



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

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

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Sasol Nitrous Oxide Abatement Project
Version 5
31 January 2007

A.2. Description of the project activity:

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Nitrous Oxide (N₂O) 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 N₂O from nitric acid production is typically released into the atmosphere, as it does not have any economic value or toxicity at typical emission levels. N₂O 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 N₂O inside the reactor once it is formed.

The baseline scenario is determined to be the release of N₂O emissions to the atmosphere at the currently measured rate, in the absence of regulations to restrict N₂O emissions. If regulations on N₂O emissions are introduced during the crediting period, the baseline scenario shall be adjusted accordingly.

Baseline emissions rate will be determined by measuring N₂O emission factor (kg N₂O/tonne HNO₃) during a *complete* production campaign prior to project implementation. To assure that the data obtained during the initial N₂O 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 N₂O 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 N₂O emission will be monitored directly in real time. Additional N₂O monitoring and recording facilities will be installed to measure the amount of N₂O 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 country¹ through industrial technology transfer (catalyst technology from a developed country to South Africa). The project activity will reduce N₂O emissions and will not increase nor decrease direct emissions of other air pollutants.

¹ See Sustainable Development Criteria Analysis in Annex 6



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 Sasol's plants.

Sasol 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)
Republic of South Africa (host)	Sasol Nitro, a division of Sasol Chemical Industries Limited. 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.		

Sasol Nitro (hereinafter called "Sasol") is a division of Sasol Chemical Industries Limited, a private company incorporated under the laws of the Republic of South Africa. Sasol Chemical Industries Limited is part of the Sasol group of companies (the Sasol Group) whose activities are coordinated by the holding company Sasol Limited, founded in 1950. The Sasol Group is an integrated oil and gas entity with substantial chemical interests. It is based in South Africa with its head office in Johannesburg, but also has manufacturing and marketing facilities elsewhere in Africa, Europe, Asia and the Americas. Sasol is listed on the Johannesburg Securities Exchange (JSE), symbol SOL, and the New York Stock Exchange (NYSE), symbol SSL. Sasol Chemical Industries Limited represents the Sasol Group's chemicals businesses with its portfolio including polymers, solvents, olefins, surfactants, waxes, phenolics and nitrogenous products. Sasol Nitro, a division of Sasol Chemical Industries Limited, represents the nitrogenous products and related goods; it manufactures and markets ammonia, nitric acid, fertilizers, phosphoric acid, a phosphoric detergent, commercial explosives and specialized blasting accessories. The division also markets ammonia, sulfur and specialty gases produced by other Sasol divisions. Sasol Nitro operates two nitric acid plants. The smaller 557 ton 100% nitric acid per day unit in Sasolburg is linked to a downstream ammonium nitrate plant. The ammonium nitrate is processed in Sasolburg to produce low-density ammonium nitrate for use in the production of commercial explosives. The larger 860 ton per day unit in Secunda supplies a downstream ammonium nitrate plant linked to a 500,000 ton per annum fertilizer granulation facility that produces limestone ammonium nitrate (LAN) and various other fertilizer grades containing nitrogen, phosphorus and potassium. Ammonium nitrate for industrial use is sourced from both sites.

A.4. Technical description of the project activity:
A.4.1. Location of the project activity:



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A.4.1.1. <u>Host Party(ies):</u>
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Republic of South Africa

A.4.1.2. <u>Region/State/Province etc.:</u>

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Free State and Mpumalanga provinces

A.4.1.3. <u>City/Town/Community etc:</u>
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Sasolburg and Secunda.

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

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The project activity is located at two nitric acid plants owned by Sasol. The smaller unit (557 tonne per day) is located in Sasolburg and the other nitric acid plant (860 tonne per day) in Secunda.

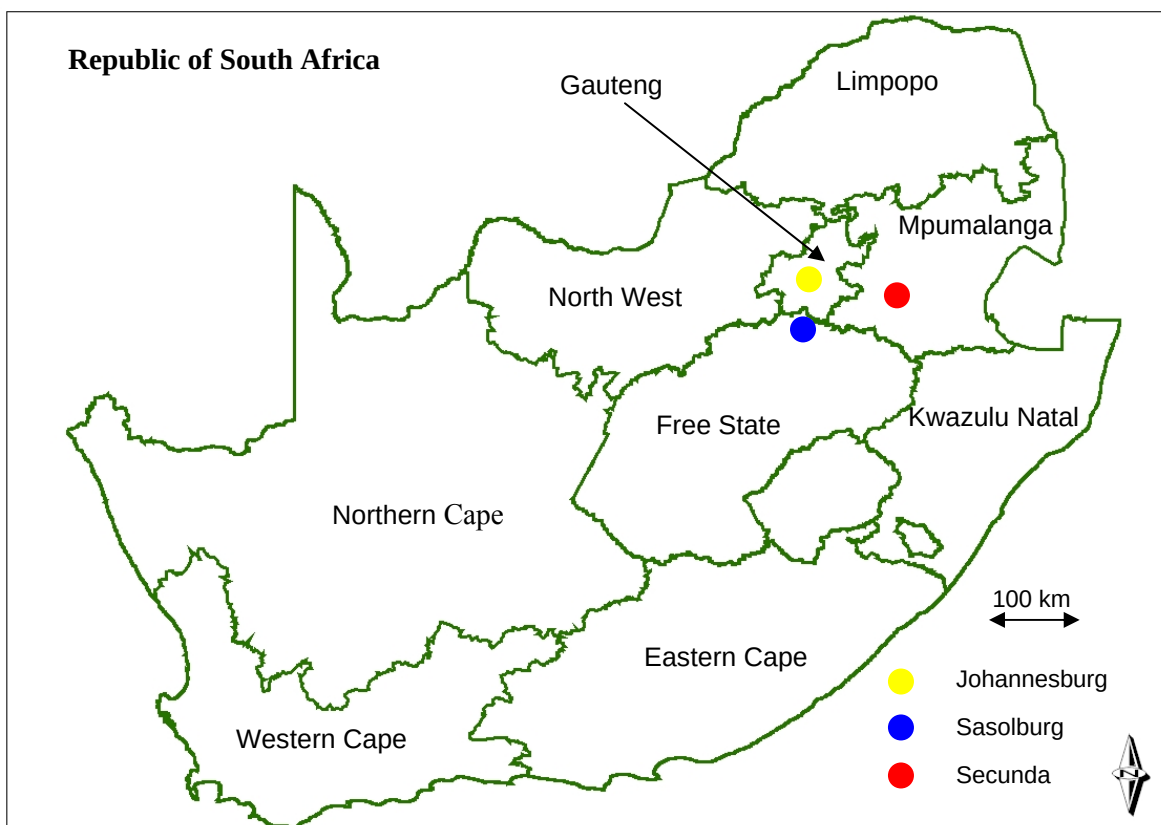


Figure 1. The location of Sasolburg and Secunda Plants

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:

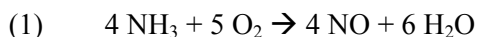
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The Ostwald process

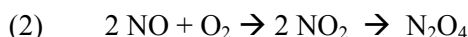
Nowadays, all commercial Nitric Acid is produced by the oxidation of ammonia, and subsequent reaction of the oxidation products with water, through the Ostwald process.

The basic Ostwald process involves 3 chemical steps:

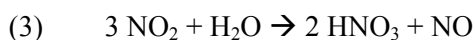
A) Catalytic oxidation of ammonia with atmospheric oxygen, to yield Nitrogen Monoxide (or Nitric Oxide).



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



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



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

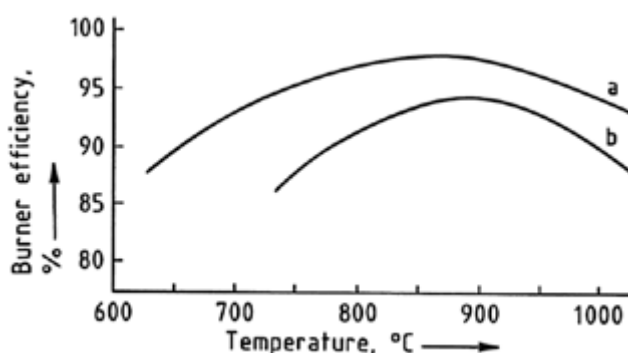


Figure 2. Conversion of Ammonia to Nitrogen Monoxide on Platinum Gauze as a function of temperature a) 100 kPa; (b) 400 kPa [1]

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

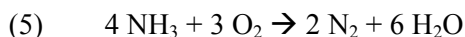
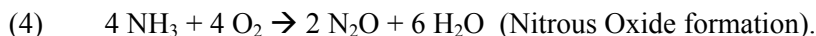
Nitrous Oxide formation

Nitrous oxide is formed during the catalytic oxidation of Ammonia. Over a suitable catalyst, a maximum 98% (typically 92-96%) of the fed Ammonia is converted to Nitric Oxide (NO) according to reaction (1) above. The remainder participates in undesirable side reactions that lead to Nitrous Oxide (N₂O), among other compounds.

² Thieman et al., "Nitric Acid, Nitrous Acid, and Nitrogen Oxides", *Ullmann's Encyclopedia of Industrial Chemistry 6th Edition*, Wiley-VCH Verlag GmbH & Co. KGaA. All rights reserved.



Side reactions during oxidation of Ammonia:



N₂O abatement technology classification

The potential technologies (proven and under development) to treat N₂O emissions at Nitric acid plants, have been classified as follows, based on the process location of the control device:

Primary: N₂O is prevented from forming in the oxidation gauzes.

Secondary: N₂O once formed, is eliminated anywhere between the outlet of the ammonia oxidation gauzes and the inlet of the absorption tower.

Tertiary: N₂O is removed at the tail gas, after the absorption tower and previous to the expansion turbine.

Quaternary: N₂O 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 N₂O; the secondary approach has the following advantages:

- The catalyst does not consume electricity, steam, fuels or reducing agents (all sources of leakage) to eliminate N₂O emissions; thus, operating costs are negligible and the overall energy balance of the plant is not affected.
- Installation is relatively simple and does not require any new process unit or re-design of existing ones (reactor basket needs some modifications to accommodate the new catalyst).
- Installation can be done simultaneously with a primary gauze changeover; thus, the loss in production due to incremental down time will be limited.
- Considerably lower capital cost when compared to other approaches.

The selected technology has been developed by **W.C. Heraeus GmbH** (Hanau, Germany; hereinafter called “Heraeus”), a wholly owned subsidiary of Heraeus Holding GmbH; the Heraeus Group has been in the precious metals business for more than 150 years. Heraeus is currently engaged in the production and trade of precious metals as well as complex material technology such as dental material, sensors, fused silica and specialty lighting sources. Heraeus began production of catalyst gauzes for nitric and cyanic acid production in 1915, and now serves this industry through the W.C. Heraeus Nitro Technologies Group business unit.

After extensive research, Heraeus has developed a “secondary” catalyst that decomposes N₂O without affecting Nitric Acid production. The active element of the catalyst is a proprietary coat of precious metals (the same elements already present in the oxidation gauzes) deposited over ceramic pieces made of

alfa-alumina (a common reactor material used in e.g. Raschig rings) of several shapes and sizes. The catalyst has a very high activity for N_2O decomposition; in a typical medium pressure plant, a catalyst weight of 30 kg/m^2 of cross sectional surface is sufficient to reduce N_2O concentration well below 100 ppmv. Theoretically, any given level of N_2O abatement can be reached, but in practice the abatement will be limited by practical and economical considerations. Heraeus secondary catalyst is not designed as catchment for precious metals, so it does not adsorb any material lost from the primary gauzes.

Effect of catalyst thickness on N_2O abatement

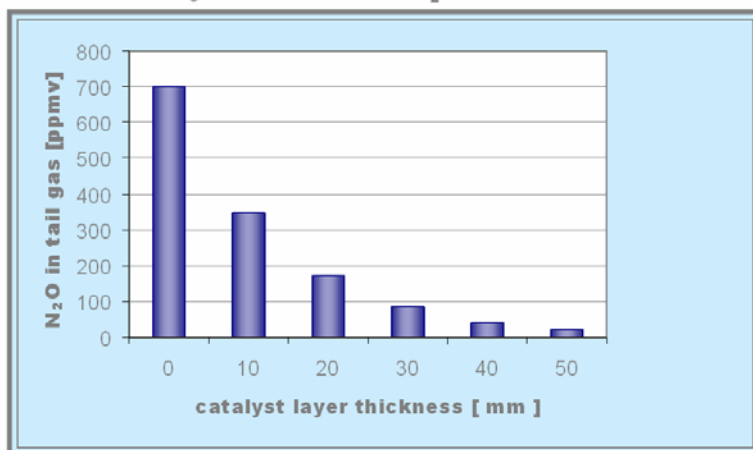


Figure 3. Effect of catalyst thickness on N_2O abatement
(Courtesy of W.C. Heraeus)

Some advantages specific to the selected secondary catalyst are:

- No measurable effect on ammonia to nitric oxide yield.
- Any level of N_2O in tail gas is achievable by adjusting the catalyst bed thickness.
- No new elements (like foreign metals) are introduced to the process, thus plant risk remains unchanged.
- The longest current run is 24 months, representing the 2nd campaign of the specific middle pressure plant.

Secondary catalyst installation

Figure 4 depicts a simplified diagram of the secondary catalyst installation to be performed at Sasol. Both Sasol plants have a Raschig ring bed as part of the support/homogenization system on their oxidation reactors. Due to its high degree of selectivity (towards N_2O decomposition) the depth of the secondary catalyst bed to be installed is only a few centimetres thick, much thinner than the actual Raschig ring bed.

To create space to insert the new catalyst, enough layers of Raschig rings will be removed from the basket. The precious metal coated ceramic pieces (the secondary catalyst) will come inside a cage of Kanthal or Megapyr steel (same material used for separating screens on the primary gauze pack) to secure even distribution of the pieces over the cross section area of the reactor. The outside rim of the caged catalyst is sealed with the reactor walls, in order to avoid any by-passing of the N_2O rich gases. Once the secondary catalyst is installed, the primary gauzes are placed on top of the basket, as usual. Then, the

secondary catalyst acts as support system for the primary gauze pack and both catalysts are in close contact.

Secondary Catalyst Installation sketch

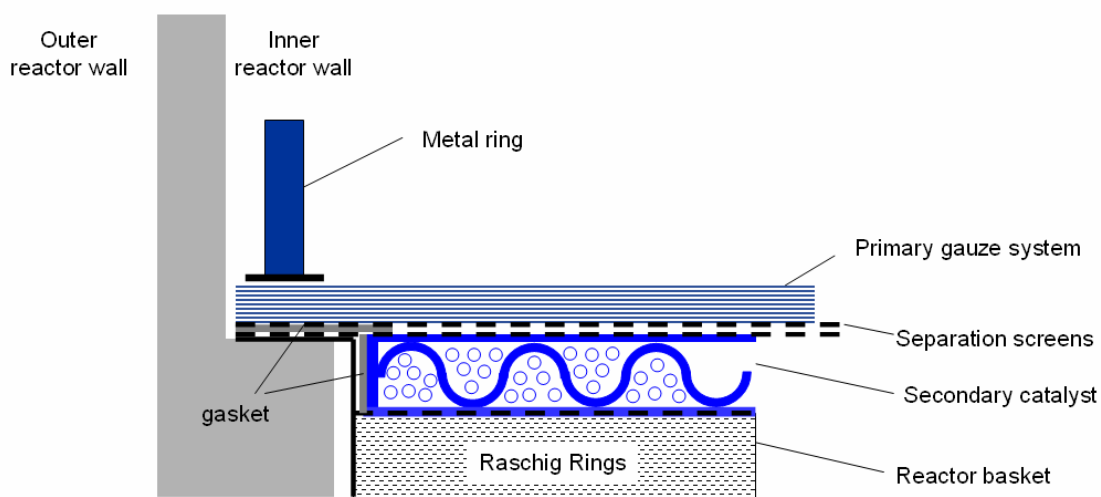


Figure 4. Secondary catalyst installation sketch

A.4.4 Estimated amount of emission reductions over the chosen <u>crediting period</u>:

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Total *ex-ante* emissions reductions are estimated to be 960,322 tonnes CO₂e/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 ₂ e		
	Sasolburg	Secunda	Total
Year 1	515,837	444,485	960,322
Year 2	515,837	444,485	960,322
Year 3	515,837	444,485	960,322
Year 4	515,837	444,485	960,322
Year 5	515,837	444,485	960,322
Year 6	515,837	444,485	960,322
Year 7	515,837	444,485	960,322
Total estimated reductions (tonnes of CO ₂ e)	3,610,859	3,111,395	6,722,254
Total number of crediting years	7		
Annual average over the crediting period of estimated reductions (tonnes of CO ₂ e)	515,837	444,485	960,322

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 the version 2 of AM0034 “Catalytic reduction of N₂O inside the ammonia burner of nitric acid plants”. Version 2 of the “Tool for the demonstration and assessment of additionality” 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 N₂O emissions from Sasolburg and Secunda Nitric Acid Plants meeting all the conditions specified in the selected approved methodology (AM0034):

- Sasolburg and Secunda plants limit the application of this project activity to existing nitric acid production capacity installed no later than 31 December 2005. Definition of “existing” production capacity is applied for the process with the existing ammonia oxidization reactor where N₂O is generated and not for the process with new ammonia oxidizer. Existing production “capacity” is defined as the designed capacity, measured in tons of nitric acid per year.
- The project activity will not result in the shut down of any existing N₂O destruction or abatement facility or equipment in the plant.
- The project activity shall not affect the level of nitric acid production.
- There are currently no regulatory requirements or incentives to reduce levels of N₂O emissions from nitric acid plants in South Africa.
- No N₂O abatement technology is currently installed in Sasolburg or in Secunda plant.
- The project activity will not increase NO_x emissions.
- NO_x abatement catalyst installed, if any, prior to the start of the project activity is not a Non-Selective Catalytic Reduction (NSCR) DeNO_x unit.
- Operation of the secondary N₂O abatement catalyst installed under the project activity does not lead to any process emissions of greenhouse gases, directly or indirectly.
- Continuous real-time measurements of N₂O concentration and total gas volume flow can be carried out in the stack:
 - o Prior to the installation of the secondary catalyst for one campaign, and
 - o 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 Sasolburg and Secunda nitric acid plants 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 N₂O contained in the waste stream exiting the stack. The abatement of N₂O 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 ₂ O	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 ₂ O	Included	
	Leakage emissions from production, transport, operation and decommissioning of the catalyst.	CO ₂	Excluded	No leakage emissions are expected.
		CH ₄	Excluded	
		N ₂ O	Excluded	

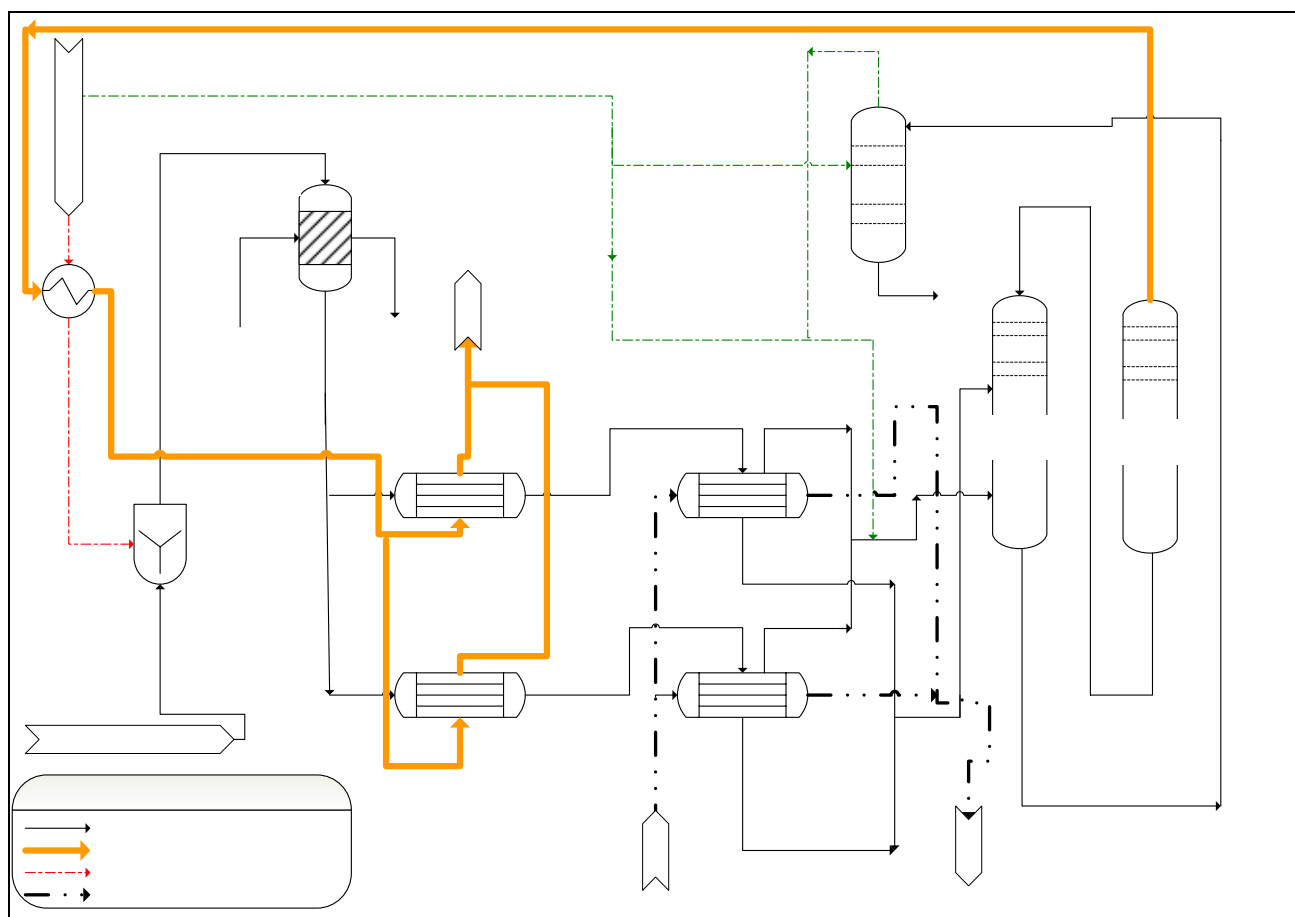


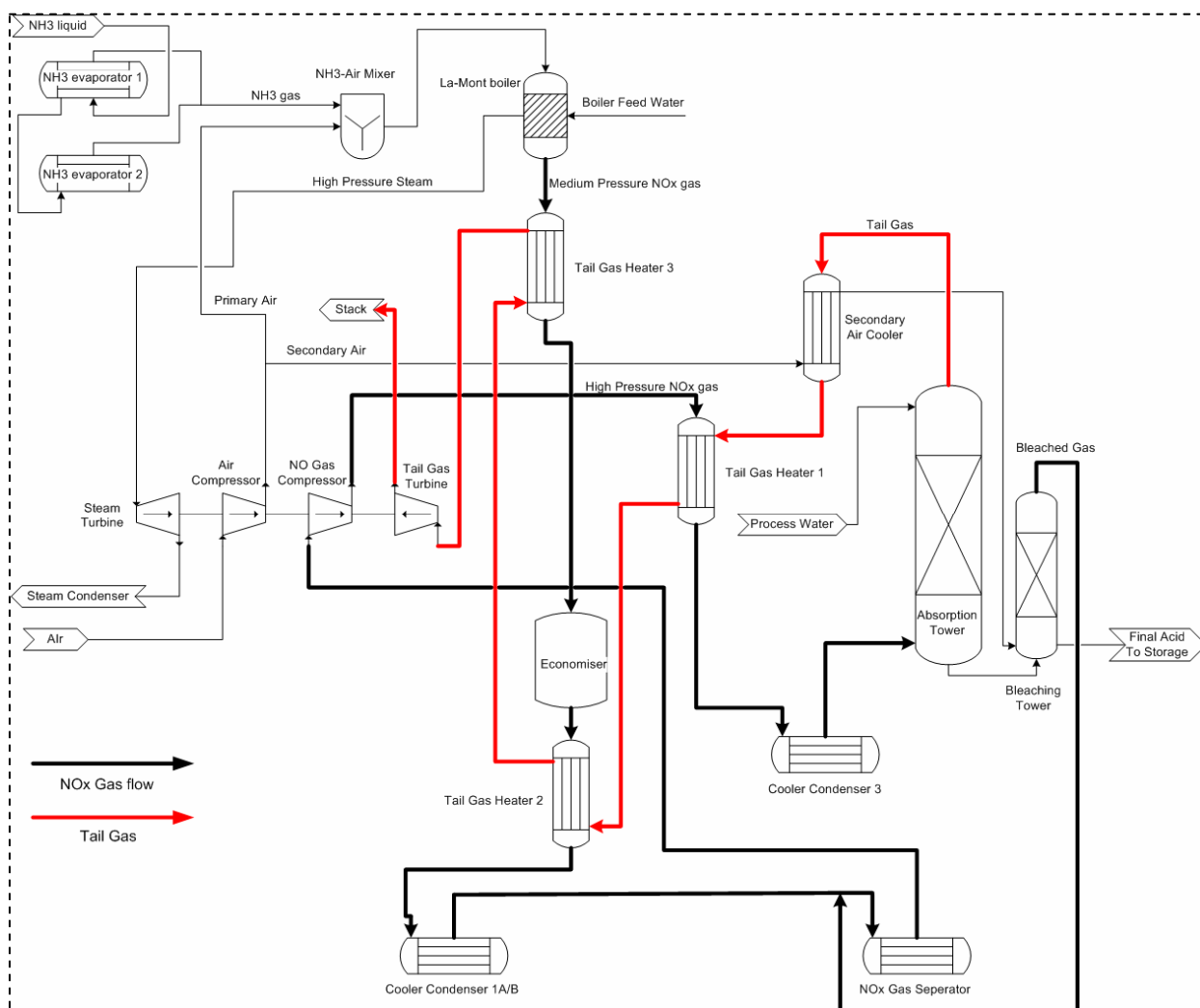
Figure 5. Project boundary for Sasolburg Nitric Acid Plant

Air-compressors

Secondary air

La-Mont boiler

To turbine and de-NOx



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 N₂O destruction in the tail gas of Nitric Acid Plants” as it is specified in selected AM0034. The analysis of baseline scenarios involves six steps:

Step 1. Identify technically feasible options 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 N₂O 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 N₂O.
- Alternative use of N₂O, such as:
 - Recycling N₂O as a feedstock
 - Use of N₂O for external purposes
- The installation of an N₂O destruction or abatement technology:
 - Primary approach
 - Secondary approach
 - Tertiary approach, including Non Selective Catalytic Reduction (or NSCR De NO_x)³
 - 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 N₂O 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 /N₂O abatement unit (e.g. UHDEs Envinox process)
- Installation of a new end-of-pipe treatment such as chemical (H₂O₂) 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 South Africa concerning N₂O emissions. It is unlikely that any such limits on N₂O emissions will be imposed in the near future. In fact, given the cost and complexity of suitable N₂O destruction and abatement technologies, it is unlikely that a limit would be introduced at South Africa considering it has ratified the Kyoto Protocol and actively participates in CDM.

Sasolburg and Secunda nitric acid plants are in compliance with the Atmospheric Pollution Prevention Act of the Republic of South Africa, which covers NO_x regulations, as indicated in Air permits 238-1 and A1308/1 (for Sasolburg and Secunda, respectively). Therefore the continuation of the status quo is a valid baseline alternative.

³ NSCR: A NSCR DeNO_x-unit will reduce N₂O emissions as a side reaction to the NO_x reduction. Consequently, new NSCR installation can be seen as an alternative N₂O 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;
 - Limited 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. N₂O destruction, abatement rate);
 - 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 (African Explosives Ltd, at Modderfontaine, plans installing a secondary catalyst to eliminate N₂O emissions, also as CDM project activity, which is currently under validation process).

There are four different groups of N₂O 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 N₂O abatement solution in itself.

Available tertiary approaches are the NSCR (Non Selective Catalytic Reduction) and the EnviNOx® process commercialized by Uhde GmbH (Germany); both systems are not selective towards N₂O 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 N₂O abatement (high operating costs).

The potential removal of N₂O 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 installation that uses such technology is in operation.



The use of N₂O for external purposes is technically not feasible at Sasol Nitric Acid Plants, as the quantity of gas to be treated is extremely high, compared to the amount of nitrous oxide that could be recovered. The use of N₂O for external purposes is practiced neither in South Africa nor anywhere else.

We may discard recycling N₂O 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 South Africa, or anywhere else.

Therefore the following baseline alternatives are eliminated in this step:

- Installation of a primary or quaternary N₂O abatement technology
- The use of N₂O for external purposes
- Recycling of N₂O 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 N₂O 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 significant running costs since they consume incremental fuel and/or reducing agents (such as Ammonia) to operate.

No income from any kind of potential product or by-product except CERs are able to pay back investment costs as well as running costs for the installation of any available secondary or tertiary abatement systems as no marketable products or by-products are generated by these N₂O 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: 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 South Africa. 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 South Africa has a secondary catalyst (or any other type of N_2O abatement technology) currently installed (although all South African producers which are taking steps to do so, always do it within the CDM).

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

Step 6: Re-assessment of Baseline Scenario in course of proposed project activity lifetime:

In the event of re-assessment of the baseline scenario as a consequence of new NO_x regulations over the course of the crediting period of the proposed project activity, the reassessment of baseline scenario shall be undertaken using the same 5 step process. In such a case the additionality of the project too must be re-demonstrated.

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): >>

Sasol Nitrous Oxide Abatement Project involves the installation of secondary catalysts whose only purpose and effect is the decomposition of nitrous oxide once it is formed.

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

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

Then, baseline will be determined by measuring N_2O baseline emission factor ($kg\ N_2O/tonne\ HNO_3$) during a *complete* production campaign, called “initial N_2O measurement campaign for baseline determination”, prior to project implementation.

To ensure that data obtained during such initial campaign are representative of the actual GHG emissions from the source plant, a set of process parameters known to affect N_2O generation and that are under the control of the plant operator, has been gathered from historical data of last campaigns.



Based on plant historical operating conditions, and plant design data, a range of values for any given parameter has been established considering specific control capabilities of Sasol' nitric acid plants. In order to properly characterize baseline emission rates, operation during such initial campaign is controlled during the specified range (a maximum, minimum or range has been established for each parameter). Only those N₂O 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 N₂O monitoring equipment will be deducted from the baseline emissions factor.

At the moment of presenting this PDD Sasolburg and Secunda plants are carrying out their initial campaigns for baseline emission factor determination. The emissions factor determined from such measurements will be presented for crediting of emission reductions.

The additionality of the project activity is demonstrated and assessed using the latest version of the "Tool for demonstration and assessment of additionality". We will demonstrate that the baseline scenario is the continuation of the status quo and N₂O emissions are not reduced by any N₂O destruction or abatement technology at Sasolburg and Secunda nitric acid plants.

Step 0 of the tool can be avoided since the proposed methodology, requiring baseline measurements prior to project implementation, cannot be retroactive.

Moreover, Step 1 of the tool can also 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 N₂O 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 (investment analysis summary included in Annex 5).

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

A Common practice analysis was conducted in Step 5 of Section B.4. No similar project at nitric acid plants are identified in South Africa or in the region. The nitric acid industry typically releases into the atmosphere the N₂O generated as a by-product, as it does not have any economic value or toxicity at typical emission levels. N₂O emissions in the stack gas can be considered to be the business-as-usual activity and it is spread all over the country. No nitric acid plant in South Africa has a secondary catalyst installed.

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

Step 5. Impact of CDM registration

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

Conclusion:

Currently, there are no national regulations or legal obligations in South Africa concerning N₂O emissions. It is unlikely that any such limits on N₂O emissions will be imposed in the near future. In fact, given the cost and complexity of suitable N₂O destruction and abatement technologies, it is unlikely that a limit would be introduced by South Africa that has ratified the Kyoto Protocol and actively participates in CDM.

Sasol is in no need to invest in any N₂O 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 90% 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 "Tool for demonstration and assessment of additionality", approved by the CDM Executive Board. No income from any kind of potential product or by-product except CERs are able to pay back investment costs as well as running costs for the installation of the proposed project activity as no marketable product or by-product exists.



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

B.6. Emission reductions:

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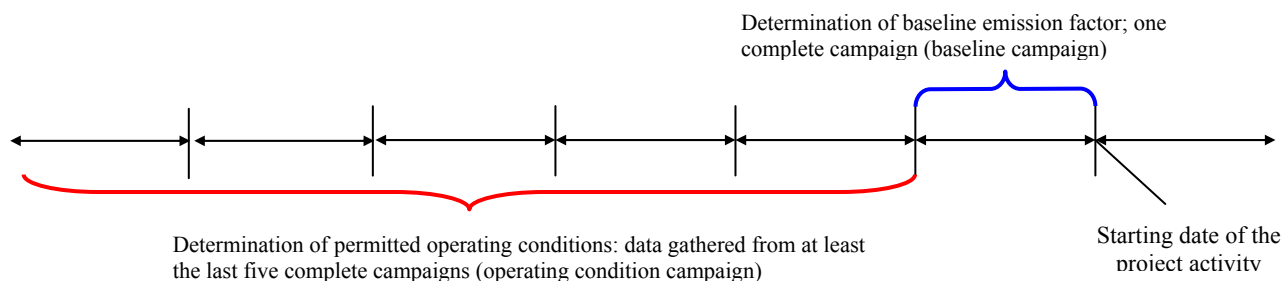
B.6.1. Explanation of methodological choices:

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Baseline emissions procedure

Following AM0034 the baseline shall be established through continuous monitoring of both N₂O concentration and gas flow volume in the stack of the nitric acid plant for *one complete* campaign prior to project implementation.

The schematic of the procedure is as follows:

**1 - Determination of the permitted operating conditions of the nitric acid plant to avoid overestimation of baseline emissions:*****Oxidation temperature and pressure***

For Sasolburg, the “permitted range for oxidation temperature” is calculated based on historical data from previous campaigns. For Secunda, this range is determined taking into consideration the plant design data.

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, and design data to define “permitted operating conditions” will be available for the validation process of the project activity.



For both Sasolburg and Secunda nitric acid plants, the range of oxidation pressure as indicated in the operating manual for the existing equipment is used to determine “permitted operating conditions”, due to lack of sufficient historical data.

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

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

For both Sasolburg and Secunda nitric acid plants, the upper limits for ammonia flow and ammonia to air ratio as specified by the ammonia oxidation catalyst manufacturer will be used to determine “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 N₂O concentration and gas volume flow

For the determination of the baseline emission factor N₂O concentration and gas volume flow will be monitored throughout the baseline campaign. Separate readings for N₂O concentration and gas flow volume for a defined period of time (e.g. every hour of operation, it provides an average of the measured values for the previous 60 minutes) will be performed. Error readings (e.g. downtime or malfunction) and extreme values will be eliminated from the output data series.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to maverick. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is to be applied to the complete data series of N₂O 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 N₂O concentration of stack gas (NCSG))

Then, the average mass of N₂O emissions per hour is estimated as product of the NCSG and VSG. The N₂O emissions per campaign are estimates product of N₂O emission per hour and the total number of complete hours of operation of the campaign using the following eq. 1 from AM0034:

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



where:

BE_{BC}	Total baseline emissions in the baseline measurement period, in, tN ₂ O
VSG_{BC}	Mean stack gas volume flow rate in the baseline measurement period, in Nm ³ /h
$NCSG_{BC}$	Mean concentration of N ₂ O in the stack gas in the baseline measurement period, in mg N ₂ O/Nm ³
OH_{BC}	Number of operating hours in the baseline measurement period, in h

The plant specific baseline emissions factor representing the average N₂O emissions per tonne of nitric acid over *one full campaign* is derived by dividing the total mass of N₂O emissions by the total output of 100% concentrated nitric acid for that period for baseline emission factor determination.

The overall measurement uncertainty of the monitoring system, expressed as a percentage (*UNC*) will be used to reduce the N₂O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) as follows:

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

where:

EF_{BL}	Baseline emission factor, in tN ₂ O/ tHNO ₃
NAP_{BC}	Nitric acid production during the baseline campaign, in, tHNO ₃
<i>UNC</i>	Overall measurement uncertainty of the monitoring system, in %, calculated as the combined uncertainty of the applied monitoring equipment

Impact of regulations

Should N₂O emissions regulations that apply to nitric acid plants be introduced in the South Africa or jurisdiction covering the location of the nitric acid plants (Sasolburg and Secunda), 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 N₂O emissions for a set period;
- A relative limit on N₂O emissions expressed as a quantity per unit of output; or
- A threshold value for specific N₂O mass flow in the stack;

In this case, a corresponding plant-specific emissions factor cap (max. allowed tN₂O/tHNO₃) is to be derived from the regulatory level. If the regulatory limit is lower than the baseline factor determined for the project activity, the regulatory limit shall become as the new baseline emission factor, that is.

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

Composition of the ammonia oxidation catalyst



In the case of the Sasolburg plant the composition of the ammonia oxidation catalyst used for the baseline campaign and after the implementation of the project are identical to that used in the campaigns for setting the operating conditions (previous five campaigns), then there shall be no limitations on N₂O baseline emissions.

In case of the Secunda plant there has been a change in the composition of the ammonia oxidation catalyst during the last five campaigns. The FTC system was replaced by an FTC plus, which has better performance than the original. so that 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.”

Campaign Length

In order to take into account the variations in campaign length and its influence on N₂O emission levels, the historic campaign lengths and the baseline campaign length are to be determined and compared to the project campaign length. Campaign length is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes.

Historic Campaign Length

For Sasolburg and Secunda nitric acid plants the average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous 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 than CL_{normal} , all N₂O 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 N₂O values that were measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) will be eliminated from the calculation of EF_{BL} .”

Parameters to be monitored for composition of the catalyst are as follows:

GS_{normal} Gauze supplier for the operation condition campaigns

GS_{BC} Gauze supplier for baseline campaign

GS_{project} Gauze supplier for the project campaign

GC_{normal} Gauze composition for the operation condition campaigns

GC_{BC} Gauze composition for baseline campaign

GC_{project} Gauze composition for the project campaign

Project emission procedure



Actual project emissions will be determined during the project activity from continuous measurements of N₂O concentration and total flow rate in the stack gas of the nitric acid plant.

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

Estimation of campaign-specific project emissions

The monitoring system will provide separate reading for N₂O concentration and gas flow for a define period of time (e.g. every hour of operation, i.e. an average of the measuring values of the past 60 minutes). Error readings (e.g. downtime or malfunction) and extreme values are eliminated from the output data series. Next, the same statistical evaluation that was applied to the baseline data series 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 N₂O concentration and total flow rate are used in the following formula (Eq. 3 from AM0034) to calculate project emissions:

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

where:

PE_n	Total Project emissions of the nth campaign, in tN ₂ O
VSG_n	Mean stack gas volume flow rate for the nth project campaign, in Nm ³ /h
$NCSG_n$	Mean concentration of N ₂ O in the stack gas for the project campaign, in mg N ₂ O/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 N₂O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign.

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



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

where:

EF_n Emission factor calculated for the n th campaign, in kg N₂O/ton HNO₃
 PE_n Total Project emissions of the n th campaign, in tN₂O
 NAP_n Nitric acid production in the n th campaign, in ton 100% HNO₃

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

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

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

To calculate the total emission reductions achieved in the n th 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).

$$\begin{aligned} \text{If } EF_{ma,n} > EF_n, & \text{ then } EF_p = EF_{ma,n} \\ \text{If } EF_{ma,n} < EF_n, & \text{ then } EF_p = EF_n \end{aligned} \quad (\text{Eq. 6})$$

Minimum project emission factor

A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N₂O 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 use EF_{min} and not EF_n .

Project Campaign Length

a. Longer Project Campaign

If the length of each individual project campaign CL_n is longer than or equal to the average historic campaign length CL_{normal} , then all N₂O 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):

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

where

ER_n	Emission reductions for the n th 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 n th campaign of the project activity, in, $tHNO_3$
GWP_{N_2O}	global warming potential, of N_2O set as 310 tCO_2e/tN_2O for the 1 st commitment period

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

Documentation to prove design capacity (nameplate) of the nitric acid plant should be available for the validation process of the project activity.⁴

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:	°C
Description:	The “permitted range” for oxidation temperature and pressure is to be determined using one of the following sources: a) Historical data for the operating range of temperature and pressure from the previous five campaigns (or fewer, if the plant has not been operating for five campaigns); or, then

⁴ By nameplate (design) implies the total yearly capacity (considering 365 days of operation per year) as per the documentation of the plant technology provider (such as the Operation Manual). If the plant has been modified to increase production, and such de-bottleneck or expansion projects were completed before December 2005, then the new capacity is considered nameplate, provided proper documentation of the projects is available (such as, but not limited to: properly dated engineering plans or blueprints, engineering, materials and/or equipment expenses, or third party construction services, etc.).



	b) If no data on historical temperatures and pressures is available, the range of temperature and pressure stipulated in the operating manual for the existing equipment; or, c) If no operating manual is available or the operating manual gives insufficient information, from an appropriate technical literature source. If option a) is selected, the permitted range is determined through a statistical analysis of the historical data in which the time series data is to be interpreted as a sample for a stochastic variable. All data that falls within the upper and lower 2.5% percentiles of the sample distribution is defined as abnormal and shall be eliminated. The permitted range of operating temperature and pressure is then assigned as the historical minimum (value of parameter below which 2.5% of the observation lie) and maximum operating conditions (value of parameter exceeded by 2.5% of observations).
Source of data used:	Calculated from historical process data (Sasolburg) and from plant design data (Secunda).
Value applied:	For Sasolburg: 703°C- 884°C For Secunda: 860-920°C
Justification of the choice of data or description of measurement methods and procedures actually applied :	Sasolburg Plant has complete historical registers for oxidation temperature (previous 5 campaigns); then, historical data is used to determine normal oxidation temperature. Secunda Plant stores operational data for 6 months only (electronically); then, plant design data was used to determine normal oxidation temperature.
Any comment:	None

Data / Parameter:	Normal Operating Pressure, OP_{normal} (range of pressure)
Data unit:	Bar
Description:	The “permitted range” for oxidation temperature and pressure is to be determined using one of the following sources: a) Historical data for the operating range of temperature and pressure from the previous five campaigns (or fewer, if the plant has not been operating for five campaigns); or, then b) If no data on historical temperatures and pressures is available, the range of temperature and pressure stipulated in the operating manual for the existing equipment; or, c) If no operating manual is available or the operating manual gives insufficient information, from an appropriate technical literature source. If option a) is selected, the permitted range is determined through a statistical analysis of the historical data in which the time series data is to be interpreted as a sample for a stochastic variable. All data that falls within the upper and lower 2.5% percentiles of the sample distribution is defined as abnormal and shall be eliminated. The permitted range of operating temperature and pressure is then assigned as the historical minimum (value of parameter below which 2.5% of the observation lie) and maximum operating conditions (value of parameter exceeded by 2.5% of observations).
Source of data used:	Both plants define it based on Plant design data (the operating manual).
Value applied:	For Sasolburg: 3.7 bar- 4.5 bar



	For Secunda: 2.5 bar - 5.0 bar
Justification of the choice of data or description of measurement methods and procedures actually applied :	At Sasolburg Plant, complete historical registers for oxidation pressure (previous 5 campaigns) are unavailable; then, plant design data was used to determine normal oxidation pressure. Secunda Plant stores operational data for 6 months only (electronically); then, plant design data was used to determine normal oxidation pressure.
Any comment:	None

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

Data / Parameter:	Maximum Ammonia Flow Rate, AFR_{max}
Data unit:	Kg NH ₃ /hour
Description:	The upper limits for ammonia flow and ammonia to air ratio shall be determined using one of the following three options, in preferential order: a. Historical maximum operating data for hourly ammonia gas and ammonia to air ratio for the previous five campaigns (or fewer, if the plant has not been operating for five campaigns; excluding abnormal campaigns; or, b. If no data is available, calculation of the maximum permitted ammonia gas flow rates and ammonia to air ratio as specified by the ammonia oxidation catalyst manufacturer or for typical catalyst loadings; or, c. If information for (b) above is not available, based on a relevant technical literature source.
Source of data used:	Defined considering option b (as specified by the ammonia oxidation catalyst manufacturer) for both plants.
Value applied:	For Sasolburg: 6,771.0 For Secunda: 10,630.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	At Sasolburg Plant, complete historical registers for ammonia flow to reactor (previous 5 campaigns) are unavailable; then, maximum ammonia load as specified by the primary catalyst manufacturer was used to determine maximum ammonia flow rate. Secunda Plant stores operational data for 6 months only (electronically); 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:	The upper limits for ammonia flow and ammonia to air ratio shall be determined using one of the following three options, in preferential order: a. Historical maximum operating data for hourly ammonia gas and ammonia to air ratio for the previous five campaigns (or fewer, if the plant has not been operating for five campaigns; excluding abnormal campaigns; or, b. If no data is available, calculation of the maximum permitted ammonia gas flow rates and ammonia to air ratio as specified by the ammonia oxidation



	catalyst manufacturer or for typical catalyst loadings; or, c. If information for (b) above is not available, based on a relevant technical literature source
Source of data used:	Defined considering option b (as specified by the ammonia oxidation catalyst manufacturer) for both plants.
Value applied:	For Sasolburg: 0.084 (Kg NH ₃ /kg air) For Secunda: 0.063 (Kg NH ₃ /kg air)
Justification of the choice of data or description of measurement methods and procedures actually applied :	At Sasolburg Plant, complete historical registers for ammonia flow rate to reactor (previous 5 campaigns) are unavailable; then, maximum load as specified by the primary catalyst manufacturer was used to determine maximum ammonia to air flow rate. Secunda Plant stores operational data for 6 months only (electronically); then, maximum ammonia 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:	The normal historic campaign length (CL_{normal}) is defined as the average campaign length for the historic campaigns used to define normal operating condition (the previous five campaigns). This parameter will be used as a cap on the length of the baseline campaign.
Source of data used:	Calculated from historical process data.
Value applied:	For Sasolburg: 114,727 Tons HNO ₃ For Secunda: 183,602 Tons HNO ₃
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated for both plants as described (above), from historical data. One untypical recent campaign was excluded for Secunda (campaign cut short to install AMS and start with baseline measurements) and one from Sasolburg (cut short to install DCS system and anticipate some required maintenance activities).
Any comment:	None

Data / Parameter:	Normal Gauze Supplier, GS_{normal}
Data unit:	Company name
Description:	Gauze supplier during operating condition campaigns (the previous five campaigns).
Source of data used:	From historical process data
Value applied:	W.C. Heraeus
Justification of the choice of data or description of measurement methods and procedures actually applied :	W.C. Heraeus supplies primary catalyst package to Sasol on a contract basis for commercial/economic reasons.



Any comment:	None
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Data / Parameter:	Normal Gauze Composition, GC_{normal}
Data unit:	
Description:	Sasol uses the Heraeus FTC-system as primary catalyst which is a fully integrated catalytic package made of PGM alloys using the knitting technique. Each package is designed individually for the reactor and consists of different welded layers of HA- and FTC-gauzes.
Source of data used:	From historical process data.
Value applied:	For Secunda: Pt 54.0 to 55.0 %, Rh 3.5 to 3.8 %, Pd 41.0 to 43.0 % For Sasolburg: Pt 54.0 to 56.0 %, Rh 3.6 to 3.9 %, Pd 40.0 to 42.0%.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Current gauze composition (the FTC-system) for each plant delivers 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 for each plant, 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.
- The technology provider, Heareus, indicate that the estimated reduction efficiency to be achieved as a consequence of project implementation is 90%. Then, in order to present estimative values in this PDD, we consider project emission factor to be equal to the 10% of baseline emission factor ($EF_p = 0.10 \cdot EF_{BL}$)

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

$$ER_n = (EF_{BL} - EF_p) \cdot NAP_n \cdot GWP_{N_2O} \quad (\text{Eq. 8})$$

where

ER_n Emission reductions for the n th 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 n th campaign of the project activity, in, $tHNO_3$

GWP_{N_2O}

The assumptions parameters are specified in the following table:

Estimated values	Sasolburg	Secunda	Total
$NAP, t HNO_3/yr$	190,000	290,000	480,000
$EF_{BL}, t N_2O / t HNO_3$	0.00970	0.005490	-
$EF_p, t N_2O / t HNO_3$	0.00097	0.000549	-
$GWP_{N_2O} tCO_2e/tN_2O$	310		

Then,

For Sasolburg:

$$ER_n = (0.00970 - 0.00097) \cdot 190,000 \cdot 310 = 515,837 tonCO_2e / year \quad (\text{Eq. 9})$$

For Secunda:

$$ER_n = (0.005490 - 0.000549) \cdot 290,000 \cdot 310 = 444,485 tonCO_2e / year$$

Note: In order to follow the calculations see Spreadsheet “Sasol Emission Reduction Calculation 31 Jan 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 CO₂e)	Estimation of baseline emissions (tonnes of CO₂e)	Estimation of leakage (tonnes of CO₂e)	Estimation of emission reduction (tonnes of CO₂e)
Year 1	106,702	1,067,024	-	960,322
Year 2	106,702	1,067,024	-	960,322
Year 3	106,702	1,067,024	-	960,322
Year 4	106,702	1,067,024	-	960,322
Year 5	106,702	1,067,024	-	960,322
Year 6	106,702	1,067,024	-	960,322
Year 7	106,702	1,067,024	-	960,322
Total	746,914	7,469,168	-	6,722,254

**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 Sasolburg and Secunda plants.
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, in the case of Secunda Plant. An Ultrasound principle device is used at Sasolburg, with independent probes to measure pressure and temperature; calculations to normalize flow are performed automatically by the AMS.
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.

Data / Parameter:	Baseline Temperature of the Stack Gas, TSG_{BC}
Data unit:	°C
Description:	Temperature of the gas in the stack gas during baseline campaign
Source of data to be used:	AMS (Flow meter) at Sasolburg and Secunda plants.
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, in the case of Secunda Plant. An Ultrasound principle device is used at Sasolburg, with independent probes to measure pressure and temperature; calculations to normalize flow are performed automatically by the AMS.
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.

Data / Parameter:	Baseline Pressure of the Stack Gas, PSG_{BC}
Data unit:	bar
Description:	Pressure in the stack gas during baseline campaign
Source of data to be used:	AMS (Flow meter) at Sasolburg and Secunda plants.
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, in the case of Secunda Plant. An Ultrasound principle device is used at Sasolburg, with independent probes to measure pressure and temperature; calculations to normalize flow are performed automatically by the AMS.
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.

Data / Parameter:	Baseline N_2O Concentration in the Stack Gas, $NCSG_{BC}$
Data unit:	$mg\ N_2O / m^3$ (converted from ppmv 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) of Sasolburg and Secunda plants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction
Description of measurement methods and procedures to be applied:	N_2O concentration is measured by on-line analyzer (Non Dispersive Infra Red principle). A gas stream is continuously drawn from the stack by the sampling system under proper conditions (line is heat traced to avoid condensation), and driven to the infrared cell. The device is set up to measure concentration and record the output electronically every 2 seconds.



QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. 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.

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 of Sasolburg and Secunda plants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	The distributed control system of each plant (Sasolburg and Secunda) will record effective operating time of the plant by monitoring periods when the plants are producing nitric acid.
QA/QC procedures to be applied:	Operating up time of the plant will be cross check against production logbook data. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9001).
Any comment:	Measured 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 infrared analyzer supplier will issue a manufacturer's performance declaration. The declaration specifies the uncertainty level of the instrument. Uncertainty from the flow measuring device will also be estimated and accounted for using proper statistical methods, to determine the overall uncertainty of the AMS (Automated Measuring System).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For Sasolbrg: 2.77% For Secunda: 2.67%



Description of measurement methods and procedures to be applied:	The overall uncertainty is determined as the combined uncertainty of the flow meter and uncertainty of the N ₂ O concentration measurement
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	None

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 Sasolburg and Secunda plants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Nitric acid production is assumed to be constant for each plant, so that project emissions do not vary from year to year. The values of the nitric acid production used for the calculation of expected emission reductions are: 190,000 ton HNO ₃ /year (based on historical data) and 290,000 ton HNO ₃ /year (based on nameplate capacity) for Sasolburg plant and for Secunda plant respectively.
Description of measurement methods and procedures to be applied:	At Secunda, daily production is measured by using an accurate mass flow meter (Coriolis principle), and correcting by the average of several concentration checkups performed in analytical lab. Sasolburg performs daily mass balances at the end-product storage tanks with the help of electronic level indicators and load cells to determine production.
QA/QC procedures to be applied:	Cross checking of production measured by mass balance vs direct flow measurement is performed routinely on both plants. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9001).
Any comment:	Measured during a complete campaign before project implementation to properly characterize baseline emissions factor.

Data / Parameter:	Baseline Emission Factor, EF_{BL}
Data unit:	kg N ₂ O / 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 ₂ O 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 increase during the campaign. The N ₂ O emission factor used for ex ante calculations are:



	Sasolburg: 9.70 kg N ₂ O / ton 100% HNO ₃ . Secunda: 5.49 kg N ₂ O / ton 100% HNO ₃ .
Description of measurement methods and procedures to be applied:	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 ₂ O concentration, and the operating hours.
QA/QC procedures to be applied:	No QA/QC procedure is needed.
Any comment:	All parameters will be measured during a complete campaign before project implementation to properly characterize baseline emissions factor. A baseline emission factor will be determined for Sasolburg and Secunda plants independently.

Data / Parameter:	Baseline Oxidation Temperature, OT_{BC}
Data unit:	°C
Description:	Oxidation temperature of the ammonia reactor for the baseline campaign
Source of data to be used:	Process control system of Sasolburg and Secunda plants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Reactor temperature is measured by 3 thermocouples installed through the reactor wall, near the oxidation catalyst; the signal from such devices is acquired by the Distributed Control System and stored electronically at a given time interval.
QA/QC procedures to be applied:	New thermocouples are installed on a routine basis when required (off or open signal – meaning the unit is broken).
Any comment:	Monitored during the initial campaign for baseline emission factor determination in order to avoid manipulations that could increase baseline N ₂ O formation.

Data / Parameter:	Baseline Oxidation Pressure, OP_{BC}
Data unit:	Bar
Description:	Oxidation pressure of the ammonia reactor for the baseline campaign
Source of data to be used:	Process control system of Sasolburg and Secunda plants.
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	At both Plants, oxidation pressure is tracked by measuring device with electronic signal transmission; the signal is acquired by the Distributed Control



and procedures to be applied:	System and stored electronically at a given time interval.
QA/QC procedures to be applied:	Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9001).
Any comment:	Monitored during the initial campaign for baseline emission factor determination in order to avoid manipulations that could increase baseline N ₂ O 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:	Process control system of Sasolburg and Secunda plants.
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 both plants, ammonia flow to oxidation reactor is tracked by a mass flow measuring device (orifice plate principle) with automatic pressure and temperature compensation; the signal from the device is acquired by the Distributed Control System and stored electronically at a given time interval.
QA/QC procedures to be applied:	Overall mass balances of ammonia to the plant are performed on a monthly basis to cross check flows and overall conversion efficiency. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9000).
Any comment:	Monitored during the initial campaign for baseline emission factor determination in order to avoid manipulations that could increase baseline N ₂ O formation.

Data / Parameter:	Baseline Ammonia to Air Flow Rate, AIFR_{BC}
Data unit:	Kg NH ₃ /hour
Description:	Ammonia to air flow rate to the ammonia oxidation reactor for the baseline campaign.
Source of data to be used:	Process control system of Sasolburg and Secunda plants.
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	Air flow to oxidation reactor is tracked by 2 mass flow measuring devices in series (orifice plate principle); the signal from the device is acquired by the Distributed Control System and stored electronically at a given time interval.



applied:	The Ammonia to Air ratio is calculated based on the actual flow analysis from the individual streams.
QA/QC procedures to be applied:	Overall mass balances of ammonia to the plant are performed on a routine basis to cross check flows and overall conversion efficiency.
Any comment:	Monitored during the initial campaign for baseline emission factor determination in order to avoid manipulations that could increase baseline N ₂ O 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:	Plant production log book
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For Sasolburg: 114,727 Tons HNO ₃ For Secunda: 183,602 Tons HNO ₃
Description of measurement methods and procedures to be applied:	At Secunda, daily production is measured by using an accurate mass flow meter (Coriolis principle), and correcting by the average of several concentration checkups performed in analytical lab. Sasolburg performs daily mass balances at the end-product storage tanks with the help of electronic level indicators and load cells to determine production.
QA/QC procedures to be applied:	Cross checking of production measured by mass balance vs direct flow measurement is performed routinely on both plants. Critical instruments are calibrated on a routine basis according to the quality assurance system of the plant (ISO 9001).
Any comment:	None

Data / Parameter:	Baseline Gauze Supplier GS_{BC}
Data unit:	Company name
Description:	Gauze supplier for the baseline campaign
Source of data to be used:	Procurement offices of Sasolburg and Secunda Plants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Cover of supply contract or bill for gauzes for baseline campaign, or equivalent document to prove commercial transaction.



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QA/QC procedures to be applied:	None
Any comment:	None

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 plant procurement office and gauze Supplier technical service department
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Section of supply contract for gauzes that specifies the technical characteristics agreed during baseline campaign. If necessary, additional data could be requested to supplier's technical service office in order to provide complete technical profile of gauzes.
QA/QC procedures to be applied:	None
Any comment:	None

Data / Parameter:	Project Volume Flow in the Stack Gas, $VSG_{project}$
Data unit:	Nm^3 / hour
Description:	Volume flow rate in the stack gas for the project campaign
Source of data to be used:	AMS (Flow meter) at Sasolburg and Secunda plants.
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 automatically compensates for actual stack pressure and temperature in order to normalize output data, in the case of Secunda Plant. An Ultrasound principle device is used at Sasolburg, with independent probes to measure Pressure and temperature; calculations to normalize flow are performed automatically by the AMS.



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.

Data / Parameter:	Project Temperature of the Stack Gas, TSG_{BC}
Data unit:	°C
Description:	Temperature of the gas in the stack gas during project campaign
Source of data to be used:	AMS (Flow meter) at Sasolburg and Secunda plants.
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, in the case of Secunda Plant. An Ultrasound principle device is used at Sasolburg, with independent probes to measure pressure and temperature; calculations to normalize flow are performed automatically by the AMS.
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.

Data / Parameter:	Project Pressure of the Stack Gas, PSG_{BC}
Data unit:	bar
Description:	Pressure in the stack gas during baseline campaign
Source of data to be used:	AMS (Flow meter) at Sasolburg and Secunda plants.
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, in the case of Secunda Plant. An Ultrasound principle device is used at Sasolburg, with independent probes to measure pressure and temperature; calculations to normalize flow are performed automatically by the AMS.
QA/QC procedures to	Regular calibrations according to vendor specifications and recognised industry



be applied:	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.

Data / Parameter:	Project N₂O Concentration in the Stack Gas, NCSG_{project}
Data unit:	mg N ₂ O/ m ³ (converted from ppmv if necessary)
Description:	N ₂ O concentration in the stack gas for the project campaign
Source of data to be used:	AMS (Infrared gas analyzer) at Sasolburg and Secunda plants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	N ₂ O concentration is measured by on-line analyzer (Non Dispersive Infra Red principle). A gas stream is continuously drawn from the stack by the sampling system under proper conditions (line is heat traced to avoid condensation), and driven to the infrared cell. The device is set up to measure concentration and record the output electronically every 2 seconds.
QA/QC procedures to be applied:	Regular calibrations according to vendor specifications and recognised industry standards. 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.

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 of Sasolburg and Secunda plants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction
Description of measurement methods and procedures to be applied:	The distributed control system of the plant will record effective operating time of the plant by monitoring periods time when both ammonia and air flows signals (coming from the devices installed to measure flow of both parameters) have reached their normal operational levels.



QA/QC procedures to be applied:	Operating time of the plant will be cross checked against production logbook data. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9001).
Any comment:	Measured 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 Sasolburg and Secunda plants.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Nitric acid production is assumed to be constant for each plant, so that project emissions do not vary from year to year. The values of the nitric acid production used for the calculation of expected emission reductions are: 190,000 ton HNO_3 /year and 290,000 ton HNO_3 /year for Sasolburg plant and for Secunda plant respectively.
Description of measurement methods and procedures to be applied:	Daily production is measured by using a very accurate mass flow meter (Coriolis principle), and correcting by the average of several (3 to 5) concentration checkups performed in analytical lab.
QA/QC procedures to be applied:	Mass balance at the end-product storage tanks is performed on a monthly basis; cross checking of production from mass balance with direct flow measurement is performed routinely. Critical instruments are calibrated on a routine basis according to the quality assurance system of the plant (ISO 9001).
Any comment:	Measured during the complete lifetime of the project activity.

Data / Parameter:	Project Emission Factor, EF_n
Data unit:	kg 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	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. That emission coefficient is reduced in 90% following the specifications of the technology provider, Heraeus. Project emissions factors applied for Sasolburg and Secunda are: Sasolburg: 9.7 kg N_2O / ton 100% HNO_3 . Secunda: 5.49kg 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 ₂ O concentration, and the operating hours. All parameters will be measured during a complete campaign before project implementation to properly characterize baseline emissions factor. A baseline emission factor will be determined for Sasolburg and Secunda plants independently.
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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:	Sasolburg and Secunda production log books.
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 Secunda, daily production is measured by using an accurate mass flow meter (Coriolis principle), and correcting by the average of several concentration checkups performed in analytical lab. Sasolburg performs daily mass balances at the end-product storage tanks with the help of electronic level indicators and load cells to determine production.
QA/QC procedures to be applied:	Cross checking of production measured by mass balance vs direct flow measurement is performed routinely on both plants. Critical instruments are calibrated on a routinely basis according to the quality assurance system of the plant (ISO 9001).
Any comment:	None

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 Sasolburg and Secunda Plants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.



Description of measurement methods and procedures to be applied:	Cover of supply contract or bill for gauzes for project campaigns, or equivalent document to prove commercial transaction.
QA/QC procedures to be applied:	None
Any comment:	None

Data / Parameter:	Project Gauze Composition, GC_n
Data unit:	%
Description:	Gauze concentration for the project campaign
Source of data to be used:	Procurement offices of Sasolburg and Secunda Plants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable. We do not use this parameter to estimate expected emission reduction.
Description of measurement methods and procedures to be applied:	Section of supply contract for gauzes that specifies the technical characteristics agreed during baseline campaign. If necessary, additional data could be requested to supplier's technical service office in order to provide complete technical profile of gauzes.
QA/QC procedures to be applied:	None
Any comment:	None

Data / Parameter:	Emission Factor set by regulation, EF_{reg}
Data unit:	Kgs 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

B.7.2 Description of the monitoring plan:

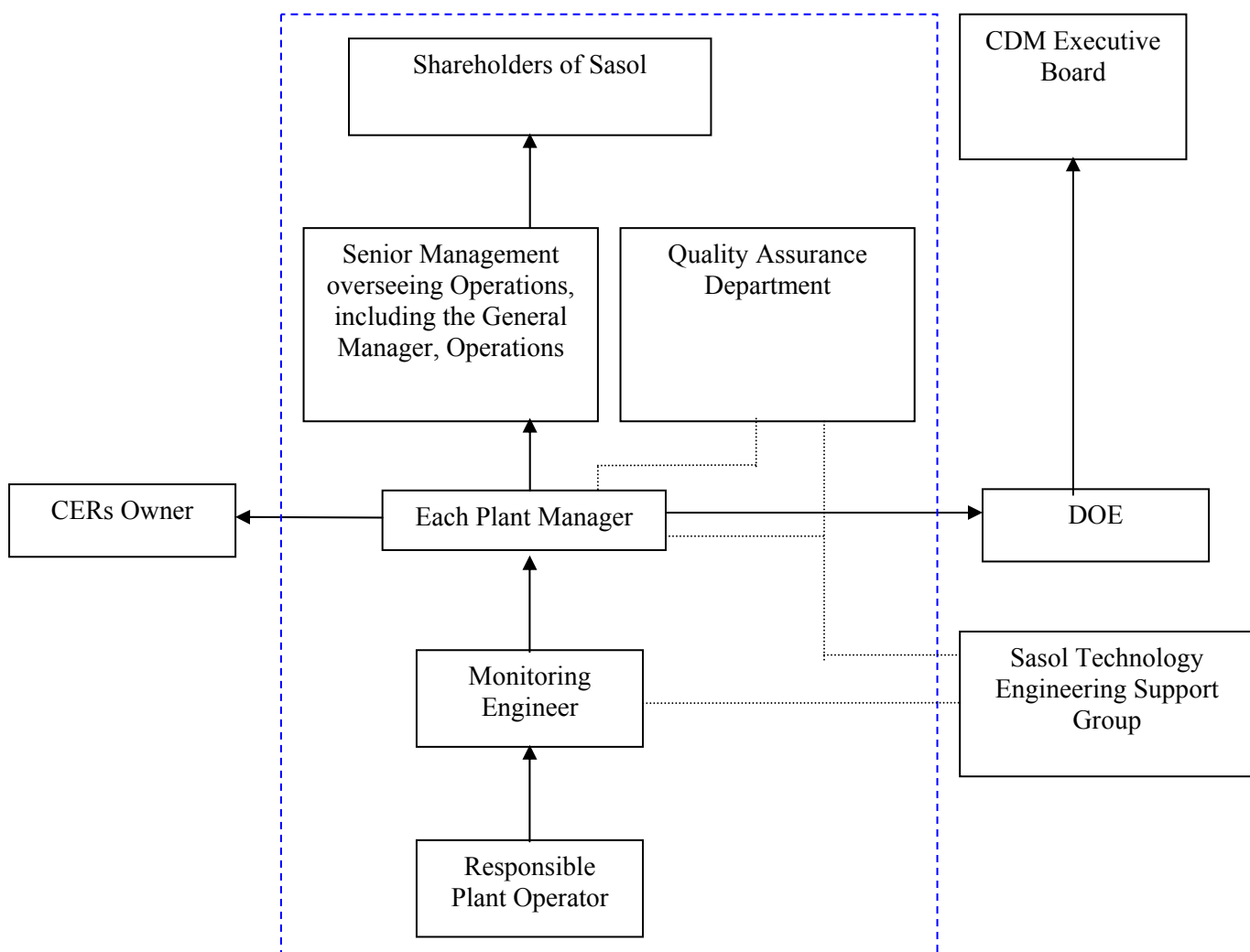
>>

Both Sasolburg and Secunda Nitric acid plants are 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, both plants have been operating stack emissions units (f.e. NO_x) for a number of years. The plants have access to specialized technical services available from the Sasol Technology Group, a division of Sasol Limited.

The plant manager will be responsible for the ongoing operation and maintenance of the N₂O monitoring system. Operation, maintenance, calibration and service intervals will be according to the manufacturer specifications and international standards (see QA/QC section below), and incorporated into the management structure of ISO 9000 standard procedures.

The proposed CDM project will be closely monitored, metered and recorded. The management and operation of the proposed nitrous oxide abatement project at the two Sasol plants will be the responsibility of each 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, coincidentally 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:

- At each plant, the responsible Plant Operator will be in charge of the supervision of automated measuring system (AMS) and the data acquisition system (DAS) that are installed to measure and acquire both emission and process data. Supported by the DAS, the Plant Operator will report the relevant data to the Monitoring 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 of the respective plant will be responsible to ensure that the CDM project activity at plant level is implemented in compliance with the PDD and other relevant standards. The Plant Manager will be assisted by the Quality Assurance Department which will conduct routine compliance audits. The Plant Manager will routinely report to the General Manager Operations as to the overall progress with the CDM project activity. At any time that the Plant Manager wants or needs to follow the implementation of the CDM project activity, he/she will ask for a report from the Monitoring 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.
- Sasol Technology Engineering Support Group 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 and QA Department also have Sasol Technology available as a resource for assistance when required.
- The DOE will then send the corresponding verification report to the CDM Executive Board in order to evaluate it and make able the issuance of the CERs.

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

Considering the arguments and the schematic illustration above, 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: 30/01/2007 (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 Gautam Dutt, MGM International Ltda. (not project participant).

Tel: +54-11-5219-1230

e-mail: whugler@mgminter.com; nzanzottera@mgminter.com; gdutt@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:**

>>

01/03/2007

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:**

>>

01/05/2007, following registration of the project

C.2.1.2. Length of the first crediting period:

>>

7 years

C.2.2. Fixed crediting period:

>>

Not selected.

C.2.2.1. Starting date:

>>

N.A.

C.2.2.2. Length:

>>

N.A.

SECTION D. Environmental impacts

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

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Sasol 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 N₂O will be converted into N₂ and O₂ avoiding the high global warming effects of the GHG.



The installation of secondary catalysts has a positive environmental impact because it reduces N₂O 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. Sasolburg and Secunda nitric acid plants are in compliance with the Atmospheric Pollution Prevention Act of the Republic of South Africa, which covers NO_x regulations, as indicated in Air permits 238-1 and A1308/1 (for Sasolburg and Secunda, respectively).

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 South African authorities.

SECTION E. Stakeholders' comments

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

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Specific stakeholders were contacted telephonically to request their participation in the stakeholder consultation process. After the phone communication, several documents were delivered to each of them (by fax or e-mail):

- A letter inviting them to participate,
- An executive summary of the proposed project and
- A survey document for completion by the stakeholder.

The lists of the stakeholders who were contacted are indicated below:

Sasolburg Plant

Surname	Name	Organisation
Jacobs	Arisja	Echo Ridge Newspaper
de Beer	Lizelle	Highveld Herald
van Wyk	Johan	Highveld East Tourism Organisation
Dlamini	Mpilo	Highveld East Tourism Organistaion
Michele	M Ernest	Town Planner
King	Nicolas (Dr)	Endangered Wildlife Trust
Maseko	Mauritius	Emabalenhle Environmental Club
Gumbi	Sibongile	Earthlife Africa
Knowles	Mike	Govan Mbeki Munici
Moatsi	Ramsadi	Dep of Environmental Affairs and Tourism
Batchelor	Garth (Dr)	Department of Agriculture
Mashego	Phillip	Chemical Workers Industrial Union
Machema	Tahleo	Dep of Education - Zamokuhle Primary

Secunda Plant

Surname	Name	Organisation
Piet	Odendaal	National Association for Clean Air
J T	Mothatle	Zamdela Environmental Steering Committee
Greg	Jacobs	Earthlife Africa
Florah	Pitsu	Tourism Board
Kennedy	Mahlatsi	Sasolburg TLC
Masithela	NH	Depatment of Tourism, Environment and Economic Affairs
Denis	Boden	Air Pollution Action Committee
Harold	Annegarn	Atmosphere and Energy Research Group
Basil	Baker	Save the Vaal Environment
Veronica	Cronje	Sasolburg Community Chest
Monica	Gibbs	Sasolburg Technical College
Wimpie	Lodewyk	Technical High School
Duma J	Plaatjie	Western Vaal Metropolitan Local Council
Isaac	Ramathesele	Metsimaholo Local Municipality
Albert	Phanyana	South African Chemical Workers Union
Karen	Benade	Sasol Chemical Industries



Stakeholders were asked to submit their opinions within 7 days. After this period, stakeholders who didn't response were contacted again and requested several times for comment with an additional 14 days response period allowed. In general stakeholder agreed that they would support this kind of project activities.

In addition to contacting specific stakeholders, an article of the proposed project was placed in two local publications, one in Secunda and the other in Sasolburg.

The article briefly describes the proposed project and invites any person to submit comment. It also invites the public to attend a public presentation of the project which was conducted at Sasol Nitro's offices in Secunda and Sasolburg respectively. The specific stakeholders were also contacted individually with an invitation to attend the public presentation.

E.2. Summary of the comments received:

>>

At the time of submitting this PDD, comments received from the stakeholders can be summarised as follows:

Surname	Name	Organisation	Comments
Jacobs	Arisja	Echo Ridge Newspaper	The stakeholder commented that she “think it is good”, and confirmed that she would recommend other institutions to consider projects of this kind and that that the project will contribute to sustainable development for the region and South Africa. No other comments were given and no further information was required.
Gumbi	Sibongile	Earthlife Africa	The stakeholder commented that “this is a good initiative” and that Sasol should “keep it up”. She confirmed that she “would recommend other industries and government to develop such projects” and that that the project will contribute to sustainable development for the region and South Africa. The only other comment made was that her “concern is that the project is only about N ₂ O. what about other gases suc as SO ₂ ”. No other comments were given and no further information was required.
Knowles	Mike	Govan Mbeki Municipality	The stakeholder commented that the project will make a “positive contribution to the environment” and that “a reduction in air pollution is a positive step”. He confirmed that he would recommend other institutions to consider projects of this kind and that that the project will contribute to sustainable development for the region and South Africa “by not depleting natural resources and



			decreasing pollution”. No other comments were given and no further information was required.
Piet	Odendaal	National Association for Clean Air	The stakeholder commented that “the project is highly commendable” and confirmed that he would recommend other institutions to consider projects of this kind and that that the project will contribute to sustainable development for the region and South Africa. No other comments were given and no further information was required.
Veronica	Cronje	Sasolburg Community Chest	The stakeholder commented that “according to the information received the project sounds necessary and environmentally friendly”, confirmed that she would recommend other institutions to consider projects of this kind and that that the project will “hopefully” contribute to sustainable development for the region and South Africa. No other comments were given and no further information was required.
Madelein	Barnard	Technical High School Sasolburg	The stakeholder commented that “the project has many merits” and confirmed that she would recommend other institutions to consider projects of this kind and that that the project will contribute to sustainable development for the region and South Africa. She also commented that “this issue is not only the responsibility of the Government and Industries but of each and everyone”. No other comments were given and no further information was required.
Monica	Gibbs	Flavius Mareka FET College	The stakeholder commented that “technology must be adapted to contribute to a cleaner and saver environment” and that “Sasol once again is responsible in this regard.” She confirmed that she would recommend other institutions to consider projects of this kind and that that the project will contribute to sustainable development for the region and South Africa. She also commented that the company and community will benefit from the project. No other comments were given and no further information was required.
King	Nicolas(Dr)	Endangered Wildlife Trust	The stakeholder commented that “the project as outlined seems to have merit” but expressed opinion that “we are not necessarily supportive of the CDM as a means for payment” as “Sasol should implement such prevention programmes as a matter of course and not simply because they can be offset by CDM payments”. The stakeholder confirmed that the project will contribute to sustainable development for the region and South



		Africa, but commented that “at a global scale the impact must be considered neutral as it is a CDM offset”. “Were Sasol to implement it independently, then it would be an overall positive contribution.”
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E.3. Report on how due account was taken of any comments received:

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As indicated in section E.2. above, all stakeholders whom responded at the date of submission of the PDD supported the project and that the project supports sustainable development in the region and South Africa. All stakeholders, with the exception of Dr N King of the Endangered Wildlife Trust, confirmed that they would recommend others to develop projects of this kind and that the project supports sustainable development. No comments required further actions with the exception of Dr King and Ms Sibongile Gumbi from Earthlife Africa. Ms Sibongile Gumbi from Earthlife Africa was contacted personally concerning her comment about “other gases” and Sasol’s commitment to reduce pollution on all fronts was discussed with her. Dr King was also contacted personally concerning his comments regarding the CDM mechanism as method of payment for the project. In discussion with Dr King, he re-confirmed that first price would be if industry would implement emission reductions without looking at income from CER sales to offset costs, thereby ensuring a global net benefit. He did, however, also indicate that he appreciates why Sasol Nitro is looking at the CDM process as method to offset project costs.

As such no further specific action is required based on the feedback received other than for Sasol to proceed with the implementation of the project upon receipt of approval.

Sasol will continue to seek response from stakeholders whom have not responded at the date of submission of the PDD and will take due account of any comments that may still be received.

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

Organization:	Sasol Nitro
Street/P.O.Box:	15 Baker Street, Rosebank / PO Box 5486, Johannesburg, 2000
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State/Region:	Gauteng
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FAX:	27 11 344 2287
E-Mail:	
URL:	www.sasol.com
Represented by:	
Title:	General Manager: Fertilizers
Salutation:	Dr.
Last Name:	Louw
Middle Name:	
First Name:	Johannes
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Direct FAX:	27 11 522 2587
Direct tel:	27 11 344 2156
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Represented by:	
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Salutation:	Mr.
Last Name:	Swanepoel
Middle Names:	
First Name:	Etienne
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Direct tel:	27 11 344 2189
Personal E-Mail:	etienne.swanepoel@sasol.com



Annex 2

INFORMATION REGARDING PUBLIC FUNDING

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

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

Baseline emissions for each plant are 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:

	Nitric acid plant	Sasolburg	Secunda
Parameter			
Tail gas N ₂ O concentration (ppm)		3,060	1,704
Typical Nitric acid production output (ton 100% HNO ₃ /year)		190,000	290,000
Maximum historic Nitric acid production (ton 100% HNO ₃ /day)		557	860
N ₂ O baseline emission factor (kg N ₂ O / ton 100% HNO ₃)		9.70	5.50
N ₂ O destruction factor (%)		90	90
UNC (%)		2.77	2.67
Operating days		347	347

Annex 4**MONITORING INFORMATION**

The current CDM project “Nitrous Oxide Abatement Project at Sasol” will measure on a quasi-continuous basis (uninterrupted sampling of flue gases with concentration and normalized flow analysis on short, discrete time periods) the N₂O mass flow leaving the Nitric acid plant through an Automated Measuring System (AMS⁵) using technologies and procedures in accordance with AM0034: “Catalytic reduction of N₂O inside the Ammonia burner of nitric acid plants”.

Both Sasolburg and Secunda plants are currently ISO 9001/2000 and ISO 14001/2004 certified; certification documents will be available on site during validation for their review. The monitoring procedures (deployed as per the current monitoring plan and being an integral part of it), will be fully integrated into Sasol’s Quality and Environmental Management System.

As a producer of fertilizers, explosives and related products, Sasol Nitro management and staff are committed to comply with the requirements of the ISO 9001:2000 Quality Management System and to

⁵ 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.



continually improve the effectiveness of the system. To achieve this Sasol Nitro management and staff will:

- Establish and review quality objectives
- Conform to the requirements of both our internal and external customers
- Strive to understand the requirements of our jobs to ensure continual optimisation towards rendering defect free work, services and final products that meet specifications
- Commit ourselves to a clear description and communication of our own requirements, needs and expectations and to continually insist on conformance to quality requirements
- Ensure that this policy is communicated and understood by all employees and contractors who perform quality functions

This policy will be reviewed as and when required for continuing suitability and effectiveness.

Sasol Nitro Fertilizer is currently in its 4th year of ISO 9001:2000 certification and Sasol Nitro Sasolburg is certified for the past 10 years and never had a major non-conformance. External audits are done on an annual basis by an accredited external auditor and are complemented by regular internal audits.

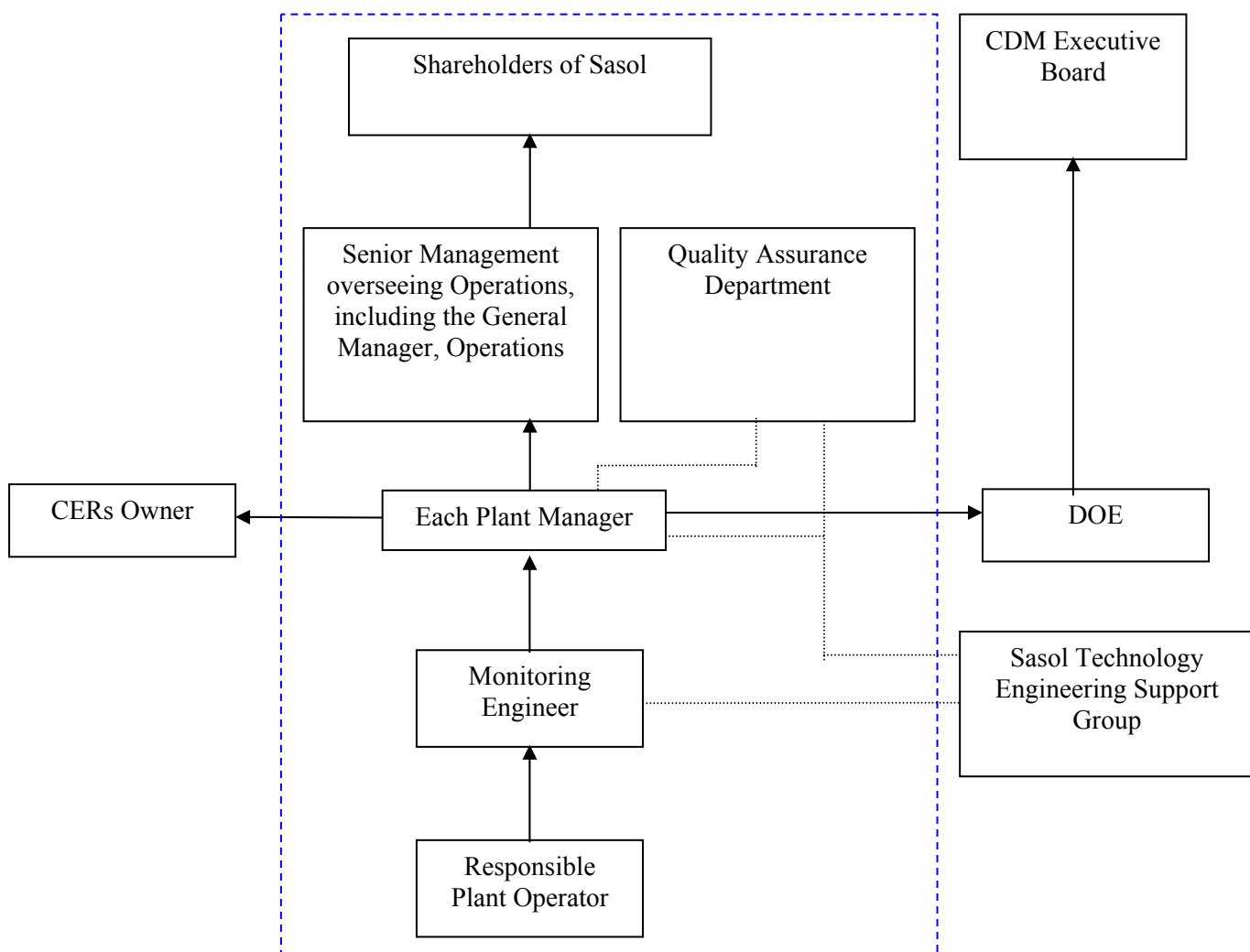
Both plants are certified in ISO 9001:2000 (Quality Management System) and ISO 14001:2004 (Environmental Management System).

Both Sasolburg and Secunda Nitric acid plants are 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, both plants have been operating stack emissions units (f.e. NO_x) for a number of years. The plants have access to specialized technical services available from the Sasol Technology Group, a division of Sasol Limited.

The plant manager will be responsible for the ongoing operation and maintenance of the N₂O monitoring system. Operation, maintenance, calibration and service intervals will be according to the manufacturer specifications and international standards (see QA/QC section below), and incorporated into the management structure of ISO 9000 standard procedures.

The proposed CDM project will be closely monitored, metered and recorded. The management and operation of the proposed nitrous oxide abatement project at the two Sasol plants will be the responsibility of each 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, coincidentally 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:

- At each plant, the responsible Plant Operator will be in charge of the supervision of automated measuring system (AMS) and the data acquisition system (DAS) that are installed to measure and acquire both emission and process data. Supported by the DAS, the Plant Operator will report the relevant data to the Monitoring 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 of the respective plant 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.
- Sasol Technology Engineering Support Group 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 and QA Department also have Sasol Technology available as a resource for assistance when required.
- The DOE will then send the corresponding verification report to the CDM Executive Board in order to evaluate it and make able the issuance of the CERs.
- Shareholders of Sasol Nitro 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 N₂O measurements taken when the plant is operating within the permitted range will be considered during the calculation of baseline emissions.

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

As explained on tables of section B.7.1 of the pdd, some additional and/or redundant measurements will be also acquired and monitored in order to cross check reasonability of key parameters such as stack waste gas flow (by means of continuous oxygen concentration monitoring at the stack) and nitric acid production (performing mass balances on routine basis using data from calibrated weight load cells, wave-radar tank level sensors and bench-scale analysis such as frequent density checks for determining nitric acid concentration).

**Emission reduction calculations**

The amount of mass (tons) of N₂O that the project actually avoids from being vented to the atmosphere on each production campaign and plant, expressed as Carbon Dioxide equivalent (or tCO₂e), 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 ₂ O
VSG_{BC}	Mean stack gas volume flow rate in the baseline measurement period, in Nm ³ /h
$NCSG_{BC}$	Mean concentration of N ₂ O in the stack gas in the baseline measurement period, in mg N ₂ O/Nm ³
OH_{BC}	Number of operating hours in the baseline measurement period, in h

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

Where:

EF_{BL}	Baseline emission factor, in tN ₂ O/ 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 N₂O 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 ₂ O
VSG_n	Mean stack gas volume flow rate for the nth project campaign, in Nm ³ /h
$NCSG_n$	Mean concentration of N ₂ O in the stack gas for the project campaign, in mg N ₂ O/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 <i>nth</i> campaign, in kg N ₂ O/ton HNO ₃
PE_n	Total Project emissions of the <i>nth</i> campaign, in tN ₂ O



NAP_n Nitric acid production in the n th 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 n th campaign, tCO ₂ e
EF_{BL}	Baseline emission factor, in tN ₂ O/ tHNO ₃
EF_p	Project emission factor, applicable to the n th campaign, in tN ₂ O/ tHNO ₃
NAP_n	Nitric acid production during the n th campaign of the project activity, in, tHNO ₃
GWP_{N_2O}	global warming potential, of N ₂ O set as 310 tCO ₂ e/tN ₂ O for the 1 st commitment period

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

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

The monitoring system will provide separate reading for N₂O concentration and gas flow for a define period of time (e.g. every hour of operation, i.e. an average of the measuring values of the past 60 minutes). Error readings (e.g. downtime or malfunction) and extreme values are eliminated from the output data series. Next, the same statistical evaluation that was applied to the baseline data series will be applied to the project data series:

- a) calculate the sample mean ($\bar{x}$)
- 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 n th 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 use 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 each 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

Both Sasolburg and Secunda plants have 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 BImSchV 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 $\lambda = 2.5\text{--}8\ \mu\text{m}$ 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 ₂ O	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 ₂ H ₂	0– 200 ppm	0– 100 ppm	0– 100 ppm	B
C ₂ H ₄	0– 500 ppm	0– 300 ppm	0– 300 ppm	B
C ₂ H ₆	0– 100 ppm	0– 50 ppm	0– 50 ppm ²⁾	B
C ₃ H ₈	0– 250 ppm	0– 100 ppm	0– 100 ppm ²⁾	B
C ₃ H ₆	0– 100 ppm	0– 50 ppm	0– 50 ppm ²⁾	B
C ₄ H ₁₀	0– 100 ppm	0– 50 ppm	0– 50 ppm ²⁾	B
C ₄ H ₈	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 ₂ O	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. N₂, 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 N₂.

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: $\leq 1\%$ of span per $10\text{ }^{\circ}\text{C}$;
for ranges smaller than Class 1 to Class 2:
 $\leq 2\%$ of span per $10\text{ }^{\circ}\text{C}$
- On sensitivity with temperature compensation:
 $\leq 3\%$ of measured value per $10\text{ }^{\circ}\text{C}$
- On sensitivity with thermostat effect at $55\text{ }^{\circ}\text{C}$ (optional):
 $\leq 1\%$ of measured value per $10\text{ }^{\circ}\text{C}$

Air Pressure Effect

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

The pressure sensor is located in the sample gas path if hoses are used as the internal gas lines.

If tubing is used for internal gas lines the pressure sensor is routed to the outside via a hose.

Pressure Sensor Working Range: $p_{\text{bar}} = 600\text{--}1250\text{ hPa}$

Power Supply Effect

$24\text{ VDC} \pm 5\%$: $\leq 0.2\%$ of span

Dynamic Response**Warm-Up Time**

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

90% Response Time

$T_{90} = 2.5\text{ sec}$ 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 (9-inch rack housing) or bottom (wall-mount housing) of the analyzer module with $1/8\text{ NPT}$ 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 $5\text{ }^{\circ}\text{C}$ below the ambient temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is required.

Inlet Pressure

$p_{\text{a}} = 2\text{--}500\text{ hPa}$

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**

$24\text{ VDC} \pm 5\%$ from the built-in power supply or an external unit

Power Consumption

Approx. 75 W

Installation Site Requirements**Vibration**

max. $\pm 0.04\text{ mm}$ 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: $+5\text{ to }+40/45\text{ }^{\circ}\text{C}$ when installed in housing with/without electronics module;
Storage and Transport: $-25\text{ to }+65\text{ }^{\circ}\text{C}$

For stack flow measurement, Sasolburg plant installed an ultrasound principle unit, model Flowsick 100 PMA manufactured by Sick AG (Germany). The Flowsick series are also TÜV certified and comply with relevant regulations in Germany such as 13th and 17th BImSchV. Table below summarizes some performance characteristics of the unit:



Device Data	PHD	PMD	PMA
Measured quantity	gas velocity, volume flow S.S./O.S., gas temperature		
Measuring range	v: ± 40 m/s; freely selectable		
Accuracy emission measur. ¹⁰⁾	± 0.1 m/s		
Reproducibility process control	$\pm 1\%$ for $v > 2$ m/s; ± 0.02 m/s for $v < 2$ m/s		
Signals	1 analog output: 0/2/4...20 mA; 750 Ω load 4 relay outputs f. status signals: 48 V/1 A (el. isolated)		
Interfaces	RS 232		
Response time (T_{90})	1...300 s; freely selectable		
Mounting angle	45°...60°		
Options	2 analog modules, 1 pulse output 1 interface mod. RS 232/422/485		1 analog module 1 pulse output
Purge-air supply	Purge-air unit for inner ch. pressure: $-0.1...+0.1$ bar		
Power supply	90...140 V AC/180...240 V AC; 50/60 Hz; ca. 20 W		
Protection class	IP 65		

For stack flow measurement, Secunda plant selected as primary meter an Annubar principle (multiple pressure differential) unit, model 485 Annubar primary manufactured by Rosemount Inc. (USA). Secunda has an ultrasound flowmeter (Flowsick 100) also installed in the stack for redundancy. 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

$\pm 0.75\%$ of flow rate

Repeatability

$\pm 0.1\%$

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 N₂O at nitric acid plants, there is no official specification for uncertainty available. Then, considering official specification of uncertainties defined for equivalent pollutants (f.e. NO_x, SO₂) 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 N₂O, 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 1⁶ report.

Specific performance characteristics for N₂O analyzer (ABB AO 2000 URAS14) – Sasolburg:**Contributing partial standard uncertainties and reference to their origins**

Selectivity H ₂ O	0.00	mg/m ³
Selectivity others (largest sum)	1.86	mg/m ³
Lack of fit	0.17	mg/m ³
Drift	39.77	mg/m ³
Pressure dependence	0.00	mg/m ³
Temperature dependence	31.51	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	3.98	mg/m ³
Origin of data	Article in UmweltMagazin, 2001	

Specific performance characteristics for N₂O analyzer (ABB AO 2000 URAS14) – Secunda:

⁶ The Uras14 infra-red photometer currently used in ABB's AO2000 analyzers and ACN systems has not been tested for N₂O measurement to EN 14181, so no official QAL1 Declaration can be provided for the existing installations. 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.

**Contributing partial standard uncertainties and reference to their origins**

Selectivity H ₂ O	0.00	mg/m ³
Selectivity others (largest sum)	1.86	mg/m ³
Lack of fit	0.17	mg/m ³
Drift	39.77	mg/m ³
Pressure dependence	0.00	mg/m ³
Temperature dependence	34.24	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	3.98	mg/m ³
Origin of data	Article in UmweltMagazin, 2001	

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 each plant. The QAL1 reports confirm the N₂O analyzers (in both cases an AO 2000- URAS 14 NDIR supplied by ABB GmbH) are suitable to perform the indicated analysis (N₂O 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 $UNC = ((N_2O \text{ Analyzer uncertainty})^2 + (\text{Flow meter uncertainty})^2)^{1/2}$). The overall measurement uncertainty for each plant is available for the validation of the project activity.

QAL2: Validation of the AMS following its Installation.

The next level of quality assurance prescribed on EN14181:2004 (QAL2), describes a procedure for the determination of the calibration function and its variability, by means of certain number of parallel measurements (meaning simultaneously with the AMS), performed with a Standard Reference Method (which should be a proven and accurate⁷ 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

⁷ 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 N₂O, 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.



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. At the time of validation, Sasol was in the process of selecting a suitable testing laboratory to conduct the QAL2 tests. The QAL2 report from the certified lab will be available for DOE review during the first verification audit. Any data collected previous to the reception of the QAL2 lab report will be corrected through proper application of the calibration function. From then on, the calibration function will be fed to DCS algorithm so the data generated by the AMS is automatically corrected.

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 units at both Sasolburg and Secunda were installed by qualified contractors under the direct supervision of the equipment manufacturers, considering both relevant South African and international standards. Each Plant Manager, as well as members of Sasol Technology Engineering Support Group, actively supervised all phases of installation, from system design to commissioning.

QAL3: Ongoing quality assurance during operation.

Procedures described at QAL3 of EN 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 each of Sasol'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 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 (Sasol 0081) 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 Sasol resources and the third parties involved during such activities). Maintenance and service logs are well kept at both Sasol plants 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 each plant's AMS at least once every 3 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):	700.000	total period 07-12
Total CER's :	888.615	per year
CER' deductions :	(122.518)	per year
Net CER's Revenue (USD) :	3.830.486	per year
Other Income (USD):	-	per year
Variable Costs (USD) :	(480.210)	per year
Tax (USD) :	(971.580)	per year
NPV (USD) :	6.382.428	total period 07-12
IRR (%) :	87,7%	total period 07-12

**Annex 6****SOUTH AFRICAN DNA: SUSTAINABLE DEVELOPMENT CRITERIA**

	Criteria	Indicator	Project Contribution to Sustainable Development
Environmental	Impact on local environmental quality	• Impact of the project on air quality. • Impact of the project on water pollution. • Impact of the project on the generation or disposal of solid waste. • Any other positive or negative environmental impacts of the project (such as impacts on noise, safety, visual impacts, or traffic).	• The project will reduce direct emissions of N₂O. • The project will not increase nor decrease direct emissions of other air pollutants such as NO_x, and particulate matter due to the introduction of a secondary catalyst in the ammonia burner. • The project will have no impact on water pollution as no waste will be generated that may enter water bodies. • The project will not generate solid waste. The exhausted secondary catalyst will be sent to Germany to be recovered for re-use. • The project will not generate any negative impact on noise, safety, visual impact or traffic.
	Change in usage of natural resources	• Impact of the project on community access to natural resources • Impact of the project on the sustainability of use of water, minerals other non renewable natural resources • Impact of the project on the efficiency of resource utilisation	• The project does not impact on the community's access to natural resources. If anything, given that this project will reduce air emissions; it will in effect improve community access to a cleaner natural environment. • Operation of the catalyst used to reduce N₂O emissions does not consume electricity, steam, fuels or any other natural resource. The energy balance and resource utilization of the plant remains unchanged and the project therefore does not impact on the sustainability of use of water, minerals or other non renewable natural resources nor does it impact the efficiency of resources utilization.



	Criteria	Indicator	Project Contribution to Sustainable Development
	Impacts on biodiversity and ecosystems	Changes in local or regional biodiversity arising from the project.	The project will not impact on biodiversity as the nitric acid plants are located in industrial zones.
Economic	Economic impacts	- Impact of the project of foreign exchange requirements. - Impact of the project on existing economic activity in the area. - Impact of the project on the cost of energy. - Impact of the project on foreign direct investment.	- The project will have limited impact on foreign exchange rate requirements in that the catalyst will be procured from a foreign supplier. This will however be offset by the sale of CER's to offshore buyers. - The project will have a positive contribution to FDI through the sale of CERs to Annex 1 countries (Western Europe, Canada, Japan, etc.) generated by the project. - The project activity can be developed due to financial benefits obtained by selling CERs. - This project should encourage other local industries to also implement the project activity and thereby it results in an economic activity improvement in the area.
	Appropriate technology transfer	- Positive or negative implications for the transfer of technology to South Africa arising from the project. - Impact of the project on local skills development. - Demonstration and replication potential of the project.	- The project paves the way for a potential transfer of catalyst technology from developed countries to South Africa, contributing to the sustainable development of the country through industrial technology transfer. - The project has contributed to new skills development on CDM opportunities to Sasol Nitro's employees. - Project will also contribute to skills development related to installation, operation and monitoring of secondary catalyst N₂O abatement technology. - The Sasol N₂O Abatement Project has the potential to be replicated by other nitric acid plants.



	Criteria	Indicator	Project Contribution to Sustainable Development
Social	Alignment with national provincial and local development priorities	• How the project is aligned with the provincial and national government objectives. • How the project is aligned with local development objectives. • Impact of the project on the provision of, or access to, basic services to the area. • Impact of the project on the relocation of communities if applicable • Contribution of the project to any specific sectoral objectives (for example, renewable energy targets)	• The provincial and national governments are committed to air quality and this project will contribute to providing cleaner air in the area. • The project does not impact on the local provision or access of services in the area or the relocation of communities.
	Social equity and poverty alleviation	• Impact of the project on employment levels? (specify the number of jobs created/lost; the duration of time employed, distribution of employment opportunities, types of employment, categories of employment changes in terms of skills levels and gender and racial equity). • Impact of the project on community social structures. • Impact of the project on social heritage. • Impact of the project on the provision of social amenities to the community in which the project is situated. • Contribution of the project to the development of previously underdeveloped areas or specially designated development nodes.	• The project will improve the labour and health conditions of Sasol Nitro employees' onsite. • Transboundary pollution will also be reduced in the area. • There will be no job losses at Sasol Nitro's plant as staff that were running the plant before project implementation will be skilled to take new tasks at the plant. • Other than the positive impacts as described above, the project will have no impact on community social structures, social heritage, the provision of social amenities to the community, the development of previously underdeveloped areas or specially designated development nodes.



	Criteria	Indicator	Project Contribution to Sustainable Development
General	General project acceptability	• Are the distribution of project benefits reasonable and fair?	• The project contributes to regional and national economic and technological development via the installation, operation and monitoring of the secondary catalyst N₂O abatement technology. • The projects conforms to the National Environmental Management Act principles of sustainable development in that N₂O emissions will be reduced whilst there will no negative impacts on natural resource requirements, the environment or local communities. • The benefits of reduced air emissions will be the enjoyment of cleaner air by Sasol Nitro employees and the local community. • The potential benefits of certified emission reduction (CERs) credits will assist Sasol Nitro to offset the considerable cost of the secondary catalyst, operating and maintaining the monitoring equipment as well as the additional capital cost to implement the project activity. The potential net benefit to Sasol Nitro is uncertain in view of the uncertainty regarding the volume and price of CERs. Sasol Nitro is confident in the ability of the technology to reduce emissions, however, the onerous requirements of the monitoring methodology poses a significant risk for Sasol Nitro in that it may incur the cost of implementing and operating the technology whilst not being able to successfully validate emission reductions.
