CDM Monitoring Report Nº2
Version 02
January, 2009

"Sasol Nitrous Oxide Abatement Project"
South Africa

UNFCCC Ref Nº 0961

Monitoring period
From: October 2nd 2007
To: August 9th 2008

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1. Introduction

The purpose of this monitoring report is to provide information about GHG emission reduction achieved due to the project activity.

This monitoring report involves project activity from: October 2, 2007 to August 9, 2008 (both days included). The abovementioned period splits as follows:
Sasolburg plant:

- Second project campaign from October 3, 2007 to April 5, 2008.
- Third project campaign- from April 21, 2008 to August 9, 2008.

Secunda plant:

- First project campaign- from October 2, 2007 to January 5, 2008.
- Second project campaign- from January 12, 2008 to August 9, 2008.

Duration of the project activity period:
Registration date: May 25, 2007
Crediting period: May 25, 2007 to May 25, 2014 (renewable)

Sasol Nitro has implemented a project activity aimed to reduce N_2O emissions at its nitric acid plants, Sasolburg and Secunda.
The project activity is under the category large scale, sectoral scope 5 "Chemical Industry".

2. Reference

Approved baseline methodology
AM0034 version 2 "Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants"

Approved monitoring methodology
AM0034 version 2 "Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants"

Project Design Document
"Sasol Nitrous Oxide Abatement Project". Version 5, January 31, 2007.

Validation Report
"Sasol Nitrous Oxide Abatement Project" in South Africa.
Report Nº 2007-0195
Date: February 7, 2007

CDM Registration
"Sasol Nitrous Oxide Abatement Project".Ref. Nº 0961.
Date of registration: May 25, 2007.

3. Description of the Project Activity

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

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 ammonia fed is converted to nitric oxide (NO). The remainder participates in undesirable side reactions that lead to the production of nitrous oxide, among other compounds.
Waste N_2O from nitric acid production is typically released into the atmosphere, as it does not have any economic value or toxicity at typical emission levels. N_2O is an important greenhouse gas which has a high global warming potential (GWP) of 310.

The current project activity takes place at two nitric acid plants owned by Sasol Nitro, Sasolburg and Secunda.

4. Project Participants

Name of Party involved	Project participant (as applicable)	Party involved considered as project participant
United Kingdom	MGM Carbon Portfolio	No
Republic of South Africa (host)	Sasol Nitro, a division of Sasol Chemical Industries Limited. Private entity. Project Developer.	No

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 chemical 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 tonne 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 tonne per day unit in Secunda supplies a downstream ammonium nitrate plant linked to a 500,000 tonne 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.

5. Project Location

The project activity is located at two nitric acid plants owned by Sasol. Sasolburg plant is located at Sasolburg city, Free State; and Secunda plant is located at Secunda city, Mpumalanga.

6. Project Boundary

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 N_2O contained in the waste stream exiting the stack at each site. The abatement of N_2O is the only GHG emission under the control of the project participant.

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

The figures below show the project boundaries for Sasolburg and Secunda plants.

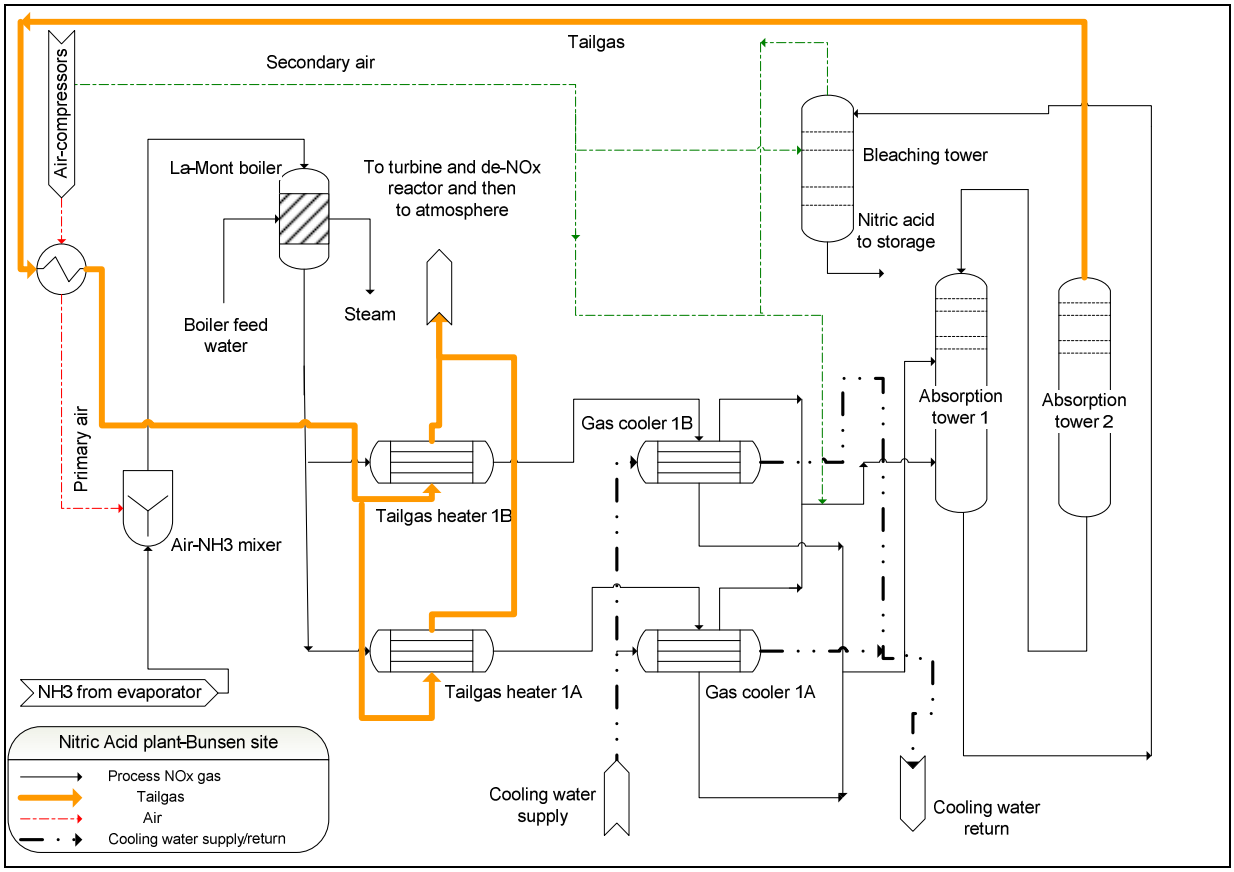

Figure 1. Project boundary for Sasolburg nitric acid plant

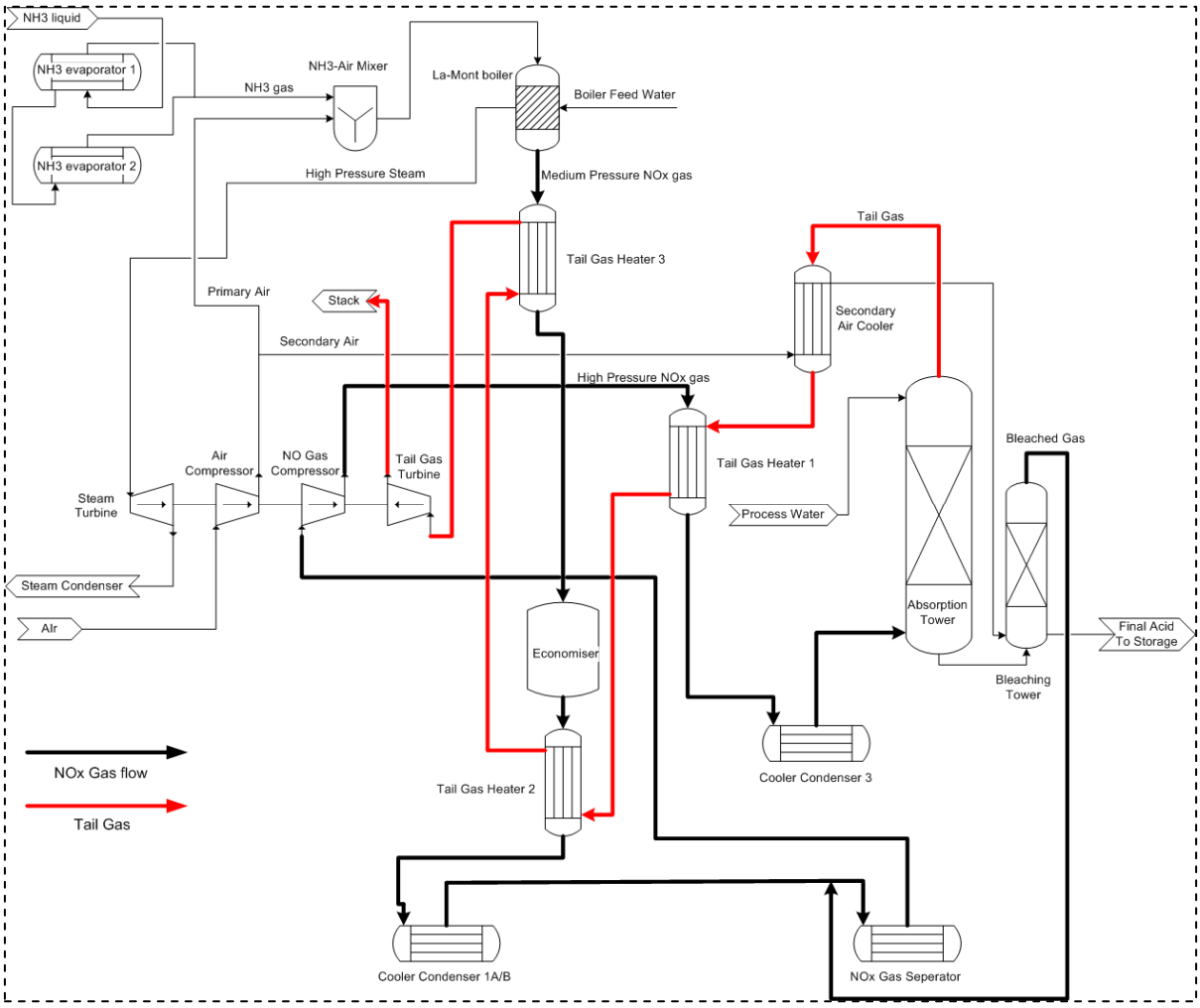

Figure 2. Project boundary for Secunda nitric acid plant

7. Monitoring Methodology and Plan

7.1. Data Monitored

The following tables show the parameters that have been monitored in order to calculate baseline emission factors.

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 monitored	Sasolburg: 71,608 Nm^3 /h Secunda: 116,409 Nm^3 /h
Recording frequency	Every two seconds

Comments:	None

Data / Parameter:	**Baseline Temperature of the Stack Gas, TSG_{BC}**
Data unit:	ºC
Description:	Temperature of the gas in the stack gas during baseline campaign
Source of data to be used:	AMS (flow meter) at Sasolburg and Secunda plants
Value of data monitored	Sasolburg: 210.9ºC Secunda: 95.5 ºC
Recording frequency	Every two seconds
Comments	Average value

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 monitored	Sasolburg: 0.8 bar Secunda: 1.0 bar
Recording frequency	Every two seconds
Comments:	Average value

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 monitored	Sasolburg: 3,020 mg N_2O/ Nm^3 Secunda: 1,474 mg N_2O/ Nm^3
Recording frequency	Every two seconds
Comments:	None

Data / Parameter:	**Baseline Operating Hours, OH_{BC}**
Data unit:	Hour
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 monitored	Sasolburg: 5,037 hours Secunda: 4,810 hours
Recording frequency	Once a day
Comments:	None

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	Measured by QAL2 test.

used:	
Value of data monitored	For Sasolburg: 3.89% For Secunda: 4.14%
Recording frequency	Calculated once
Comments:	Data obtained from QAL2 test carried out by SGS

Data / Parameter:	**Nitric Acid Production, NAP_{BC}**
Data unit:	tonne 100% HNO_3
Description:	Total nitric acid production for the baseline campaign.
Source of data to be used:	Production logs of Sasolburg and Secunda plants
Value of data monitored	Value applied for first project campaign is: Secunda: 172, 879 tonne 100% HNO_3 Values applied for second project campaigns are: Sasolburg: 96,556 tonne 100% HNO_3 Secunda: 168,648 tonne 100% HNO_3 Value applied for third project campaign is: Sasolburg: 114,705 tonne 100% HNO_3
Recording frequency	Daily
Comment:	At Sasolburg plant baseline campaign length was 130,069tonne 100% HNO_3, this production exceeds normal campaign length, 114,727 tonne 100% HNO_3, Then we used in the baseline emission factor calculation, the cumulative production up to the day before the day in which the plant exceeded normal campaign length. (February 3rd 2007). The second project campaign was 97,016 tonne 100% HNO_3, shorter than normal campaign length. Then we recalculated the baseline emission factor using the cumulative production up to the day before the day in which the plant exceeded that production. (December 17th, 2006). At Secunda plant second project campaign length was 168,809 tonne 100% HNO_3, shorter than normal campaign length (183,602 tonne %HNO_3). Then we recalculated the baseline emission that applied for the second project campaign using the cumulative production up to the day before the day in which the plant exceeded that production (March 18th, 2007)

Data / Parameter:	**Baseline Emission Factor, EF_{BL}**
Data unit:	ton N_2O / ton 100% HNO_3
Description:	Baseline emission factor is calculated from monitored data for the baseline campaign
Source of data to be used:	Calculated from monitored data.
Value of data monitored	Sasolburg: 0.00966 tonne N_2O / tonne 100% HNO_3. Secunda: 0.00457 tonne N_2O / tonne 100% HNO_3. Baseline emission factors were recalculated according to project campaign legnths. Values applied for second project campaign are: Sasolburg: 0.00892 tonne N_2O / tonne 100% HNO_3. Secunda: 0.00455 tonne N_2O / tonne 100% HNO_3.
Recording frequency	Calculated once at the end of the baseline campaign
Comments:	None

Data / Parameter:	**Baseline Oxidation Temperature, OT_{BC}**
Data unit:	ºC
Description:	Oxidation temperature of the ammonia reactor for the baseline campaign
Source of data to be used:	Process control system of Sasolburg and Secunda plants
Value of data monitored	Sasolburg: 878ºC Secunda: 870ºC
Recording frequency	Every hour
Comments:	Average value

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 monitored	Sasolburg: 4.0 bar Secunda: 4.7 bar
Recording frequency	Every hour
Comments:	Average value

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 monitored	Sasolburg: 5,819 kg NH_3/hour Secunda: 9,187 kg NH_3/hour
Recording frequency	Continuously
Comments:	Average value

Data / Parameter:	**Baseline Ammonia to Air Flow Rate, $AIFR_{BC}$**
Data unit:	kg NH_3/kg air
Description:	Ammonia to air flow rate to the ammonia oxidation reactor for the baseline campaign
Source of data to be used:	Process control system of Sasolburg and Secunda plants
Value of data monitored	Sasolburg: 0.060 kg NH_3/kg air Secunda: 0.061 kg NH_3/kg air
Recording frequency	Every hour
Comments:	Average value

Data / Parameter:	**Baseline Campaign Length, CL_{BL}**
Data unit:	tonne 100% HNO_3
Description:	Campaign length is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes. (see baseline nitric acid production, NAP_{BC})
Source of data to be used:	Plant production log book
Value of data	Value applied for first project campaign is:

monitored	Secunda: 172, 879 tonne 100% HNO_3 Values applied for second project campaigns are: Sasolburg: 96,556 tonne 100% HNO_3 Secunda: 168,648 tonne 100% HNO_3 Value applied for third project campaign is: Sasolburg: 114,705 tonne 100% HNO_3
Recording frequency	Daily
Comments:	At Sasolburg plant baseline campaign length was 130,069tonne 100% HNO_3, this production exceeds normal campaign length, 114,727 tonne 100% HNO_3, Then we used in the baseline emission factor calculation, the cumulative production up to the day before the day in which the plant exceeded normal campaign length. (February 3rd 2007). The second project campaign was 97,016 tonne 100% HNO_3, shorter than normal campaign length. Then we recalculated the baseline emission factor using the cumulative production up to the day before the day in which the plant exceeded that production. (December 17th, 2006). At Secunda plant second project campaign length was 168,809 tonne 100% HNO_3, shorter than normal campaign length (183,602 tonne %HNO_3). Then we recalculated the baseline emission that applied for the second project campaign using the cumulative production up to the day before the day in which the plant exceeded that production (March 18th, 2007)

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 monitored	Sasolburg: W.C. Heraeus Secunda: W.C. Heraeus
Recording frequency	Once
Comments:	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 acid plant procurement office and gauze Supplier technical service department
Value of data monitored	Sasolburg: Pt 54.0 to 56.0 %, Rh 3.6 to 3.9 %, Pd 40.0 to 42.0%. Secunda: Pt 54.0 to 55.0 %, Rh 3.5 to 3.8 %, Pd 41.0 to 43.0 %
Recording frequency	Once
Comments:	None.

The following tables show the parameters monitored in order to calculate project emissions.

First project campaign

Data / Parameter:	**Project Volume Flow in the Stack Gas, $VSG_{project}$**
Data unit:	Nm^3 / hour
Description:	Mean 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 monitored	Secunda: 117,837 Nm^3 / hour
Recording frequency	Every two seconds
Comments:	None

Data / Parameter:	**Project Temperature of the Stack Gas, $TSG_{project}$**
Data unit:	ºC
Description:	Temperature of the gas in the stack gas during project campaign
Source of data to be used:	AMS (flow meter) at Sasolburg and Secunda plants
Value of data monitored	Secunda: 92 ºC
Recording frequency	Every two seconds
Comments:	Average value

Data / Parameter:	**Project Pressure of the Stack Gas, $PSG_{project}$**
Data unit:	bar
Description:	Pressure 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 monitored	Secunda: 1.0 bar
Recording frequency	Every two seconds
Comments:	Average value

Data / Parameter:	**Project N_2O Concentration in the Stack Gas, $NCSG_{project}$**
Data unit:	mg N_2O/ m^3 (converted from ppmv if necessary)
Description:	Mean N_2O 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 monitored	Secunda: 649 mg N_2O/ m^3
Recording frequency	Every two seconds
Comments:	None

Data / Parameter:	**Project Operating Hours, $OH_{project}$**
Data unit:	Hour
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 monitored	Secunda: 6,062 hours
Recording frequency	Daily
Comments:	None

Data / Parameter:	**Project Nitric Acid Production, $NAP_{project}$**
Data unit:	tonne 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 monitored	Secunda: 77,415 tonne 100% HNO_3
Recording frequency	Daily
Comments:	Nitric acid production during the first project campaign was 215,393 tonne HNO_3 Production for the monitoring period was 77,415 tonne 100% HNO_3

Data / Parameter:	**Project Emission Factor, EF_n**
Data unit:	tonne N_2O / tonne 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 monitored	Secunda: 0.00215 tonne N_2O / tonne 100% HNO_3.
Recording frequency	Calculated once after ending the project campaign
Comments:	None

Data / Parameter:	**Project Campaign Length, CL_n**
Data unit:	tonne 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 monitored	Secunda: 215,393 tonne HNO_3
Recording frequency	Calculated at the end of the project campaign
Comments:	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 monitored	Secunda: W.C. Heraeus
Recording frequency	Once
Comments:	None

Data / Parameter:	**Project Gauze Composition, GC_n**
Data unit:	% (Pt, Rh, Pd)

Description:	Gauze concentration for the project campaign
Source of data to be used:	Procurement offices of Sasolburg and Secunda plants
Value of data monitored	Secunda: Pt 54.0 to 55.0 %, Rh 3.5 to 3.8 %, Pd 41.0 to 43.0 %
Recording frequency	Once
Comments:	None

Data / Parameter:	**Emission Factor set by regulation, EF_{reg}**
Data unit:	kg N_2O/ tonne 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 monitored	No local or national regulation has been introducing during project period
Recording frequency	At date of introducing or change of regulation
Comments:	

Second project campaign

Data / Parameter:	**Project Volume Flow in the Stack Gas, $VSG_{project}$**
Data unit:	Nm^3 / hour
Description:	Mean 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 monitored	Sasolburg: 68,824 Nm^3 / hour Secunda: 113,964 Nm^3 / hour
Recording frequency	Every two seconds
Comments:	None

Data / Parameter:	**Project Temperature of the Stack Gas, $TSG_{project}$**
Data unit:	ºC
Description:	Temperature of the gas in the stack gas during project campaign
Source of data to be used:	AMS (flow meter) at Sasolburg and Secunda plants
Value of data monitored	Sasolburg: 228 ºC Secunda: 90 ºC
Recording frequency	Every two seconds
Comments:	Average value

Data / Parameter:	**Project Pressure of the Stack Gas, $PSG_{project}$**
Data unit:	bar
Description:	Pressure 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 monitored	Sasolburg: 0.85 bar Secunda: 1.04 bar
Recording frequency	Every two seconds
Comments:	Average value

Data / Parameter:	**Project N_2O Concentration in the Stack Gas, $NCSG_{project}$**
Data unit:	mg N_2O/ m^3 (converted from ppmv if necessary)
Description:	Mean N_2O 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 monitored	Sasolburg: 475 mg N_2O/ m^3 Secunda: 586 mg N_2O/ m^3
Recording frequency	Every two seconds
Comments:	None

Data / Parameter:	**Project Operating Hours, $OH_{project}$**
Data unit:	Hour
Description:	Total operating hours for the project campaign
Source of data to be	Process control system of Sasolburg and Secunda plants

used:	
Value of data monitored	Sasolburg: 4,374 hours Secunda: 4,747 hours
Recording frequency	Daily
Comments:	None

Data / Parameter:	**Project Nitric Acid Production, $NAP_{project}$**
Data unit:	tonne 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 monitored	Sasolburg: 97,016 tonnes 100% HNO_3 Secunda: 168,809 tonnes 100% HNO_3
Recording frequency	Daily
Comments:	None

Data / Parameter:	**Project Emission Factor, EF_n**
Data unit:	tonne N_2O / tonne 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 monitored	Sasolburg: 0.00147 tonne N_2O / tonne 100% HNO_3 Secunda: 0.00188 tonne N_2O / tonne 100% HNO_3
Recording frequency	Calculated once after ending the project campaign
Comments:	None

Data / Parameter:	**Moving Average Emission factor, $EF_{ma,n}$**
Data unit:	tonne N_2O / tonne 100% HNO_3
Description:	Moving average of emission factor calculated as the average of the emission factors of all previous project campaigns
Source of data to be used:	Calculated from campaign emissions factors
Value of data monitored	Sasolburg: 0.00133 tonne N_2O / tonne 100% HNO_3. Secunda: 0.00202 tonne N_2O / tonne 100% HNO_3.
Recording frequency	Calculated at the end of each project campaign
Comments:	None

Data / Parameter:	**Emission factor used to determine emission reductions, EF_p**
Data unit:	tonne N_2O / tonne 100% HNO_3
Description:	Emission factor used to calculate the emission from the particular campaign.
Source of data to be used:	Calculated using campaign emission factors. EF_p will be determined as the higher of $EF_{ma,n}$ and EF_n.
Value of data monitored	Sasolburg: 0.00147 tonne N_2O / tonne 100% HNO_3. Secunda: 0.00202 tonne N_2O / tonne 100% HNO_3.
Recording frequency	Calculated at the end of each project campaign
Comments:	None

Data / Parameter:	**Project Campaign Length, CL_n**
Data unit:	tonne 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 monitored	Sasolburg: 97,016 tonnes HNO_3 Secunda: 168,809 tonnes HNO_3
Recording frequency	Calculated at the end of the project campaign
Comments:	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 monitored	Sasolburg: W.C. Heraeus Secunda: W.C. Heraeus
Recording frequency	Once
Comments:	None

Data / Parameter:	**Project Gauze Composition, GC_n**
Data unit:	% (Pt, Rh, Pd)
Description:	Gauze concentration for the project campaign
Source of data to be used:	Procurement offices of Sasolburg and Secunda plants
Value of data monitored	Sasolburg: Pt 54.0 to 56.0 %, Rh 3.6 to 3.9 %, Pd 40.0 to 42.0%. Secunda: Pt 54.0 to 55.0 %, Rh 3.5 to 3.8 %, Pd 41.0 to 43.0 %
Recording frequency	Once
Comments:	None

Data / Parameter:	**Emission Factor set by Regulation, EF_{reg}**
Data unit:	kg N_2O/ ton HNO_3
Description:	Local and national regulations on N_2O and NO_X emissions
Source of data to be used:	Local and national regulations
Value of data monitored	No local or national regulation has been introducing during project period.
Recording frequency	At date of introducing or change of regulation
Comments:	

Third project campaign

Data / Parameter:	**Project Volume Flow in the Stack Gas, $VSG_{project}$**
Data unit:	Nm^3 / hour

Description:	Mean 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 monitored	Sasolburg: 71,350 Nm^3 / hour
Recording frequency	Every two seconds
Comments:	None

Data / Parameter:	**Project Temperature of the Stack Gas, $TSG_{project}$**
Data unit:	ºC
Description:	Temperature of the gas in the stack gas during project campaign
Source of data to be used:	AMS (flow meter) at Sasolburg and Secunda plants
Value of data monitored	Sasolburg: 219ºC
Recording frequency	Every two seconds
Comments:	Average value

Data / Parameter:	**Project Pressure of the Stack Gas, $PSG_{project}$**
Data unit:	bar
Description:	Pressure 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 monitored	Sasolburg: 0.9 bar
Recording frequency	Every two seconds
Comments:	Average value

Data / Parameter:	**Project N_2O Concentration in the Stack Gas, $NCSG_{project}$**
Data unit:	mg N_2O/ m^3 (converted from ppmv if necessary)
Description:	Mean N_2O 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 monitored	Sasolburg: 748 mg N_2O/ m^3
Recording frequency	Every two seconds
Comments:	None.

Data / Parameter:	**Project Operating Hours, $OH_{project}$**
Data unit:	Hour
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 monitored	Sasolburg: 5,394 hours
Recording frequency	Daily
Comments:	None

Data / Parameter:	**Project Nitric Acid Production, $NAP_{project}$**
Data unit:	tonne 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 monitored	Sasolburg: 57,966 tonne 100% HNO_3
Recording frequency	Daily
Comments:	Nitric acid production during the third project campaign was 121,814 tonnes HNO_3 Production for the monitoring period was 57,966 tonne 100% HNO_3

Data / Parameter:	**Project Emission Factor, EF_n**
Data unit:	tonne N_2O / tonne 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 monitored	Sasolburg: 0.00236 tonne N_2O / tonne 100% HNO_3.
Recording frequency	Calculated once after ending the project campaign
Comments:	None

Data / Parameter:	**Moving Average Emission factor, $EF_{ma,n}$**
Data unit:	tonne N_2O / tonne 100% HNO_3
Description:	Moving average of emission factor calculated as the average of the emission factors of all previous project campaigns
Source of data to be used:	Calculated from campaign emission factors
Value of data monitored	Sasolburg: 0.00177 tonne N_2O / tonne 100% HNO_3.
Recording frequency	Calculated at the end of each project campaign
Comments:	None

Data / Parameter:	**Emission factor used to determine emission reductions, EF_p**
Data unit:	tonne N_2O / tonne 100% HNO_3
Description:	Emission factor used to calculate the emission from the particular campaign.
Source of data to be used:	Calculated using campaign emission factors. EF_p will be determined as the higher of $EF_{ma,n}$ and EF_n.
Value of data monitored	Sasolburg: 0.00236 tonne N_2O / tonne 100% HNO_3.
Recording frequency	Calculated at the end of each project campaign
Comments:	None

Data / Parameter:	**Project Campaign Length, CL_n**
Data unit:	tonne 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 monitored	Sasolburg: 121,814 tonnes HNO_3
Recording frequency	Calculated at the end of the project campaign
Comments:	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 monitored	Sasolburg: W.C. Heraeus
Recording frequency	Once
Comments:	None

Data / Parameter:	**Project Gauze Composition, GC_n**
Data unit:	% (Pt, Rh, Pd)
Description:	Gauze concentration for the project campaign
Source of data to be used:	Procurement offices of Sasolburg and Secunda plants
Value of data monitored	Sasolburg: Pt 54.0 to 56.0 %, Rh 3.6 to 3.9 %, Pd 40.0 to 42.0%.
Recording frequency	Once
Comments:	None

Data / Parameter:	**Emission Factor set by regulation, EF_{reg}**
Data unit:	kg N_2O/ tonne 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 monitored	No local or national regulation has been introducing during project period.
Recording frequency	At date of introducing or change of regulation.
Comments:	

At each plant process data and data from the AMS are acquired by the DSC system.
MGM receives all the information given by the plants and elaborates the emission factors and emission reduction calculations.

7.2. Good monitoring practice and performance characteristics

The European Norm EN 14181:2004 is recommended as guidance regarding the selection, installation and operation of the AMS under Monitoring Methodology AM0034, and stipulates three quality assurance levels (QALs):

QAL1: Suitability of the AMS for the specific measuring task

The EN 14181: 2004 QAL1 reports were 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 confirmed that the N_2O analyzers (in both cases an AO 2000- URAS 14 NDIR supplied by ABB GmbH) are suitable for performing the indicated analysis (N_2O concentration). Reports were audited during validation and are available at the sites for future audits.

QAL2: Validation of the AMS following its installation

QAL2 describes a procedure for the determination of the calibration function and its variability, by means of a certain number of parallel measurements, performed with a standard reference method. The testing laboratory performing the measurements with the standard reference method shall have an accredited quality assurance system according to EN ISO/IEC 17025 or relevant (national) standards.

QAL2 tests were performed in February 2007, at both plants by SGS Environmental Services (ISO 17025 certified lab). The QAL2 reports are available for DOE review. The reports conclude that the monitoring systems at both plants comply with QAL1 and QAL2 demands of EN 14181.

In order to keep records of AMS data before and after QAL2 test as generated (unmanipulated data), the corrective formulae (calibration functions) were applied during data processing (with the aid of spreadsheets), meaning that calibration functions were not programmed on the distributed control system (DCS) of the plants (which function as data acquisition systems).

QAL3: Ongoing quality assurance during operation

QAL3 of EN 141181: 2004 checks 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. Results of periodic calibrations were analyzed graphically with the aid of Shewart charts. All monitoring equipment has been serviced and maintained according to the manufacturer's instructions and international standards by qualified personnel. Calibration and maintenance records are well kept at both Sasol plants and available for auditing purposes.

AST: annual surveillance test (AST)

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. Just as with the QAL2, it also requires a limited number of parallel measurements using an appropriate standard reference method.
An AST was performed by SGS Environmental Services (ISO 17025 certified lab) at both plants in August 2008. The AST report is available for DOE review. The report concludes the following: The QA/QC system at both plants complies with the requirements of EN 14181 QAL3; all the analyzers passed the test of variance, suitability and linearity; the flow meters passed the test on variance and suitability; and data given by the instruments at the stack comply with the data registered in the data acquisition system.

8. GHG Emission Reduction Calculations

8.1. Baseline Emissions

For baseline emission factor determination, N_2O concentration and gas volume flow for each plant were monitored throughout the baseline campaign. Hourly average readings for N_2O concentration and gas flow volume (calculated from data monitored every 2 seconds) were performed. Error readings (e.g. downtime or malfunction) and extreme values were eliminated from the output data series.

Normal operating condition determination

To ensure that data obtained during baseline campaign are representative of the actual GHG emissions from the source plant, a set of process parameters known to affect N_2O generation have been set based on plant historical operating conditions and design data. Those parameters, called by the methodology normal operating conditions, are: oxidation temperature, oxidation pressure, ammonia flow to the reactor and ammonia flow to air flow ratio.
Normal operating conditions determined for Sasolburg and Secunda plants are:

Parameter	Data unit	Value applied
Normal Operating Temperature, OT_{normal} (range of temperature)	ºC	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

Only those N_2O measurements taken when the plant was operating within the permitted range were considered in the calculation of baseline emissions.

After eliminating data measured when the plant was operating outside the permitted conditions, the following statistical procedure was applied.

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

Then, baseline emissions were calculated using the following formulae

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

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

Where

BE_{BC}	Total baseline emissions in the baseline measurement period, in tN_2O
VSG_{BC}	Mean stack gas volume flow rate in the baseline measurement period, in Nm^3/h
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas in the baseline measurement period, in mg N_2O/Nm^3
OH_{BC}	Number of operating hours in the baseline measurement period, in h
EF_{BL}	Baseline emission factor, in $tN_2O/tHNO_3$
NAP_{BC}	Nitric acid production during the baseline campaign, in $tHNO_3$
UNC	Overall measurement uncertainty of the monitoring system, in %, calculated as the combined uncertainty of the applied monitoring equipment

Another parameter that is measured and must be compared with the normal value is the campaign length.
Normal campaign length (CL_n) values are:
Sasolburg: 114,727 tonnes HNO_3
Secunda: 183,602 tonnes HNO_3

According to AM0034, the baseline campaign length must be lower than or equal to CL_n.
In the case of a project campaign, the campaign length must be greater than or equal to CL_n. If the project campaign length is shorter than CL_n the baseline emission factor must be recalculated eliminating all data obtained during the production of tonnes of nitric acid beyond CL_n.

At Sasolburg plant the baseline campaign took place between June 12, 2006 and March 5, 2007. For baseline emission factor calculation the following period was used in order to not exceed normal campaign length. From: June 12, 2006 to February 3, 2007.

The second project campaign at Sasolburg plant was shorter than the normal campaign length. Hence, we had to recalculate the baseline emission factor, using in the calculation all the values monitored before the day on which the plant exceeded the production of the project campaign. The following period was included in the calculation: From: June 12, 2006 to December 17, 2006.

To follow all the calculations see the spreadsheet "Sasolburg Baseline Emission Factor Recalculation for 2nd project campaign.xls".

At Secunda plant the baseline campaign took place between August 29, 2006 and March 23, 2007. Since the baseline campaign length did not exceed normal campaign length, the whole period was used for baseline emission factor calculation.

A similar situation to the one observed in Sasolburg took place in Secunda: the second project campaign was shorter than the normal campaign length. Hence, the baseline emission factor was recalculated and the following period was included in the calculation: From: August 29, 2006 to March 18, 2007.
To follow all the calculations see the spreadsheet "Secunda Baseline Emission Factor Recalculation for 2nd project campaign.xls".

Values obtained for Sasolburg plant are:

$$BE_{BC} = 71{,}797 \cdot 2{,}877 \cdot 10^{-9} \cdot 4{,}338 = 896.16\, tonne\, N_2O$$

$$EF_{BL} = \frac{896.16}{96{,}556}(1 - \frac{3.89}{100}) = 0.00892\, tonne\, N_2O / tonne HNO_3$$

Values obtained for the Secunda plant are:

$$BE_{BC} = 116{,}427 \cdot 1{,}468 \cdot 10^{-9} \cdot 4{,}689 = 801.41\, tonne\, N_2O$$

$$EF_{BL} = \frac{801.41}{168{,}648}(1 - \frac{4.14}{100}) = 0.00455\, tonne\, N_2O / tonne HNO_3$$

At both plants the baseline campaigns were valid because for more than 50% of the duration of the baseline, the plant was operated within normal operating conditions. In the case of Sasolburg, the plant operated for 75 % of the campaign duration within normal operating conditions; for Secunda this factor reached 95 %.

8.2. Project Emissions

For project emission factor determination, N_2O concentration and gas volume flow for each plant were monitored throughout the project campaign. Hourly average readings for N_2O concentration and gas volume flow (calculated from data monitored every 2 seconds) were performed. Error readings (e.g. downtime or malfunction) and extreme values were eliminated from the output data series.
Next, the same statistical evaluation that was applied to the baseline data series was applied to the project data series.

The mean values of N_2O concentration at the stack gas and volume flow rate at the stack gas were used in the following formula (Eq. 3 from AM0034) to calculate project emissions:

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

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

Where

PE_n	Total project emissions of the nth campaign, in tN_2O
VSG_n	Mean stack gas volume flow rate for the nth project campaign, in Nm^3/h
$NCSG_n$	Mean concentration of N_2O in the stack gas for the project campaign, in mg N_2O/Nm^3
OH_n	Number of operating hours in the project campaign, in h
EF_n	Emission factor calculated for the *nth* campaign, in tonnes N_2O/tonne HNO_3
NAP_n	Nitric acid production in the *nth* campaign, in tonnes 100% HNO_3

Derivation of a moving average emission factor

The methodology proposes the calculation of a moving average emission factor in order to take a conservative approach in emission reduction calculation. The maximum value between EF_n for the specific project campaign and the $EF_{ma,n}$ shall be used in the emission reduction calculation as EF_p emission factor.

$EF_{ma,n}$ is calculated as follows:

$$EF_{ma,n} = \frac{EF_1 + EF_2 + \ldots + EF_n}{n} (tonneN_2O / tonneHNO_3)$$

$$If\ EF_{ma,n} \geq EF_n, then\ EF_p = EF_{ma,n}$$
$$If\ EF_{ma,n} \angle EF_n, then\ EF_p = EF_n$$

Where

EF_n	Emission factor calculated for the *nth* campaign, in tonne N_2O/tonne HNO_3
$EF_{ma,n}$	Moving average (ma) emission factor after n^{th} campaign, including the current campaign, in tonne N_2O/tonne HNO_3
n	Number of campaigns to date
EF_p	Emission factor that will be applied to calculate the emission reductions from this specific campaign, in tonne N_2O/tonne HNO_3

This process is 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.

At Sasolburg plant the second and third project campaign took place as follows:
Second project campaign: October 3, 2007 to April 5, 2008.
Third project campaign: April 21, 2008 to December 8, 2008.

At Secunda plant the first and second project campaigns took place as follows:
First project camapign: April 18, 2007 to January 5, 2008.
Second project campaign: January 12, 2008 to August 9, 2008.

The amount of CERs requested in the present Monitoring Report includes complete second project campaign and partial third project campaign (from April 21, 2008 to August 9, 2008) of Sasolburg plant; and partial first project campaign (from October 2, 2007 to January 5, 2008) and complete second project campaign of Secunda plant.

Values obtained for both plants are:

Sasolburg plant

Second project campaign:

$$PE_n = 68{,}824 \cdot 475 \cdot 10^{-9} \cdot 4{,}374 = 142.95 tonneN_2O$$

$$EF_n = \frac{142.95}{97{,}016} = 0.00147 tonneN_2O / tonneHNO_3$$

$$EF_{ma,n} = \frac{0.00118 + 0.00147}{2} = 0.001325 tonneN_2O / tonneHNO_3$$

As EF_n is higher than $EF_{ma,n}$, EF_p= EF_n=0.00147 tonne N_2O/tonne HNO_3

Third project campaign

$$PE_n = 71{,}\cdot 350 \cdot 748 \cdot 10^{-9} \cdot 5{,}394 = 287.88 tonneN_2O$$

$$EF_n = \frac{287.88}{121{,}814} = 0.00236 tonneN_2O / tonneHNO_3$$

$$EF_{ma,n} = \frac{0.00118 + 0.00147 + 0.00236}{3} = 0.00177 tonneN_2O / tonneHNO_3$$

As EF_n is higher than $EF_{ma,n}$, EF_p= EF_n=0.00236 tonne N_2O/tonne HNO_3

Secunda plant

First project campaign

$$PE_n = 117{,}837 \cdot 649 \cdot 10^{-9} \cdot 6{,}062 = 463.8\, tonneN_2O$$

$$EF_n = \frac{463.8}{215{,}393} = 0.00215\, tonneN_2O / tonneHNO_3$$

Second project campaign

$$PE_n = 113{,}964 \cdot 586 \cdot 10^{-9} \cdot 4{,}747 = 317.00\, tonneN_2O$$

$$EF_n = \frac{317.00}{168{,}809} = 0.00188\, tonneN_2O / tonneHNO_3$$

$$EF_{ma,n} = \frac{0.00215 + 0.00188}{2} = 0.00202\, tonneN_2O / tonneHNO_3$$

As $EF_{ma,n}$ is higher than EF_n, EF_p= $EF_{ma,n}$=0.00202 tonne N_2O/tonne HNO_3

Complete project emission factor calculations are in the following documents:

- "Sasolburg Second Project Campaign (03 Oct 07 to 05Apr 08).xls"
- "Sasolburg Third project campaign (21 Apr 08 to 08 Dec 08).xls"
- "Secunda First Project Campaign (2Oct 07 to 5Jan 08).xls"
- "Secunda Second Project Campaign (12Jan 08 to 9Aug 08).xls".

8.3. Emission Reduction Calculation

As indicated, the present Monitoring Report involves the following period: From October 2, 2007 to August 9, 2008.

According to AM0034 version 2, the emission reductions for the project activity over a specific campaign are determined as follows:

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

Where

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

Values obtained for the project are:

Sasolburg plant

Second project campaign:

$$ER_n = (0.00892 - 0.00147) \cdot 97{,}016 \cdot 310 = 224{,}059\, tonneCO_2e$$

Third project campaign

$$ER_n = (0.00966 - 0.00236) \cdot 57{,}966 \cdot 310 = 131{,}178\, tonneCO_2e$$

Secunda plant

First project campaign

$$ER_n = (0.00457 - 0.00215) \cdot 77{,}415 \cdot 310 = 58{,}077\, tonneCO_2e$$

Second project campaign

$$ER_n = (0.00455 - 0.00202) \cdot 168{,}809 \cdot 310 = 132{,}659\, tonneCO_2e$$

Then, the total amount of emission reductions due to the implementation of the project activity during the monitoring report is:

$$ER = 224{,}059 + 131{,}178 + 58{,}077 + 132{,}659 = 545{,}597\, tonneCO_2e$$

Complete emission reduction calculations are in the following documents:

- "Sasolburg second project campaign (03 Oct 07 to 05Apr 08).xls"
- "Sasolburg-Third project campaign (21 Apr 08 to 08 Dec 08).xls"
- "Secunda First Project Campaign (02 Oct 07 to 05 Jan 08).xls"
- "Secunda Second Project Campaign (12 Jan 08 to 09 Aug 08).xls".