeting carried out on May 2nd , with the participation of representatives from the different industries present in the area and of the pertinent Environmental Authority, as it appears in the attendance list.

The presentation covered general aspects of the CDM and a detailed description of the proposed project activity. After the presentation, the audience was allowed to express their concerns and comments about the project, besides answering a questionnaire.

A total of 30 representatives from the industries of the area and the pertinent environmental authority participated in this meeting. The list of attendants is detailed in table E.1.

Then, all the information associated with the project was publicized in the websites www.monomeros.com and www.mgminter.com.ar/Monomeros_Colombo_Venezolanos/. This information included a draft of the Project Design Document, a graph explaining the CDM cycle and a file with the presentation used for the public meetings. This action aimed at making the project general information available for the interested parties. The said information was available as from May 5th. No comments regarding the information on the websites were received.

Later, a personalized invitation was made to representatives from institutes, universities, NGOs, surveillance and control entities, the Environmental Authority, the industrial sector, community in general, among others. They were invited to participate in a public meeting, which was carried out on May 12th in Comfamiliar, Norht Headquarters, Executive Room 1, in Barranquilla (Colombia). Additionally, this invitation was used for informing about the availability of consultation documents on the websites and the possibility of extending this invitation to the people or institutions that may be somehow affected by the project.

A total of 24 people representing the aforementioned sectors attended the public meeting of the interested parties. The list of attendants is detailed in table E.2.

The comments received in the two above said meetings are summarized in section E.2.

Table E.1. Interested parties that attended the Project presentation – Environmental Commitee ANDI, Barranquilla area – May 2nd, 2006

Institution/Company (If Any)	Name	Position
TEBSA	Juan Meza Campanella	
SIDUNOR	Tito Fonseca	
DAMAB	Fred A. Caro	Advisor
QUINTAL	William Ruiz P.	Environmental Management
ATUNEC	William Cabrales	Maintenance Manager
DAMAB	Manuel Pedraza	Specialized Professional
SAINT GOBAIN	Irene Arzuza	Environmental Manager
EMPICOLSA	Alexander Martínez	Quality Manager
ALUMINIO REYNOLDS	Armando Díaz Granados	Quality Management
FAGRAVE S.A.	Jorge E. Ramírez	Product Manager
FAGRAVE S.A.	Lorena Iglesias	Responsible for Management Systems
ACESCO S.A.	Isabel Cristina Uribe	Environmental Management Coordinator
ACESCO S.A.	Shirlley Llain A.	Lawyer
Generoso Mancini Cia. Ltda.	Eduardo Osorio	Product Manager
VANYLON	Dilfonso Hernández	Maintenance Engineer
VANYLON	Glevis Barros	Security
VANYLON	Isamary Barrios	Lawyer
COORECIFUENTE	Jair Murillo	President
COOREVERDECER	Eduardo Morelo	Manager
DAMAB	Germán Celi	Subdirector
DAMAB	Betty Castro E.	Pilot Program Coordinator
LLOREDA S.A.	Luis Caicedo	Quality Manager
CEMENTO ARGOS	Erika Torrenegra	Environmental Manager Engineer
UNIBOL S.A.	Antonio Florez	Environmental Advisor
QUINTAL S.A.	Elkin Bedoya	Quality Manager
VANYLON S.A.	Sneyder Villalba	Process Engineer
PQP S.A.	Reñiré Gonzalez	Quality Control Manager
DAMAB	Karina Rosales	Advisor
COOLECHERA	Navia Mendez	General Services Manager
DAMAB	Erney Castillo	Economist

Table G.2. Interested parties invited to the Project presentation – May 12th, 2006

Institution/Company (If Any)	Name	Position
BARRANQUILLA DISTRICT	Guillermo Hoenigsberg Bornacelli	District Mayor
BARRANQUILLA DISTRICT	José Pérez	Planning Secretary
ADMINISTRATIVE ENVIRONMENTAL DEPARTMENT OF BARRANQUILLA, DAMAB	Jorge Nassar Coll	General Manager
BARRANQUILLA METROPOLITAN AREA	Flor María Acuña	Metropolitan Area Director
PROBARRANQUILLA	Tatiana Orozco	
COECONOMICA	Robinsón Mafiol Coronado	NGOs Representative
REGIONAL REPRESENTATIVE OF THE NATIONAL RECYCLERS ASSOCIATION	Yeimi Monzalvo	Organized Recyclers Representative
FUNDESARROLLO	Manuel Fernandez	
DUPONT	William Sanchez	
ACIQ	Oswaldo del Castillo	
QUINTAL	William Ruiz	
CORPORACIÓN UNIVERSITARIA DE LA COSTA	Henry Maury	Dean of the Engineering Faculty
CEMENTOS ARGOS	Leonardo Dimare	
TECNOGLASS	Cristian Daes	
ANDI	Alberto Vives	
TERMOFLORES	Hilberto Díaz Martínez	General Manager
UNIVERSIDAD DEL ATLANTICO	Ernesto Cortissoz	
GASES DEL CARIBE	Ramón Davilas Martínez	General Manager
PROMIGAS	Antonio Martínez Aparicio	President
CHAMBER OF COMMERCE	Enrique Berrío Mendoza	Executive President
BARRIO LAS FLORES COMMUNITY		
COMMUNITY IN GENERAL		

E.2. Summary of the comments received:

>>

All people who attended to the meetings expressed their opinions and made comments, all of the comments were made in Spanish. The following is a summary of the translated comments and questions.

Comments and questions from the meeting of May 2nd, 2006 (representatives of the industrial sector and the pertinent Environmental Authority)

In general, all comments regarding the project received in this meeting were very positive. Most of the questions and comments were focused on the technical aspects, since the industrial sector representatives wanted to know the details of the activity. The following are some questions and comments from the meeting:

One of the meeting participants expressed interest in making a follow-up to this CDM project and other CDM projects in general, with the purpose of confirming their evolution and that if the objectives were achieved.

Very positive comments were received from various attendants, who expressed interest in developing projects of this type in the companies they were representing.

Comments and questions for the meeting of May 12th, 2006 (Environmental authorities, universities, surveillance and control entities, NGOs, private sector, community and other interested parties)

Which is the project-related investment cost, and how will it be financed?

Does the project has additionality problems?

How will the project new methodology be managed?

How will the incomes generated from the project be invested so that they can benefit the community?

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

>>

In this section, comments are categorized by subject. For each category, there is a description on how the project proponents have taken such comments into account.

Favorable comments

Favorable comments are acknowledged. The project developer intends to proceed with the project as quickly as reasonably possible so that the benefits of the project can be obtained.

Social benefits

Regarding the social benefit, the comments were focused on knowing how the incomes obtained from the project activity would be invested as social investment.

This resources investment will be channeled through the "FUNDAMONOMEROS" Foundation, responsible for the identification and execution of the social projects sponsored by the Monómeros Colombo Venezolanos Company.

Additionality

The answers to the comments regarding additionality can be found in section B of this PDD.

Environmental Aspects

With respect to the comments concerning environmental issues, there was an explanation on how the technology proposed for the project would have a positive effect on the environment, due to the control of nitrous oxide (a potent greenhouse gas).

Technical Aspects

In order to clear all doubts regarding technical operations, there was a detailed explanation on how the secondary catalysts to be used in the project will work.

With regard to the new methodology, it was explained that this methodology is expected to be approved by the Meth Panel in the short term, thus the project chronogram would be carried out without major modifications.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	MONOMEROS COLOMBO-VENEZOLANOS S.A.
Street/P.O.Box:	Vía 40 Las Flores/P.O. Box 3205
Building:	
City:	Barranquilla
State/Region:	Atlántico
Postfix/ZIP:	
Country:	Colombia
Telephone:	(57-5) 3618250
FAX:	(57-5) 3556595 - 3559996
E-Mail:	
URL:	www.monomeros.com
Represented by:	Héctor Rodelo Sierra
Title:	General Manager
Salutation:	
Last Name:	Rodelo Sierra
Middle Name:	
First Name:	Héctor
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	Hrodelo@monomeros.com.co

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funds are available for the financing of the project activity. Therefore, Monomeros Colombo Venezolanos 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	
Tail gas N_2O concentration (ppmv)	1,300
Typical Nitric acid production output (ton 100% HNO_3/year)	83,530
N_2O baseline emission factor (kg N_2O / ton 100% HNO_3)	5.56
N_2O destruction factor (%)	85
UNC (%)	2.94
Operating days	350

Annex 4

MONITORING INFORMATION

The current CDM project "Monomeros Nitrous Oxide Abatement Project" will measure on a quasi-continuous basis (uninterrupted sampling of flue gases with concentration and normalized flow analysis on short, discrete time periods) the N_2O mass flow leaving the Nitric acid plant through an Automated Measuring System (AMS[4]) using technologies and procedures in accordance with AM0034: "Catalytic reduction of N_2O inside the Ammonia burner of nitric acid plants".

The industrial complex of Monomeros Colombo-Venezolanos is currently ISO 9001/2000 certified and is working on the implementation of ISO 14001/2004 certification.

Monomero's 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. Furthermore, the plant has been operating stack emissions units (f.e. NO_X) during sixteen years. The plant has access to specialized technical services available from the Metrology and Engineering Groups that provides support to the Operation team.

[4] 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.

Before beginning the baseline campaign all the people in charge of the operation of the AMS were trained to deal with the new technology installed as consequence of the project activity. Registers of those trainings were available during the validation

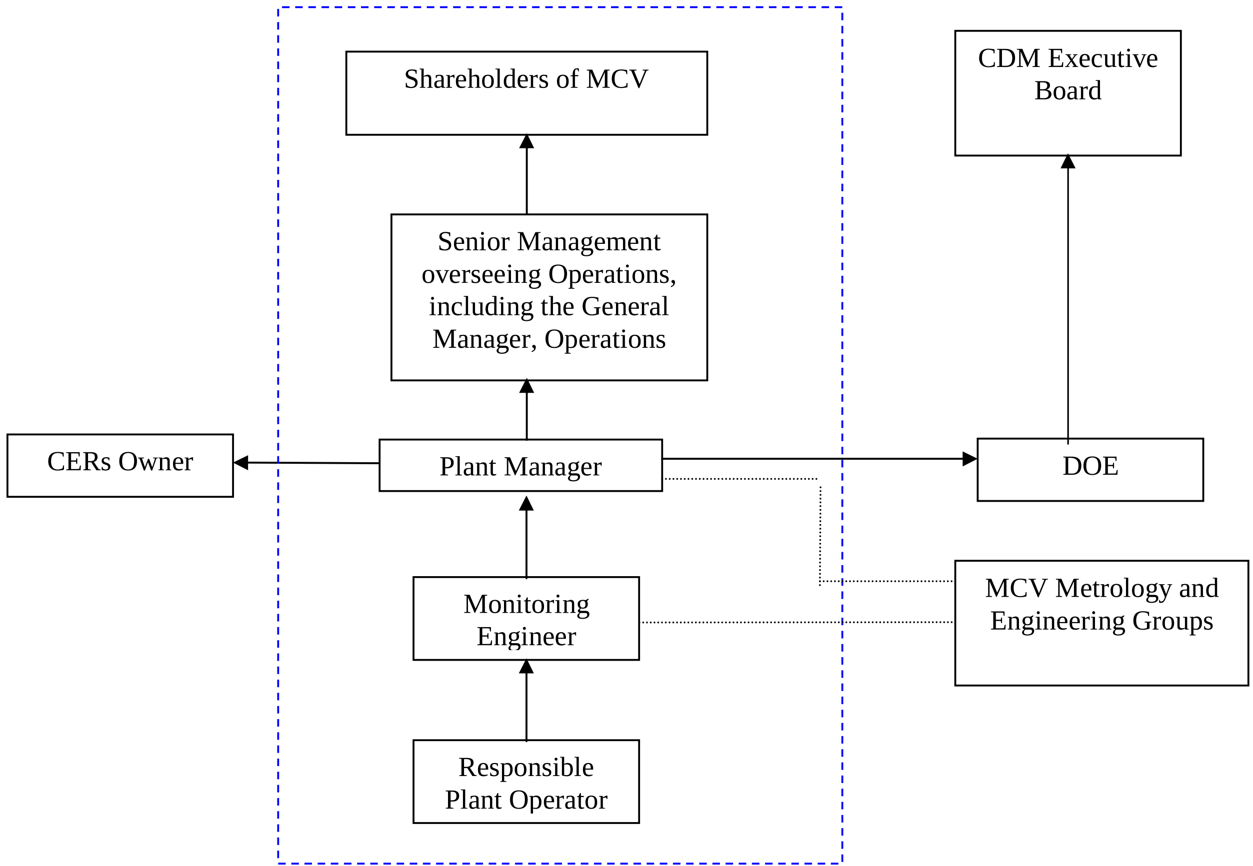
Monomeros baseline campaign began on February, 16th 2007 and will last until end of January, 2008.

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 and assured by Monomeros Internal Norms of Metrology.

Monomeros has written a manual of procedures for the proposed CDM project. This manual of procedures was available during the validation site visit.

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

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



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

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

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

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

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

- MCV Metrology and Engineering Groups can at any time be used as a support function to the Monitoring Engineer in case of personnel loss or changes. The relevant Plant Manager also has MCV Metrology and Engineering Groups available as resources for assistance when required.

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

- Shareholders of MCV will receive annually from the plant manager, 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 both baseline campaign as well as (future) project campaigns. Furthermore, the baseline methodology requires that certain process parameters are monitored (to be compared vs the permitted operating conditions) during baseline campaign; such process parameters are also described in tables B.7.1. Only those N_2O measurements taken when the plant is operating within the permitted range will be considered during the calculation of baseline emissions.

All the relevant instrumentation to measure process parameters are calibrated on a routinely basis. The signals generated by these instruments are acquired and logged electronically by the Distributed Control System (DCS). 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.

If the AMS were down during a period of the baseline campaign, the lowest value between the default IPCC emission factor (4,5 kg N_2O/ton HNO_3) and the latest value measured, would be used during downtime in baseline emission factor calculation. If the AMS were down during a period of a project campaign, the highest value between the default IPCC emission factor (4,5 kg N_2O/ton HNO_3) and the latest value measured, would be used during downtime in project emission factor calculations.

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

Emission reduction calculations

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

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

Where:

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

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

Where:

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

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

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

where:

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

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

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

where:

EF_n	Emission factor calculated for the *nth* campaign, in kg N_2O/ton HNO_3
PE_n	Total Project emissions of the *nth* campaign, in tN_2O

NAP_n Nitric acid production in the *nth* campaign, in ton 100% HNO_3

Then,

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

where

ER_n Emission reductions of the project for the *nth* campaign, tCO_2e

EF_{BL} Baseline emission factor, in tN_2O/ $tHNO_3$

EF_p Project emission factor, applicable to the *nth* campaign, in tN_2O/ $tHNO_3$

NAP_n Nitric acid production during the *nth* campaign of the project activity, in, $tHNO_3$

GWP_{N_2O} Global Warming Potential of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Description of the AMS

MCV plant has installed continuous gas analyzers from the supplier ABB, model AO2000, while the specific module to measure N_2O is a non-dispersive infrared called URAS 14. The URAS 14 has been on the market for several years and is a proven reliable instrument; this module is TUV certified to comply with German 27th BlmSchV regulation for several compounds (such as CO, NO, SO_2). Below are the instruments specifications as per manufacturer.

Infrared Analyzer Module Uras14

Measurement Principle

Non-dispersive infrared absorption in the $\lambda = 2.5–8$ µm wavelength range

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

Sample Components and Smallest Measurement Ranges

The Uras14 analyzer module has one physical measurement range per sample component. As an option, smaller measurement ranges can be electronically derived from the physical measurement range. The smallest range is measurement range 1.

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

Sample Component	Class 1 Range	Class 2 Range	Class 2 Range with Calibration Cell	Gas Group 1)
CO	0– 100 ppm	0– 10 ppm	0– 50 ppm 2)	A
CO_2	0– 100 ppm	0– 5 ppm	0– 25 ppm 2)	A
NO	0– 200 ppm	0– 150 ppm	0– 150 ppm 2)	A
SO_2	0– 100 ppm	0– 25 ppm	0– 25 ppm 2)	A
N_2O	0– 100 ppm	0– 20 ppm	0– 50 ppm 2)	A
NH_3	0– 500 ppm	0– 30 ppm	–	B
CH_4	0– 100 ppm	0– 50 ppm	0– 50 ppm 2)	A
C_2H_2	0– 200 ppm	0– 100 ppm	0– 100 ppm	B
C_2H_4	0– 500 ppm	0– 300 ppm	0– 300 ppm	B
C_2H_6	0– 100 ppm	0– 50 ppm	0– 50 ppm 2)	B
C_3H_6	0– 250 ppm	0– 100 ppm	0– 100 ppm 2)	B
C_3H_8	0– 100 ppm	0– 50 ppm	0– 50 ppm 2)	B
C_4H_{10}	0– 100 ppm	0– 50 ppm	0– 50 ppm 2)	B
C_6H_{14}	0– 500 ppm	0– 100 ppm	0– 100 ppm 2)	B
R 134a	0– 100 ppm	0– 50 ppm	0– 50 ppm 2)	B
SF_6	0–2000 ppm	0–1900 ppm	0–2000 ppm	B
H_2O	0–1000 ppm	0– 500 ppm	0– 500 ppm	C

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

Other sample components on request.

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

Stability

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

Repeatability
≤ 0.5 % of span

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

Sensitivity Drift
≤ 1% of measured value per week

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

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

Measurement Ranges

Quantity
1 to 4 ranges per sample component

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

Measurement Range Ratio
≤ 1:20

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

Measurement Range Switching
Manual; available external control or automatic

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

Calibration

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

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

Influence Effects

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

Associated Gas Effect/Cross Sensitivity
The knowledge of the sample gas composition is necessary for the analyzer configuration.
Selectivity measures to reduce associated gas effect (optional): Incorporation of interference filters, filter vessels or internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Uras14.

Temperature Effect
Ambient temperature in permissible range
- At zero-point: ≤ 1 % of span per 10 °C;
  for ranges smaller than Class 1 to Class 2:
  ≤ 2 % of span per 10 °C
- On sensitivity with temperature compensation:
  ≤ 3 % of measured value per 10 °C
- On sensitivity with thermostat effect at 55 °C (optional):
  ≤ 1 % of measured value per 10 °C

Air Pressure Effect
- At zero-point: No effect
- On sensitivity with pressure correction by means of integral pressure sensor: ≤ 0.2 % of measured value per 1 % barometric pressure change

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

Power Supply Effect
24 VDC ± 5 %: ≤ 0.2 % of span

Dynamic Response

Warm-Up Time
Approx. 30 minutes without thermostat; approx. 2 hours with thermostat

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

Materials in Contact with the Sample Medium

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

Gas Lines and Connectors
Viton hoses and PTFE tubing with stainless steel connectors;
Option: Rust- and acid-resistant steel tubes 1.4571

Gas Connections

Layout and Design
Gas ports on back (19-inch rack housing) or bottom (wall-mount housing) of the analyzer module with 1/8 NPT internal threads for commercially available adapters, e.g. Swagelok®;
See page 40 for connection drawing

Electrical Connections

System Bus
3-pin female plug

External 24-VDC Power Supply
4-pin male plug

Gas Inlet Conditions

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

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

Outlet Pressure
Atmospheric pressure

Flow Rate
20–100 l/h

Corrosive Gases
Highly corrosive associated gas components, e.g. chlorine (Cl_2) and hydrogen chloride (HCl), as well as gases or aerosols containing chlorine must be cooled or undergo prior absorption. Provide for housing purge.
Viton hoses should not be used if the sample gas contains NH_3. In this case the gas module cannot be connected to the analyzer module.

Flammable Gases
Stainless steel tubes and housing purge with N_2 should be provided when measuring flammable gases.

O_2 Concentration
If an Ex model analyzer module is installed in Zone 1, the sample gas O_2 concentration must not exceed 21 Vol.-% (see also page 42).

Purge Gas
The purge gas should not contain any sample gas components.

Power Supply

Input Voltage
24 VDC ± 5 % from the built-in power supply or an external unit

Power Consumption
Approx. 75 W

Installation Site Requirements

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

Ambient Temperature
Operation: +5 to +40 / 45 °C when installed in housing with/without electronics module;
Storage and Transport: –25 to +65 °C

For stack flow measurement, the plant selected as primary meter an Annubar principle (multiple pressure differential) unit, model 485 Annubar primary manufactured by Rosemount Inc. (USA).
Table below summarize the specifications of the Annubar unit:

Rosemount 485 *Annubar* Primary

SPECIFICATIONS

Performance

Performance Statement Assumptions
Measured pipe I.D.

Discharge Coefficient Factor
±0.75% of flow rate

Repeatability
±0.1%

Line Sizes
- Sensor Size 1: 2-in. to 8-in. (50 to 200 mm)
- Sensor Size 2: 6-in. to 96-in. (150 to 2400 mm)
- Sensor Size 3: 12-in. to 96-in. (300 to 2400 mm)

NOTE
Some mounting types are not available in larger line sizes.

TABLE 26. Reynolds Number and Probe Width

Sensor Size	Minimum Rod Reynolds Number (R_d)	Probe Width (d) (inches)
1	6500	0.590-in. (14.99 mm)
2	12500	1.060-in. (26.92 mm)
3	25000	1.935-in. (49.15 mm)

Functional

Service
- Liquid
- Gas
- Steam

Process Temperature Limits
Direct Mount Electronics
- 500 °F (260 °C)
- 750 °F (400 °C) when used with a direct mount, high temperature 5-valve manifold (Electronics Connection Platform code 6)

Remote Mount Electronics
- 1250 °F (677 °C) – *Hastelloy* Sensor Material
- 850 °F (454 °C) – Stainless Steel Sensor Material

Pressure and Temperature Limits(1)
Direct Mount Electronics
- Up to 600# ANSI (1440 psig at 100 °F (99 bar at 38 °C))
- Integral temperature measurement is not available with Flanged mounting type greater than class 600

Remote Mount Electronics
- Up to 2500# ANSI (6000 psig at 100 °F (416 bar at 38 °C)).

Good monitoring practice and performance characteristics

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

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

The suitability evaluation and its measuring procedure are described in ISO 14956:2002 “Air quality – Evaluation of the suitability of a measurement procedure by comparison with a required measuring uncertainty”. Using this standard, it shall be proven that the total uncertainty of the results obtained from the AMS meets the specification for uncertainty stated in the applicable regulations (f.e. EU Directives 2000/76/EU or 2001/80/EU). Since European regulations do not yet cover the measurement of N_2O at nitric acid plants, there is no official specification for uncertainty available. Then, considering official specification of uncertainties defined for equivalent pollutants (f.e. NOx, SO_2) as per EU regulations, a 20% of the ELV (Emission Limit Value, in this case taken as the actual test concentration or calibration gas) has been considered by the equipment manufacturer as the required measurement quality for N_2O, for purpose of expanded uncertainty calculations. The specific performance characteristics of the monitoring system chosen by the project shall be listed in the Project Design Document, as per AM0034. Then, tables below indicate such characteristics as per the corresponding QAL 1[5] report.

[5] The Uras14 infra-red photometer currently used in ABB’s AO2000 analyzers and ACN systems has not been tested for N_2O measurement to EN 14181, so no official QAL1 Declaration can be provided for the existing installations.

Specific performance characteristics for N_2O analyzer (ABB AO 2000 URAS14):

Contributing partial standard uncertainties and reference to their origins

Selectivity H2O	0.00	mg/m^3
Selectivity others (largest sum)	1.86	mg/m^3
Lack of fit	0.17	mg/m^3
Drift	49.54	mg/m^3
Pressure dependence	0.00	mg/m^3
Temperature dependence	11.94	mg/m^3
Flow dependence	0.00	mg/m^3
Voltage dependence	0.00	mg/m^3
Repeatability	0.21	mg/m^3
Uncertainty of response factors	0.00	mg/m^3
Response time	43	seconds
Origin of data	*TÜV-Report no. 24020597 (1998)*	
Long-term drift of calibration cell	4.95	mg/m^3
Origin of data	*Article in UmweltMagazin, 2001*	
Combined uncertainty of SRM	18.46	mg/m^3
Standard Reference Method (SRM), Reference	*Gas chromatography, VDI 2469*	
Uncertainty of cylinder gas	28.60	mg/m^3
Origin of data	*Datasheet of gas supplier*	

The complete EN 14181: 2004 QAL1 reports are provided by the equipment manufacturers considering the performance characteristics as measured by a qualified Technical Inspection Authority (such as the German TÜV) and the specific installation characteristics and site conditions at the plant. The QAL1 reports confirm the N_2O analyzer (AO 2000- URAS 14 NDIR supplied by ABB GmbH) are suitable to perform the indicated analysis (N_2O concentration), and provide a conservative estimation (meaning actual performance would be better) for expanded uncertainty. The complete QAL1 reports are available for validation.

The overall measurement uncertainty (*UNC*) is calculated by summing in an appropriate manner (using gauss law of error propagation) all the relevant uncertainties arising from the individual performance characteristics of the AMS components (then UNC = ((N_2O Analyzer uncertainty)^2 + (Flow meter uncertainty)^2)$^{1/2}$). The overall measurement uncertainty estimation (as part of the QAL2 report) is available for the validation of the project activity.

QAL2: Validation of the AMS following its Installation.

However, by utilizing the basic minimum performance data from the instrument's specification sheet, it was possible to generate an unofficial "Declaration", which in practice the actual equipment would better

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[6] 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.
MCV selected a European laboratory officially accredited to conduct the QAL2 tests for the European industry. The fully EN14181 compliant QAL2 report from the certified lab is available for the validation process. Any emission data collected previous to the reception of the QAL2 lab report was corrected through the proper application of the resulting calibration function.
As condition precedent for a QAL2 test, it is required that the AMS has been correctly installed and commissioned, considering (for example) that the AMS is readily accessible for regular maintenance and other necessary activities and that the working platform to access the AMS allows for parallel sampling. The AMS unit was installed by qualified contractors under the direct supervision of the equipment manufacturers, considering both relevant Colombian and international standards. The Plant Manager, as well as members of the Engineering and Metrology support groups, actively supervised all phases of installation, from system design to commissioning.

QAL3: Ongoing quality assurance during operation.

Procedures described at QAL3 of EN 141181: 2004 check for drift and precision, in order to demonstrate that the AMS is in control during its operations so that it continues to function within the required specification for uncertainty. This is achieved by conducting periodic zero and span checks on the AMS, and evaluating results obtained using control charts. Zero and span adjustments or maintenance of the AMS may be implemented, as result of such evaluation. The implementation and performance of the QAL3 procedures given in this standard are the responsibility of the plant (or AMS) owner.

The standard deviation according to QAL3 has been calculated by the equipment manufacturer based on equipment performance characteristics and field conditions for MCV's nitric acid plant. Calculation spreadsheets from the suppliers are available for validation. The data is used to monitor that the difference between measured values and true values of zero and span reference materials are equal or smaller than the combined drift and precision value of the AMS multiplied by a coverage factor of 2 (2

[6] 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.

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 validation and future verifications.

All monitoring equipment is serviced and maintained according to the manufacturer's instructions and international standards by qualified personnel (both MCV resources and the third parties involved during such activities). Maintenance and service logs are well kept at MCV 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 plant's AMS at least once every 5 years, considering the total expected uncertainty of the AMS is well below the selected required uncertainty, provided on going quality assurance (QAL3) and equipment maintenance is proven to be well implemented (as per the current monitoring plan) during the annual verification audits.

Annex 5

INVESTMENT ANALYSIS

SIMPLE INVESTMENT ANALYSIS SUMMARY AND RESULTS

Capital Investment (USD):	200,000	total period 07-15
Total CER's :	142,175	per year
CER' deductions :	(29,558)	per year
Net CER's Revenue (USD) :	900,935	per year
Other Income (USD) :	-	per year
Variable Costs (USD) :	(139,142)	per year
Tax (USD) :	(209,044)	per year
NPV (USD) :	1,466,509	total period 07-15
IRR (%) :	77.0%	total period 07-15

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