



**Project design document form for
CDM project activities
(Version 05.0)**

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Sasol Nitrous Oxide Abatement Project
Version number of the PDD	Version 8
Completion date of the PDD	05/10/2014
Project participant(s)	Sasol Nitro Sasol Financing (Pty) Limited MGM Carbon Portfolio S.a.r.l. Sasol Germany GmbH Sasol Solvents Germany GmbH
Host Party	South Africa
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	(5) Chemical industries ACM0019 - N ₂ O abatement from nitric acid production
Estimated amount of annual average GHG emission reductions	648,162 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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

Waste N_2O from nitric acid production is typically released into the atmosphere, as it does not have any economic value or toxicity at typical emission levels. N_2O is an important greenhouse gas which has a high Global Warming Potential (GWP) of 298.

The project activity involves the installation of a secondary catalyst to abate N_2O inside the reactor once it is formed. The baseline scenario is determined to be the release of N_2O emissions to the atmosphere at the currently measured rate, in the absence of regulations to restrict N_2O emissions. If regulations on N_2O emissions are introduced during the crediting period, the baseline scenario shall be adjusted accordingly. In accordance to AM0034, Baseline emissions rate was determined by measuring N_2O emission factor ($\text{kg N}_2\text{O} / \text{tonne HNO}_3$) during a complete production campaign prior to project implementation (the $\text{EF}_{\text{existing},y}$).

For the application of ACM0019, Baseline emissions will dynamically be adjusted from activity levels on an ex-post basis through monitoring the amount of nitric acid production and definition of the applicable emission factor (e.g.: $\text{EF}_{\text{existing},y}$ or $\text{EF}_{\text{new},y}$).

Project N_2O emission is monitored directly in real time. N_2O monitoring and recording facilities were installed to measure the amount of N_2O emitted by the project activity.

Total ex-ante emissions reductions are estimated to be 648,162 tonnes $\text{CO}_2\text{e}/\text{year}$ for the Second 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.

The project activity will contribute to the sustainable development of the country 1 through industrial technology transfer (catalyst technology from a developed country to South Africa). The project activity will reduce N_2O emissions and will not increase nor decrease direct emissions of other air pollutants.

The project does not impact on the local communities or access of services in the area. The project activity will not cause job losses at 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.2. Location of project activity

A.2.1. Host Party

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Republic of South Africa

A.2.2. Region/State/Province etc.

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Free State and Mpumalanga provinces

A.2.3. City/Town/Community etc.

>>

Sasolburg and Secunda.

A.2.4. Physical/Geographical location

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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.

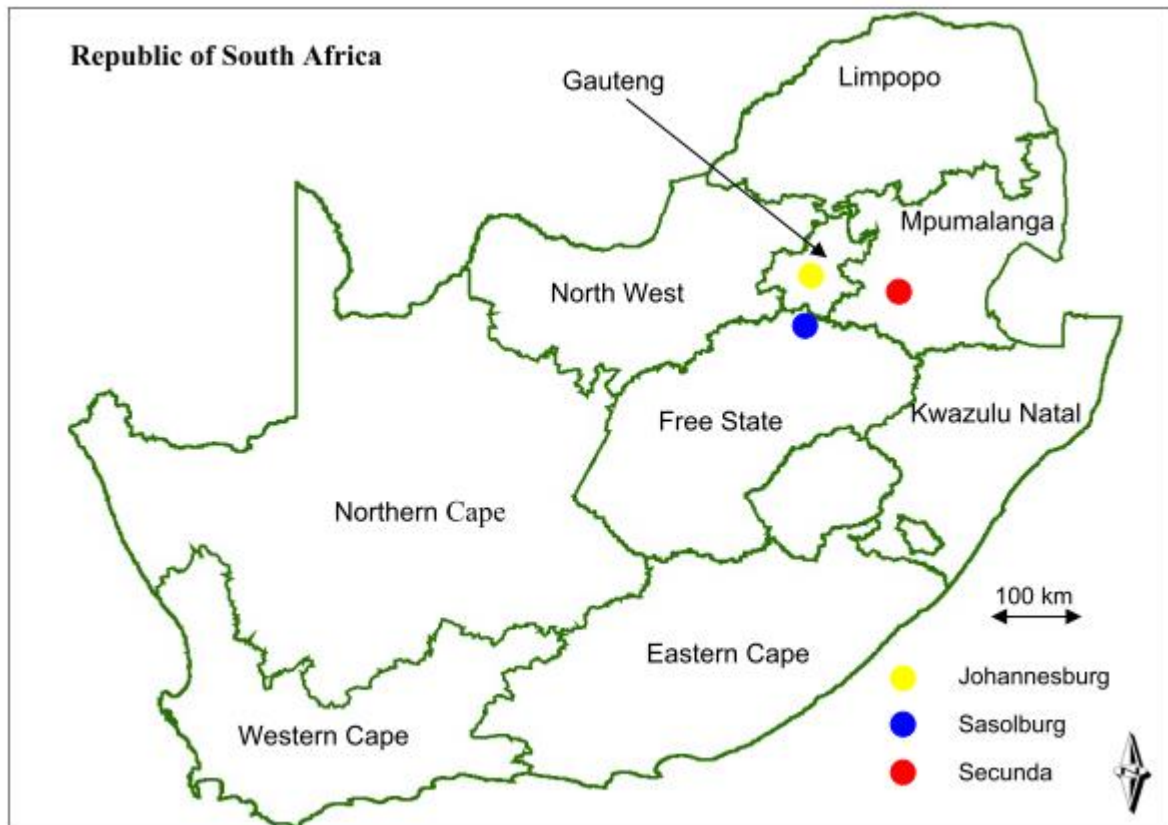


Figure 1. The location of Sasolburg and Secunda Plants

A.3. Technologies and/or measures

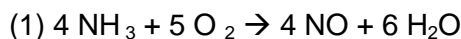
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The Ostwald process

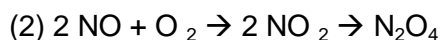
Nowadays, all commercial Nitric Acid is produced by the oxidation of ammonia, and subsequent reaction of the oxidation products with water, through the Ostwald process.

The basic Ostwald process involves 3 chemical steps:

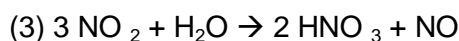
A) Catalytic oxidation of ammonia with atmospheric oxygen, to yield Nitrogen Monoxide (or Nitric Oxide).



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)¹. Reactions 2 and 3 are favored by higher pressure and lower temperatures.

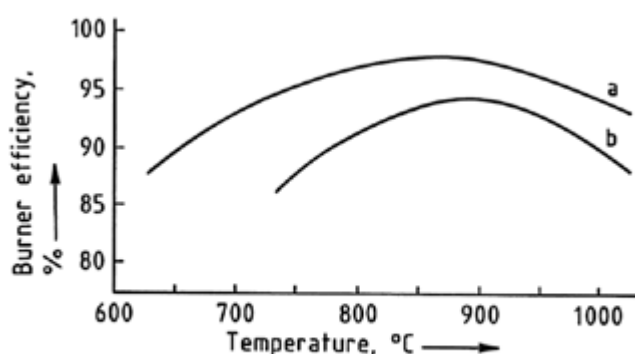


Figure 2. Conversion of Ammonia to Nitrogen Monoxide on Platinum Gauze as a function of temperature a) 100 kPa; (b) 400 kPa [1]

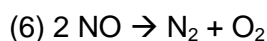
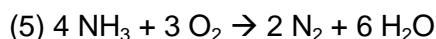
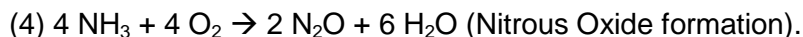
The way in which these three steps are implemented, characterizes the various Nitric Acid processes found throughout the industry. In mono pressure or single pressure processes ammonia combustion and nitrogen oxide absorption take place at the same working pressure. In dual pressure or split pressure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

Nitrous Oxide formation

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

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

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 N₂O decomposition; in a typical medium pressure plant, a catalyst weight of 30 kg/m² of cross sectional surface is sufficient to reduce N₂O concentration well below 100 ppmv. Theoretically, any given level of N₂O abatement can be reached, but in practice the abatement will be limited by practical and economic considerations. Heraeus secondary catalyst is not designed as catchment for precious metals, so it does not adsorb any material lost from the primary gauzes.

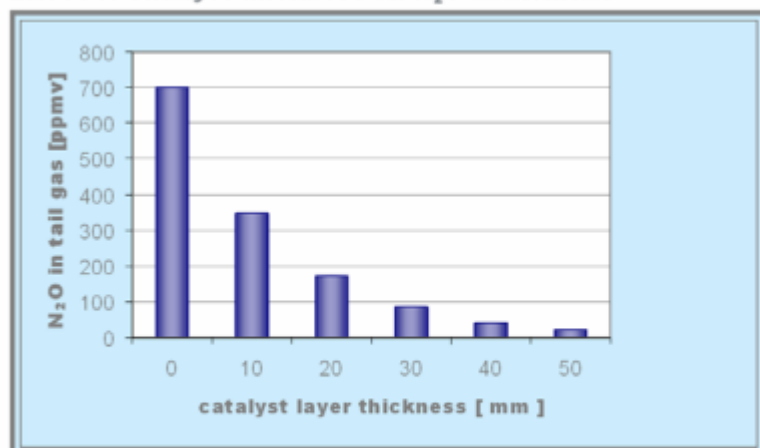
Effect of catalyst thickness on N₂O abatement

Figure 3. Effect of catalyst thickness on N₂O 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 N₂O 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 N₂O 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 N₂O 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

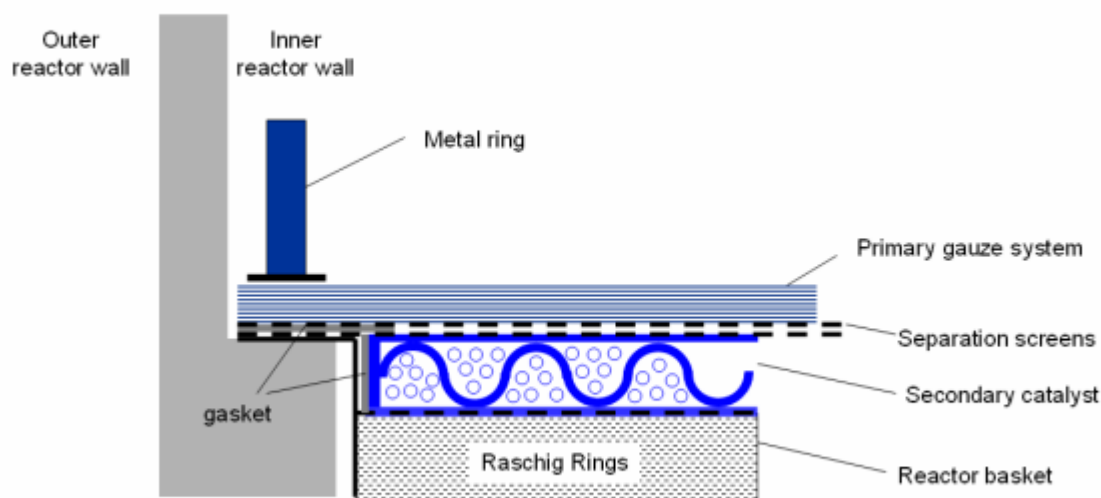


Figure 4. Secondary catalyst installation sketch

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of South Africa (host)	Sasol Nitro Sasol Financing (Pty) Limited	No
United Kingdom of Great Britain and Northern Ireland	MGM Carbon Portfolio S.a.r.l.	No
Switzerland	MGM Carbon Portfolio S.a.r.l.	No
Germany	Sasol Germany GmbH Sasol Solvents Germany GmbH	No

A.5. Public funding of 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 selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

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ACM0019 Version 02.0.0 "N₂O abatement from nitric acid production".

Version 02.0.0 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

B.2. Applicability of methodology and standardized baseline

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The chosen Baseline Methodology is applicable to the project activity. The justification is as follows:

- The project activity introduces N₂O abatement measures in a nitric acid plant.
- The nitric acid plant started commercial operation before the implementation of the CDM project activity. There was no secondary or tertiary abatement technology installed in the respective nitric acid plant.
- Continuous real-time measurements of the N₂O concentration and the total gas volume flow will be carried out in the tail gas stream after the abatement of N₂O emissions throughout the crediting period of the project activity. An Automated Measuring System (AMS) was installed.
- No law or regulation which mandates the complete or partial destruction of N₂O from nitric acid plants exists in the host country where the CDM project activity is implemented.

The tool applied to the project is also applicable. The Justification is as follows:

- The project measures the N₂O concentration in the tail gas, thus, a greenhouse gas gaseous flow.

B.3. Project boundary

	Source	GHGs	Included?	Justification/Explanation
Baseline scenario	NH ₃ oxidation at the primary catalyst gauze	CO ₂	NO	The project does not lead to any change in CO ₂ or CH ₄ emissions, and, therefore, these are not included.
		CH ₄	NO	
		N ₂ O	YES	Included, main emission source as per ACM0019
Project scenario	NH ₃ oxidation at the primary catalyst gauze	CO ₂	NO	The project does not lead to any change in CO ₂ or CH ₄ emissions
		CH ₄	NO	
		N ₂ O	YES	Included, main emission source as per ACM0019
	Operation of a tertiary N ₂ O Abatement facility	CO ₂	NO	No leakage emissions are expected. The Project doesn't have a Tertiary abatement facility.
		CH ₄	NO	
		N ₂ O	NO	

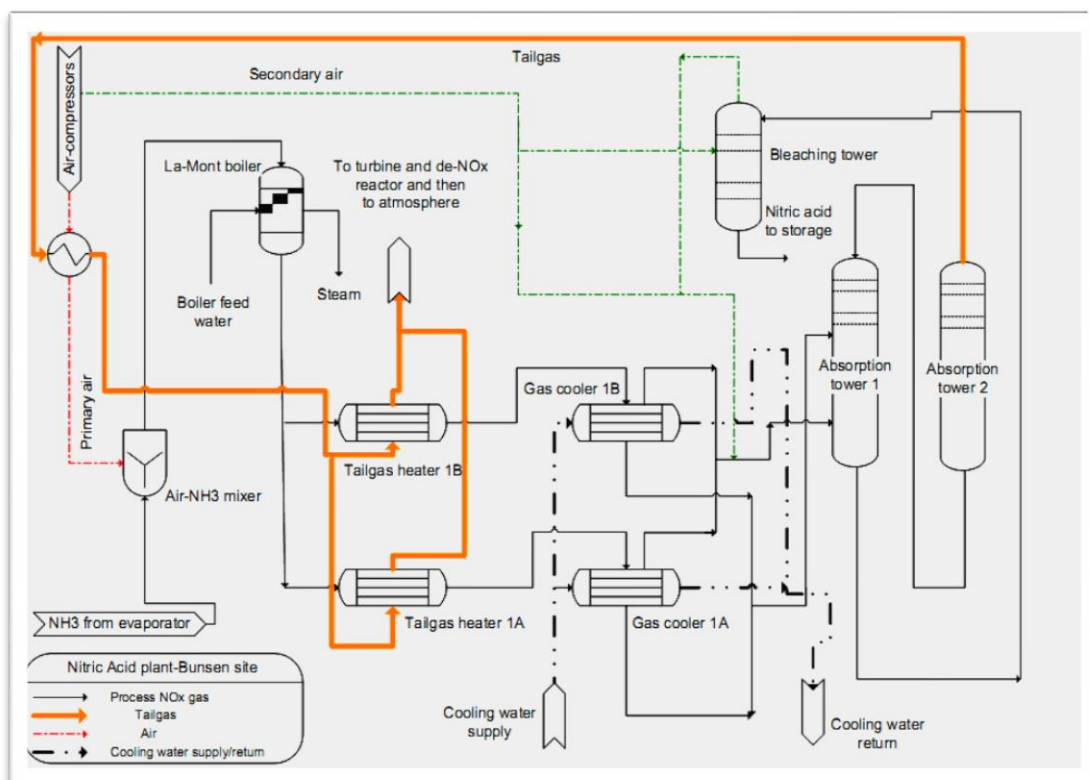


Figure 5. Project boundary for Sasolburg Nitric Acid Plant

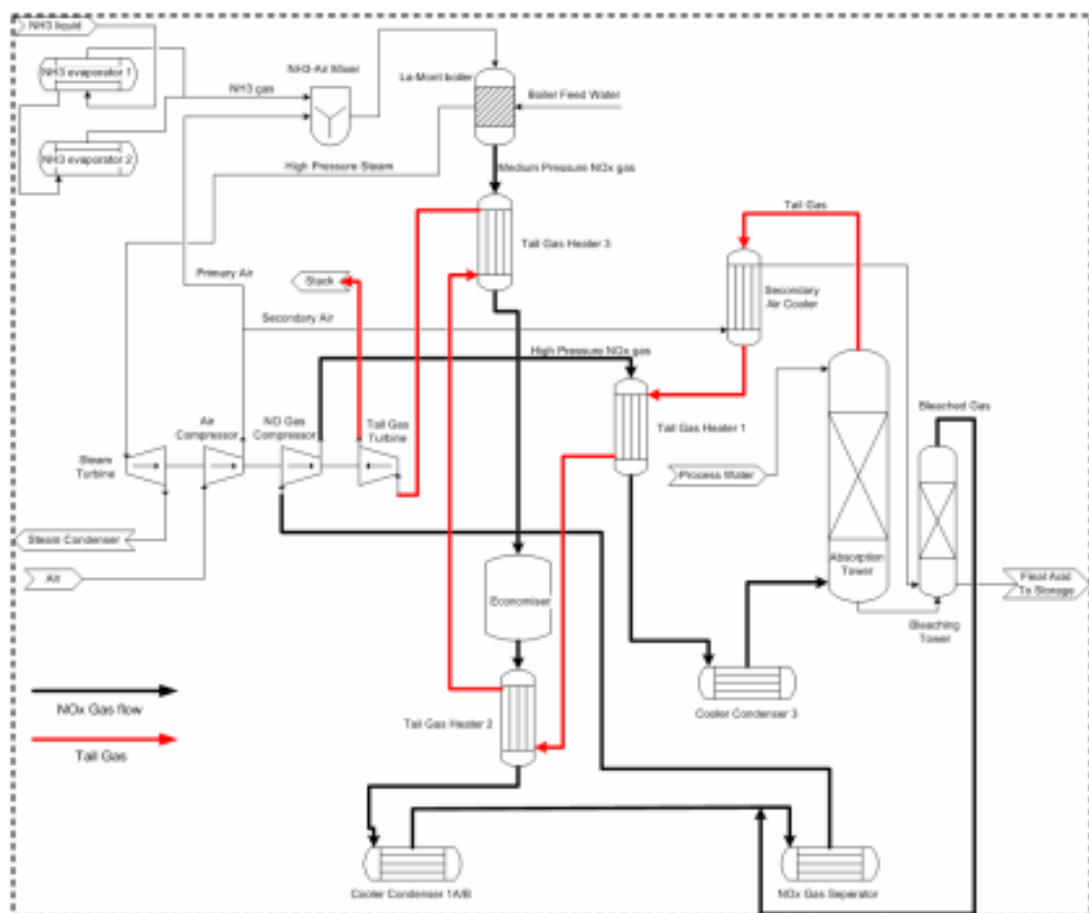


Figure 6. Project boundary for Secunda Nitric Acid Plant

B.4. Establishment and description of baseline scenario

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As per the methodology ACM0019 Version 02.0, the baseline scenario is that the N₂O is emitted to the atmosphere with no N₂O abatement measure being implemented.

B.5. Demonstration of additionality

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As per the methodology ACM0019 Version 02.0, in the absence of regulations requiring the abatement of N₂O emissions, the operator of the nitric acid plant has no economic incentives to take any N₂O abatement measures because this entails capital and operating costs but no financial benefits. Therefore, the CDM project activity is considered additional.

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

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According to ACM0019, for nitric acid plants that have used AM0034 in the first crediting period the baseline emissions are calculated as:

$$BE_y = \left(\frac{\min\{P_{production,y}; P_{product,max}\} \times EF_{existing,y}}{\max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y}} \right) \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N_2O} \times 10^{-3}$$

Where:

BE_y	=	Baseline emissions in year y (t CO ₂ e)
$P_{product,max}$	=	Design capacity (t HNO ₃)
$P_{production,y}$	=	Production of nitric acid in year y (t HNO ₃)
$EF_{existing,y}$	=	N ₂ O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N ₂ O/t HNO ₃)
$EF_{new,y}$	=	Baseline N ₂ O emission factor for nitric acid production in year y (kg N ₂ O/t HNO ₃)
GWP_{N_2O}	=	Global Warming Potential of N ₂ O valid for the commitment period
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: <ul style="list-style-type: none"> (a) For secondary N₂O abatement: the abatement system was not installed, underperforming or failed; (b) For tertiary N₂O abatement: the abatement system is by-passed, underperforming or failed

The N₂O emission factor for nitric acid plants ($EF_{existing,y}$) are calculated as follows:

$$EF_{existing,y} = \min\{EF_{historical}; EF_{default,y}\}$$

Where:

$EF_{existing,y}$	=	N ₂ O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N ₂ O/t HNO ₃)
$EF_{historical}$	=	Historical baseline emission factor of the nitric acid plant (kg N ₂ O/t HNO ₃)
$EF_{default,y}$	=	Default emission factor according to the operating pressure of the ammonia burner in year y (kg N ₂ O/t HNO ₃)

Calculation of $h_{r,y}$

As the project have used AM0034 in the first crediting period, the abatement system will be deemed to be bypassed, not working, underperform or failed in the hour h in year y if:

$$F_{N2O,tail\ gas,h} > EF_{existing\ y} \times P_{NA,h}$$

Where:

- $P_{NA,h}$ = Nitric acid produced in the hour h (t HNO₃)
- $EF_{existing\ y}$ = Default N₂O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N₂O/t HNO₃)
- $F_{N2O,tail\ gas,h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kg N₂O/h)

Project emissions

Project emissions are calculated as follows:

$$PE_y = PE_{N2O,y} + PE_{CO2,tertiary,y}$$

Where:

- PE_y = Project emissions in year y (t CO₂e)
- $PE_{N2O,y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)
- $PE_{CO2,tertiary,y}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in year y (t CO₂)

Accordingly, $PE_{N2O,y}$ is determined as follows:

$$PE_{N2O,y} = \sum_1^{h_y-h_{r,y}} F_{N2O,tail\ gas,h} \times GWP_{N2O} \times 10^{-3}$$

Where:

- $PE_{N2O,y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)
- GWP_{N2O} = Global warming potential of N₂O valid for the commitment period
- $F_{N2O,tail\ gas,h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kg N₂O/h)
- h_y = Number of hours in year y during which the plant was in operation (h)
- $h_{r,y}$ = Number of hours (h) in year y where:
- (a) For secondary N₂O abatement. Abatement system was not installed, underperforming or failed;
 - (b) For tertiary N₂O abatement. The abatement system is bypassed, underperforming or failed

$F_{N2O,tail\ gas,h}$ is determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”.

In applying the tool, the following provisions apply:

- (a) Throughout the crediting periods of the project activity, the N₂O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is to be installed and maintained throughout the crediting period based on the European Norm 14181 (2004), or any more recent update of that standard;
- (b) The monitoring system should provide separate hourly average values for the N₂O concentration and the volume or mass flow of the tail gas based on two seconds (or shorter) interval readings that are recorded and stored electronically. These N₂O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;
- (c) The correction factors derived from the calibration curve of the QAL2 audit for the monitoring components as determined during the QAL2-test in accordance with

EN14181 must be applied to both the N₂O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions;

- (d) If data for either the N₂O concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of N₂O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N₂O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N₂O calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values;
- (e) In the case that the N₂O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters P_t and T_t do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream.

Leakage

Any leakage emissions sources are deemed to be negligible.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

ER_y	=	Emission reductions in year y (t CO ₂ e)
BE_y	=	Baseline emissions in year y (t CO ₂ e)
PE_y	=	Project emissions in year y (t CO ₂ e)

“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”

In accordance with the tool there are 6 options to determine the mass flow of a particular greenhouse gas. The option used in this Project is the option A (Volume flow on dry basis). In accordance with the entity who performs the QAL2 and AST tests the average moisture content has been 2.2g H₂O/m³ dry gas for Secunda and 5.2g H₂O/m³ dry gas for Sasolburg. The formula used to calculate the N₂O mass flow is:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t} \quad (5)$$

With

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t} \quad (6)$$

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval t on a dry basis (m ³ dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m ³ gas i /m ³ dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i /m ³ gas i)
P_t	=	Absolute pressure of the gaseous stream in time interval t (Pa)
MM_i	=	Molecular mass of greenhouse gas i (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m ³ /kmol.K)
T_t	=	Temperature of the gaseous stream in time interval t (K)

B.6.2. Data and parameters fixed ex ante

(Copy this table for each piece of data and parameter.)

Data / Parameter	OP _{normal}
Unit	kPa
Description	Operating pressure of the ammonia burner
Source of data	Manufacturer specifications for Sasolburg and Secunda plants
Value(s) applied	Sasolburg: 370 to 450 kPa Secunda: 250 to 500 kPa
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	The parameter is used to determine whether the nitric acid plant operates at a low, medium or high pressure. The two plants operate in Medium pressure.

Data / Parameter	EF _{historical}
Unit	kg N ₂ O/t 100% HNO ₃
Description	Historical baseline emission factor of the nitric acid plant
Source of data	Baseline emission factor determined through the latest baseline campaign conducted in accordance with the methodology AM0034
Value(s) applied	Sasolburg: 9.46 kg N ₂ O/t 100% HNO ₃ Secunda: 4.57 kg N ₂ O/t 100% HNO ₃
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the second and third crediting period

Data / Parameter	EF _{default,y}																																						
Unit	kg N ₂ O/t 100% HNO ₃																																						
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid)																																						
Source of data	ACM0019 based on the operating pressure of the Medium Pressure Ammonia Burner:																																						
Value(s) applied	<table border="1"> <thead> <tr> <th>Year</th><th>EF_{default,y} [kg N₂O/t 100% HNO₃]</th></tr> </thead> <tbody> <tr><td>2013</td><td>8.4</td></tr> <tr><td>2014</td><td>8.2</td></tr> <tr><td>2015</td><td>8.0</td></tr> <tr><td>2016</td><td>7.8</td></tr> <tr><td>2017</td><td>7.6</td></tr> <tr><td>2018</td><td>7.4</td></tr> <tr><td>2019</td><td>7.2</td></tr> <tr><td>2020</td><td>7</td></tr> <tr><td>2021</td><td>6.8</td></tr> <tr><td>2022</td><td>6.6</td></tr> <tr><td>2023</td><td>6.4</td></tr> <tr><td>2024</td><td>6.2</td></tr> <tr><td>2025</td><td>6</td></tr> <tr><td>2026</td><td>5.8</td></tr> <tr><td>2027</td><td>5.6</td></tr> <tr><td>2028</td><td>5.4</td></tr> <tr><td>2029</td><td>5.2</td></tr> <tr><td>2030</td><td>5.0</td></tr> </tbody> </table>	Year	EF _{default,y} [kg N ₂ O/t 100% HNO ₃]	2013	8.4	2014	8.2	2015	8.0	2016	7.8	2017	7.6	2018	7.4	2019	7.2	2020	7	2021	6.8	2022	6.6	2023	6.4	2024	6.2	2025	6	2026	5.8	2027	5.6	2028	5.4	2029	5.2	2030	5.0
Year	EF _{default,y} [kg N ₂ O/t 100% HNO ₃]																																						
2013	8.4																																						
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2030	5.0																																						
Choice of data or Measurement methods and procedures	-																																						
Purpose of data	Calculation of baseline emissions																																						
Additional comment	The decrease in the value for the baseline emission factor over time is to reflect the technological development																																						

Data / Parameter	EF _{new,y}																																												
Unit	kg N ₂ O/t 100% HNO ₃																																												
Description	Baseline N ₂ O emission factor for nitric acid production in year y (related to 100 per cent pure acid)																																												
Source of data	Sourced from ACM0019																																												
Value(s) applied	<table border="1"> <thead> <tr> <th>Year</th><th>Emission factor (kgN₂O/t 100% HNO₃)^{new,y}</th></tr> </thead> <tbody> <tr><td>2005</td><td>5.10</td></tr> <tr><td>2006</td><td>4.90</td></tr> <tr><td>2007</td><td>4.70</td></tr> <tr><td>2008</td><td>4.60</td></tr> <tr><td>2009</td><td>4.40</td></tr> <tr><td>2010</td><td>4.20</td></tr> <tr><td>2011</td><td>4.10</td></tr> <tr><td>2012</td><td>3.90</td></tr> <tr><td>2013</td><td>3.70</td></tr> <tr><td>2014</td><td>3.50</td></tr> <tr><td>2015</td><td>3.40</td></tr> <tr><td>2016</td><td>3.20</td></tr> <tr><td>2017</td><td>3.00</td></tr> <tr><td>2018</td><td>2.80</td></tr> <tr><td>2019</td><td>2.70</td></tr> <tr><td>2020</td><td>2.50</td></tr> <tr><td>2021</td><td>2.50</td></tr> <tr><td>2022</td><td>2.50</td></tr> <tr><td>2023</td><td>2.50</td></tr> <tr><td>...</td><td>...</td></tr> <tr><td>Year n</td><td>2.50</td></tr> </tbody> </table>	Year	Emission factor (kgN ₂ O/t 100% HNO ₃) ^{new,y}	2005	5.10	2006	4.90	2007	4.70	2008	4.60	2009	4.40	2010	4.20	2011	4.10	2012	3.90	2013	3.70	2014	3.50	2015	3.40	2016	3.20	2017	3.00	2018	2.80	2019	2.70	2020	2.50	2021	2.50	2022	2.50	2023	2.50	Year n	2.50
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2022	2.50																																												
2023	2.50																																												
...	...																																												
Year n	2.50																																												
Choice of data or Measurement methods and procedures	None																																												
Purpose of data	Calculation of baseline emissions																																												
Additional comment	The decrease in the value for the baseline emission factor over time is to reflect the technological development																																												

Data / Parameter	$P_{\text{product,max}}$
Unit	t Product
Description	Design capacity of nitric acid production during the first crediting period
Source of data	Project operator and/or technology provider
Value(s) applied	Sasolburg: 190000 t Secunda: 290000 t
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is only for project activities applying case 1

Data / Parameter	GWP_{N_2O}
Unit	t CO ₂ e/t N ₂ O
Description	Global warming potential of N ₂ O valid for the commitment period
Source of data	Relevant decisions by the CMP
Value(s) applied	298 t CO ₂ e/t N ₂ O
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	R_u
Unit	Pa.m ³ /kmol.K
Description	Universal ideal gases constant
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	8,314
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

Data / Parameter	MM _i																																						
Unit	Kg/kmol																																						
Description	Molecular mass of greenhouse gas i																																						
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream																																						
Value(s) applied	<table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg / kmol)</th></tr><tr><td>Carbon dioxide</td><td>CO₂</td><td>44.01</td></tr><tr><td>Methane</td><td>CH₄</td><td>16.04</td></tr><tr><td>Nitrous oxide</td><td>N₂O</td><td>44.02</td></tr><tr><td>Sulfur hexafluoride</td><td>SF₆</td><td>146.06</td></tr><tr><td>Perfluoromethane</td><td>CF₄</td><td>88.00</td></tr><tr><td>Perfluoroethane</td><td>C₂F₆</td><td>138.01</td></tr><tr><td>Perfluoropropane</td><td>C₃F₈</td><td>188.02</td></tr><tr><td>Perfluorobutane</td><td>C₄F₁₀</td><td>238.03</td></tr><tr><td>Perfluorocyclobutane</td><td>c-C₄F₈</td><td>200.03</td></tr><tr><td>Perfluoropentane</td><td>C₅F₁₂</td><td>288.03</td></tr><tr><td>Perfluorohexane</td><td>C₆F₁₄</td><td>338.04</td></tr></table>			Compound	Structure	Molecular mass (kg / kmol)	Carbon dioxide	CO ₂	44.01	Methane	CH ₄	16.04	Nitrous oxide	N ₂ O	44.02	Sulfur hexafluoride	SF ₆	146.06	Perfluoromethane	CF ₄	88.00	Perfluoroethane	C ₂ F ₆	138.01	Perfluoropropane	C ₃ F ₈	188.02	Perfluorobutane	C ₄ F ₁₀	238.03	Perfluorocyclobutane	c-C ₄ F ₈	200.03	Perfluoropentane	C ₅ F ₁₂	288.03	Perfluorohexane	C ₆ F ₁₄	338.04
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Perfluorohexane	C ₆ F ₁₄	338.04																																					
Choice of data or Measurement methods and procedures	-																																						
Purpose of data	Calculation of baseline and project emissions																																						
Additional comment	-																																						

B.6.3. Ex ante calculation of emission reductions

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The ex-ante estimations of emission reduction are determined using the following formula:

$$ER_y = BE_y - PE_y$$

Where:

ER_y	=	Emission reductions in year y (t CO ₂ e)
BE_y	=	Baseline emissions in year y (t CO ₂ e)
PE_y	=	Project emissions in year y (t CO ₂ e)

The assumptions parameters are specified in the following table:

	Sasolburg	Secunda
P _{production,max} [t HNO ₃ /yr]	190000	290000
P _{production,y} [t HNO ₃ /yr]	189887	269667
GWP _{N₂O} [tCO ₂ e/tN ₂ O]	298	298
Operating Hours h _y	8654	7922
Operating Hours h _{r,y}	0	0

$F_{N_2O, tail\ gas, h}$ [kg N ₂ O/h]	15.07	46.72
--	-------	-------

Then,

For Sasolburg:

	<i>BE_y</i> [CO _{2e}]	<i>PE_y</i> [CO _{2e}]	<i>ER_y</i> [CO _{2e}]
2014	464,009	38,852	425,157
2015	452,691	38,852	413,840
2016	441,374	38,852	402,522
2017	430,057	38,852	391,205
2018	418,740	38,852	379,888
2019	407,422	38,852	368,570
2020	396,105	38,852	357,253

For Secunda:

	<i>BE_y</i> [CO _{2e}]	<i>PE_y</i> [CO _{2e}]	<i>ER_y</i> [CO _{2e}]
2014	367,249	110,293	256,957
2015	367,249	110,293	256,957
2016	367,249	110,293	256,957
2017	367,249	110,293	256,957
2018	367,249	110,293	256,957
2019	367,249	110,293	256,957
2020	367,249	110,293	256,957

Detailed calculations are provided in the Excel Spreadsheet attached

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO ₂ e)	Project emissions (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions (t CO ₂ e)
2014	831,258	149,144	0	682,114
2015	819,941	149,144	0	670,796
2016	808,623	149,144	0	659,479
2017	797,306	149,144	0	648,162
2018	785,989	149,144	0	636,844
2019	774,672	149,144	0	625,527
2020	763,354	149,144	0	614,210
Total	5,581,143	1,044,011	0	4,537,132
Total number of crediting years	7			
Annual average over the crediting period	797,306	149,144	0	648,162

B.7. Monitoring plan**B.7.1. Data and parameters to be monitored**

(Copy this table for each piece of data and parameter.)

Data / Parameter	P _{production,y}
Unit	t HNO ₃
Description	Nitric acid produced in year y
Source of data	Measurements by project participants and production reports
Value(s) applied	Sasolburg: 189887 t HNO ₃ Secunda: 269667 t HNO ₃
Measurement methods and procedures	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.
Monitoring frequency	Every monitoring period
QA/QC procedures	Measurement devices follows QA/QC supplier recommendations
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	h_y
Unit	hour
Description	Number of hours of operation in year y
Source of data	Measured
Value(s) applied	Sasolburg: 8654 Secunda: 7922
Measurement methods and procedures	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.
Monitoring frequency	Every monitoring period
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	Records to be maintained during project's lifetime

Data / Parameter	$hour_{r,y}$
Unit	hour
Description	Number of hours (hour) in year y where abatement system was not installed, underperforming or failed;
Source of data	Measured
Value(s) applied	0
Measurement methods and procedures	Based on the Event Log for each plant. The Event Log shall identify if the event was related to the production process or the abatement system and point out the duration of the event and when the plant or abatement system reached back their normal operational levels.
Monitoring frequency	Every monitoring period
QA/QC procedures	
Purpose of data	Calculation of baseline emissions
Additional comment	Records to be maintained during project's lifetime

Data / Parameter	$F_{N_2O, tail\ gas, h}$
Unit	kg N ₂ O/hour
Description	mass flow of N ₂ O
Source of data	Calculated based on the 4 measured parameters below
Value(s) applied	15.07 kg N ₂ O/hour for Sasolburg and 46.72 kg N ₂ O/hour for Secunda
Measurement methods and procedures	Calculated based on formula from Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Monitoring frequency	hourly
QA/QC procedures	-
Purpose of data	Project Emissions Calculation
Additional comment	The values applied for the PDD ER estimations and presented above are the average values for the 5 th Verification (Period from 10-Sep 2010 to 31 Jul-2011).

Data / Parameter	$V_{t, db}$
Unit	m ³ dry gas/hour
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measured, Process control system of Sasolburg and Secunda plants
Value(s) applied	To be presented in Monitoring Reports
Measurement methods and procedures	
Monitoring frequency	The monitoring system should provide separate hourly average values, based on two seconds (or shorter) interval readings that are recorded and stored electronically
QA/QC procedures	According to standard EN 14181. QAL 2 is done every three years, AST is done annually (when no QAL 2 is done) .
Purpose of data	Project Emissions Calculation
Additional comment	-

Data / Parameter	$V_{i,t,db}$
Unit	m ³ gas <i>i</i> /m ³ dry gas
Description	Volumetric fraction of greenhouse gas <i>i</i> in the gaseous stream in a time interval <i>t</i> on a dry basis
Source of data	Measured, Process control system of Sasolburg and Secunda plants
Value(s) applied	To be presented in Monitoring Reports
Measurement methods and procedures	
Monitoring frequency	The monitoring system should provide separate hourly average values, based on two seconds (or shorter) interval readings that are recorded and stored electronically
QA/QC procedures	According to standard EN 14181. . QAL 2 is done every three years, AST is done annually (when no QAL 2 is done) and QAL3 is done on a weekly basis.
Purpose of data	Project Emissions Calculation
Additional comment	-

Data / Parameter	P_t
Unit	kPa
Description	Absolute pressure of the gaseous stream in time interval <i>t</i>
Source of data	Measured
Value(s) applied	To be presented in Monitoring Reports
Measurement methods and procedures	The N ₂ O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters P_t and T_t do not need to be monitored. Values are presented only for reference.
Monitoring frequency	The monitoring system should provide separate hourly average values, based on two seconds (or shorter) interval readings that are recorded and stored electronically
QA/QC procedures	According to standard EN 14181. QAL 2 is done every three years, AST is done annually (when no QAL 2 is done)
Purpose of data	Project Emissions Calculation
Additional comment	-

Data / Parameter	T_t
Unit	°C
Description	Temperature of the gaseous stream in time interval t
Source of data	Measured
Value(s) applied	To be presented in Monitoring Reports
Measurement methods and procedures	The N ₂ O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters Pt and Tt do not need to be monitored. Values are presented only for reference.
Monitoring frequency	The monitoring system should provide separate hourly average values, based on two seconds (or shorter) interval readings that are recorded and stored electronically
QA/QC procedures	According to standard EN 14181. QAL 2 is done every three years, AST is done annually (when no QAL 2 is done)
Purpose of data	Project Emissions Calculation
Additional comment	-

B.7.2. Sampling plan

>>
NA

B.7.3. Other elements of monitoring plan

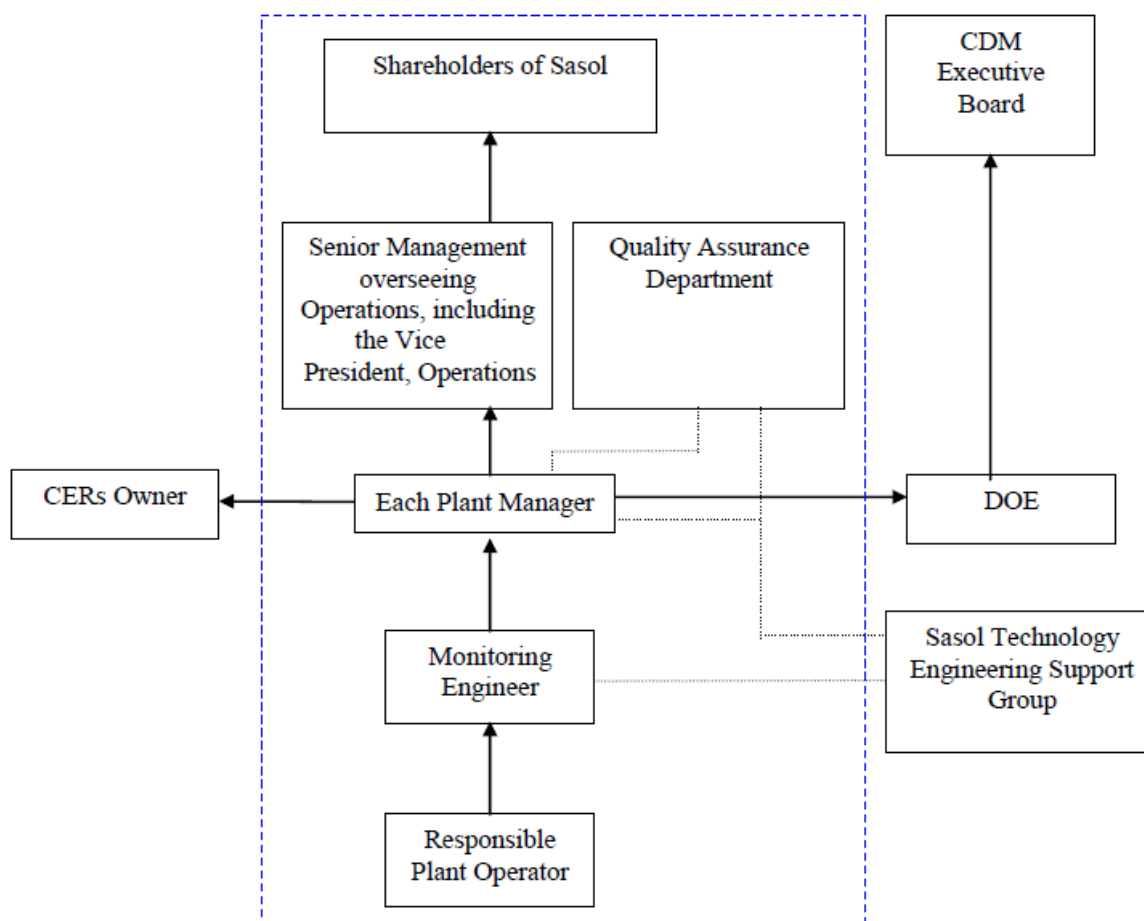
>>

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 9001 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 analysing 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 Vice President 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.

All the monitored data required to calculate the ERs and used as part of verifications will be kept for at least two years after the end of crediting period or the last issuance of CERs, whichever occurs later.

B.7.4. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>

5th October 2014.

Pablo Fernandez de Mello e Souza

Technical Director

MGM Carbon Portfolio Sarl.

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+41 79 4010741

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>

01/03/2007

C.1.2. Expected operational lifetime of project activity

>>

25 years

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>

Renewable

C.2.2. Start date of crediting period

>>

25 May 14

C.2.3. Length of crediting period

7 years

SECTION D. Environmental impacts**D.1. Analysis of environmental impacts**

>>

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 N_2O will be converted into N_2 and O_2 avoiding the high global warming effects of the GHG.

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

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

Then, an Environmental Impact Assessment (EIA) is not necessary for this activity as it is stated in the national regulation. 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. Environmental impact assessment

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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. Local stakeholder consultation**E.1. Solicitation of comments from local stakeholders**

>>

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	Deptament 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 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."

E.3. Report on consideration of comments received

>>

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.

SECTION F. Approval and authorization

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A letters of approval and authorization have been provided by the Republic of South Africa DNA

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Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input checked="" type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
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Appendix 2. Affirmation regarding public funding

Not Applicable

Appendix 3. Applicability of methodology and standardized baseline

The methodology is applicable under the following conditions:

(a) In the case that the nitric acid plant started commercial operation before the implementation of the CDM project activity, the project participants shall demonstrate that there was no secondary or tertiary N₂O abatement technology installed in the respective nitric acid plant; The two Nitric Acid plants started the commercial operation far before the implementation of the CDM project activity.

The two plants ran a Baseline Campaign before the installation of the Secondary Catalyst. At Sasolburg plant baseline campaign took place between June, 12th 2006 and March, 5th 2007. At Secunda plant baseline campaign took place between August, 27th 2006 and March, 24th 2007. The Secondary Catalysts were commissioned on and had the commissioning of the Secondary Catalyst 7th March 2006 at Sasolburg and on 18th April 2007 at Secunda.

(b) Continuous real-time measurements of the N₂O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N₂O emissions throughout the crediting period of the project activity;

The Monitoring System attends this requirement. Please refer to section B.7 for further details.

(c) No law or regulation which mandates the complete or partial destruction of N₂O from nitric acid plants exists in the host country where the CDM project activity is implemented.

Currently there is no law in South Africa which limits the emissions of N₂O. Sasol will continuously monitor the legislation to see if any new legislation about this subject is issued. For now, the closest new legislation which can impact Sasol operations is the potential introduction of a Carbon Tax, which will not specifically limit the N₂O emissions.

Appendix 4. Further background information on ex ante calculation of emission reductions

Parameter	Data unit	Value applied
Normal Operating Temperature, OT_{normal} (range of temperature)	°C	For Sasolburg: 703- 884 For Secunda: 860-920
Normal Operating Pressure, OP_{normal} (range of pressure)	bar	For Sasolburg: 3.7 – 4.5 For Secunda: 2.5 – 5.0
Maximum Ammonia Flow Rate, AFR_{max}	Kg NH_3 /hour	For Sasolburg: 6,771 For Secunda: 10,630
Maximum Ammonia to Air Flow Rate, $AIFR_{max}$	Kg NH_3 /kg air	For Sasolburg: 0.084 For Secunda: 0.063

Normal campaign (CL_n) length values are:

Sasolburg: 114,727 tons HNO_3

Secunda: 183,602 tons HNO_3

Parameters for Baseline emissions Calculations

	Sasolburg	Secunda
BE _y	475,326	367,249
P _{product,max}	190,000	290,000
P _{production,y}	189,887	269,667
E _{Fexisting,y}	8.4	4.57
E _{fnew,y}	3.7	3.7
GWPN _{2O}	298	298
h _y	8,654	7,922
h _{r,y}	0	0

Parameters for Project emissions calculations

	Sasolburg	Secunda
PEN _{2O,y}	38,852	110,293
GWPN _{2O}	298	298
FN _{2O,tail gas,h}	15.07	46.72
h _y	8,654	7,922
h _{r,y}	0	0

Emission Reduction Calculation

For Sasolburg:

	<i>BEy</i> [CO _{2e}]	<i>PEy</i> [CO _{2e}]	<i>ERy</i> [CO _{2e}]
2014	464,009	38,852	425,157
2015	452,691	38,852	413,840
2016	441,374	38,852	402,522
2017	430,057	38,852	391,205
2018	418,740	38,852	379,888
2019	407,422	38,852	368,570
2020	396,105	38,852	357,253

For Secunda:

	<i>BEy</i> [CO _{2e}]	<i>PEy</i> [CO _{2e}]	<i>ERy</i> [CO _{2e}]
2014	367,249	110,293	256,957
2015	367,249	110,293	256,957
2016	367,249	110,293	256,957
2017	367,249	110,293	256,957
2018	367,249	110,293	256,957
2019	367,249	110,293	256,957
2020	367,249	110,293	256,957

Appendix 5. Further background information on monitoring plan

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 N₂O 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, SO₂). 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.

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.

Stability**Linearity Deviation**

≤ 1 % of span

Option: Linearization for automobile exhaust gas measurement according to EPA specifications

Repeatability

≤ 0.5 % of span

Temperature Effect

Ambient temperature in permissible range

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

Air Pressure Effect

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

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

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

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

Power Supply Effect

24 VDC ± 5 %: ≤ 0.2 % of span

Dynamic Response**Warm-Up Time**

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

90% Response Time

$T_{90} = 2.5\text{ sec}$ 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 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

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.

Gas Inlet Conditions**Temperature**

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

Inlet Pressure

$p_a = 2\text{--}500\text{ hPa}$

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

Power Consumption

Approx. 75 W

Installation Site Requirements**Vibration**

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

Ambient Temperature

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

For stack flow measurement, 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. ⁴⁹	± 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		
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: 8-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 (μ) (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:

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 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 accurate analytical protocol as per relevant norms or legislation). The variability of the measured values obtained with the AMS is then compared with the uncertainty given by the applicable legislation, if the measured variability is lower than the permitted uncertainty, it is concluded the AMS has passed the variability test. Since (as explained above), official uncertainty is not available, an appropriate level is determined based on those that do exist for similar pollutants and techniques (in this case 20% of ELV). As per international standards, there are two potentially suitable Standard Reference Methods: 1) bench scale gas chromatography as per VDI standard 2469 or 2) Nondispersive 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.

Appendix 6. Summary of post registration changes

Not Applicable. No Post registration changes were requested during the first crediting period.

The Only notification sent to UNFCCC Secretariat was an e-mail from the 19 November 2013 informing the interest from Project Participants to renew the crediting period and appointing DNV as the DOE.

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