CDM
MONITORING REPORT #1-Rev4
of
“N2O Emission Reduction in Nitric Acid Plant at Paulínia, SP - Brazil”
UNFCCC 1011

From: July 28, 2007
To: March 3, 2008

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1 Introduction

The purpose of this monitoring report is to calculate and clarify GHG emission reduction quantity achieved by this project for periodic verification.

This monitoring report covers the project campaign 1 from July 28, 2007 to March 3, 2008.

Duration of the project activity period:
Registration Date: 02 Jun 07
Crediting Period: 28 July 07 – 27 July 2014 (renewable)

2. Reference

Approved Baseline and Monitoring methodology:
AM0028 version 4 - Catalytic N2O destruction in the tail gas of Nitric Acid or Caprolactam Production Plants
AM0034 version 2 - Catalytic reduction of N2O inside the ammonia burner of nitric acid plants

Project Design Document:
N2O Emission Reduction in nitric acid plant Paulínia, SP, Brazil.
Version number of the document: 4
Date: January 23rd, 2007

CDM registration number:
"N2O Emission Reduction in nitric acid plant Paulínia, SP, Brazil" – UNFCCC ref number 1011

3. Definition

n : Project campaign (in this report, see dates § 1)
PDD : Project Design Document of this project "N2O Emission Reduction in nitric acid plant Paulínia, SP, Brazil." Version number of the document: 4, issued on January, 23rd, 2007

4. General description of project

4.1 Project activity

Nitrous oxide (N_2O) is a by-product of nitric acid production. It is of low toxicity but is a greenhouse gas (GHG), whose GWP is large (GWP=310 in the IPCC 2nd Assessment Report). Emissions of N_2O will be controlled under the Kyoto Protocol. As far as we are aware, there are however no national or regional regulations or restrictions on the emission of N_2O in Brazil. There are in fact no governmental regulations with quantified emission limits in any non-Annex I countries at this point.

In this project, Rhodia Energy Brazil Ltda. additionally installed a secondary catalyst for the abatement of N_2O emissions in the existing nitric acid plant of Paulínia. This installation reduces the GHG emissions, which would otherwise be released to the atmosphere if the project were not implemented.
The N2O abatement catalyst was installed in the factory site of Paulínia Rhodia Poliamida e Especialidades Ltda. in July, 2007 and the destruction of N_2O started in July 28, 2007.

This project activity was registered at UNFCCC on June 2nd, 2007 with the number 1011.

4.2 Location of the project activity

The N2O abatement catalyst was installed in the nitric acid plant of Rhodia Poliamida e Especialidades Ltda in Paulínia, SP, Brazil.

4.3 Technology employed by the project activity

The basic Ostwald process involves 3 chemical steps:

A) Catalytic oxidation of ammonia with atmospheric oxygen, to yield Nitrogen Monoxide (or Nitric Oxide).
(1) $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$

B) Oxidation of the Nitrogen Monoxide to Nitrogen Dioxide or Dinitrogen Tetroxide
(2) $2\ NO + O_2 \rightarrow 2\ NO_2 \leftrightarrow N_2O_4$

C) Absorption of the Nitrogen Oxides with water to yield Nitric Acid
(3) $3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$

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

Reactions 2 and 3 are favored by higher pressure and lower temperatures.
The way in which these three steps are implemented, characterizes the various Nitric Acid processes found throughout the industry. In single pressure (our case) 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, typically 90-99% 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.

Possible side reactions during oxidation of Ammonia:
(4) 4 NH3 + 4 O2 → 2 N2O + 6 H2O (Nitrous Oxide formation).
(5) 4 NH3 + 3 O2 → 2 N2 + 6 H2O
(6) 2 NO → N2 + O2
(7) 4 NH3 + 6 NO → 5 N2 + 6 H2O

N2O abatement technology classification

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

The technology applied at Paulínia nitric acid plant involves the installation of a new catalyst, not previously installed, below the oxidation gauzes ("secondary catalyst") with the purpose of decomposing N_2O.
This choice has the following advantages:

- Catalyst does not consume electricity, steam, fuels or reducing agents (all sources of leakage) to eliminate N_2O emissions. Therefore, operating costs are reduced to the cost of the catalyst itself.
- Installation is extremely simple and does not require new process unit or redesign of existing one. The main investment consists in the implantation of the measurement equipments (analyzer, flow meter, etc.).
- Installation can be simultaneously done with the primary gauze changing; without loss in production due to incrementing downtime.

This "secondary catalyst" decomposes N_2O without affecting Nitric Acid production. Typically the catalyst has a very high activity for N_2O decomposition; in a typical medium pressure plant. Basically, high level (more than 80%) of N_2O abatement can be reached.
The catalyst selected as secondary catalyst has showed the following specific advantages:

- No measurable effect on ammonia to nitric oxide yield.
- Low level of N_2O in tail gas is achievable by adjusting the catalyst bed thickness.

- No additional greenhouse gases or other emissions are generated by the reactions on the N_2O abatement catalyst.

The Nitric Acid Plant at Paulínia uses a basket structure that gives support to the nitric acid generation gauze. For creating space to insert the new catalyst, some layers of Raschig rings were removed from the basket. 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.
The N_2O abatement catalyst supplier is obliged by Rhodia Energy Brazil Ltda. to take back the catalyst at the end of their useful life and refine, recycle or dispose of them according to the prevailing EU standards and hence fulfill sustainability standards.

5. Project Boundary

The project boundary encompasses the complete process equipment for the nitric acid production.
The only GHG emission important to the project activity is N_2O contained in the waste stream exiting the stack.
An overview of all emission sources inside the project boundary can be verified below:

	Source	Gas	Included?	Justification/Explanation
Baseline	Nitric Acid Plant (Burner Inlet to Stack	CO_2	No	The process does not lead to any CO_2 and CH_4 emissions
		CH_4	No	
		N_2O	Yes	
Project Activity	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	No	The process does not lead to any CO_2 and CH_4 emissions
		CH_4	No	
		N_2O	Yes	
	Leakage emissions from production, transport, operation and decommissioning of the catalyst	CO_2	No	No leakage emissions are expected
		CH_4	No	
		N_2O	No	

6. Baseline and monitoring methodology applied to the project activity

The baseline has been established through continuous monitoring of both N_2O concentration and gas flow volume in the stack of the nitric acid plant for one complete campaign prior to project implementation.

6.1 Determination of the permitted operating conditions of the nitric acid plant to avoid overestimation of baseline emissions:

In order to avoid the possibility that the operating conditions of the nitric acid production plant are modified in such a way that increases N_2O generation during the baseline campaign, the normal ranges for operating conditions have been determined for the following parameters:

- (i) oxidation temperature;
- (ii) oxidation pressure;
- (iii) ammonia gas flow rate, and
- (iv) air input flow rates.

The permitted range has been established using the procedures described below. Note that data for these parameters are routinely logged in the process control system of the plant.

i. Oxidation temperature and pressure:
Process parameters monitored are the following:

OT_h Oxidation temperature for each hour (°C)
OP_h Oxidation pressure for each hour (kgf/cm^2 gauge)
OT_{normal} Normal range for oxidation temperature (°C)
OP_{normal} Normal range for oxidation pressure (kgf/cm^2 gauge)

The "permitted range" for oxidation temperature and pressure has been determined using historical data for the operating range of temperature and pressure from the five (5) campaigns previous to the baseline campaign.

ii. Ammonia gas flow rates and ammonia to air ratio input into the ammonia oxidation reactor (AOR):
Parameters monitored:

AFR Ammonia gas flow rate to the AOR (tNH_3/h)
AFR_{max} Maximum ammonia gas flow rate to the AOR (tNH_3/h)
AIFR Ammonia to air ratio (%)
$AIFR_{max}$ Maximum ammonia to air ratio (%)

The upper limits for ammonia flow and ammonia to air ratio have been determined using historical maximum operating data for hourly ammonia gas and ammonia to air ratio for the five (5) campaigns previous to the baseline campaign.

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

N_2O concentration and gas volume flow have been monitored throughout the baseline campaign. The monitoring system is installed using the European Norm 14181 (2004). This

monitoring system provides separate readings for N_2O concentration (NCSG) and gas flow volume (VSG) at the stack for every two seconds during operation of the plant. Error readings due downtime or malfunction and extreme values are to be automatically eliminated from the output data series by the monitoring system.
Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation has been applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure has been applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

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

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign (OH) using the following equation:

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

where:
BE_{BC} : total N_2O emissions during the baseline campaign (t N_2O)
VSG_{BC} : mean gas volume flow rate at the stack in the baseline measurement period (Nm^3/h)
$NCSG_{BC}$: mean concentration of N_2O in stack gas in the baseline campaign (mg N_2O /Nm^3)
OH_{BC} : operating hours of the baseline campaign (h)

The plant specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over the baseline campaign has been derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid for that period. The overall uncertainty of the monitoring system (UNC) has been determined and the measurement error has been expressed as a percentage.

The N_2O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) is reduced by the estimated percentage error as follows:

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

where:
EF_{BL} : baseline N_2O emissions factor (t N_2O /t HNO_3)
BE_{BC} : total N_2O emissions during the baseline campaign (t N_2O)
NAP_{BC}: nitric acid production during the baseline campaign (t HNO_3)
UNC : overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment

In the absence of any national or regional regulations for N_2O emissions in Brazil, the resulting EF_{BL} has been used as the baseline emission factor.

The gauze supplier and gauze composition during the baseline campaign have been the same as used during the historic campaigns when the permitted operating conditions were established. As a consequence, the EF_{BL} derived is valid.

As the plant operated within the permitted range of normal operating conditions for more than 50% of the time, the baseline campaign can be considered valid and the resulting EF_{BL} can be used to calculate the resulting emission reduction of the project.

6.3 Baseline Campaign Length

In order to take into account the variations in campaign length and its influence on N_2O emission levels, the historic campaign lengths and the baseline campaign length are to be determined and compared to the project campaign length. Campaign length is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes.

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

If Baseline Campaign Length (CL_{BL}) $\leq$ CL_{normal}, all N_2O values measured during the baseline campaign can be used for the calculation of EF_{BL} (subject to the elimination of data that was monitored during times where the plant was operating outside of the "permitted range").

If CL_{BL} > CL_{normal}, N_2O values that were measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) are to be eliminated from the calculation of EF_{BL}.

At Paulínia nitric acid plant the value obtained for CL_{normal} was 29 695 t HNO_3. The baseline campaign was conducted from September 15, 2006 to April 05, 2007 and achieved a production bigger than that value. Therefore, according to the rules indicated above the CL_{BL} is 29 695 t HNO_3, which was reached on March 20, 2007.

6.4 Statistical Tests comparing Baseline Campaign with "normal" operating conditions

In accordance with AM0034, statistical tests were performed to compare the average values of the permitted operating conditions with the average values obtained during the baseline campaign.
If the mean values of OT_h and OP_h of the baseline campaign fall within the 95% confidence interval of normal operating conditions, and if the mean values of AFR and AIFR of the baseline campaign are lower than AFR_{max} and $AIFR_{max}$, respectively, then the baseline campaign is considered to be representative of a normal campaign ,

According to these tests the baseline campaign was found to be representative of a normal campaign.

6.5 Leakage

As defined in AM0034, no leakage emission calculation is required since no leakage emissions have occurred as a result of the project activity now nor are expected in the future.

6.6 Project emissions

During the project activity, N_2O concentration, gas volume flow in the stack of the nitric acid plant together with temperature and pressure of ammonia gas flow and ammonia-to-air ratio are measured continuously.

The statistical evaluation described below was applied to the baseline data and to this project campaign.

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

The emissions due to the project activity in a given campaign (PE_n) are the total emissions of N_2O during the nth campaign:

$$\mathbf{PE_n = VSG \times NCSG \times 10^{-9} \times OH\ (t\ N_2O)}$$

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

Step1: estimate campaign specific emissions factor for each campaign during the project's crediting period is obtained by dividing the total mass of N_2O emissions during that campaign (PE_n) by the total production of 100% concentrated nitric acid (NAP) during that same campaign.
For example, for campaign n the campaign specific emission factor would be:

$$\mathbf{EF_n = PE_n / NAP_n\ (t\ N_2O/t\ HNO_3)}$$

Step 2: estimate a moving average emissions factor (EF_{ma}) at the end of a campaign n as follows:

$$\mathbf{EF_{ma,n} = (EF_1 + EF_2 + \ldots + EF_n) / n\ (t\ N_2O /t\ HNO_3)}$$

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

To calculate the total emission reductions achieved in a campaign the higher of the two values $EF_{ma,n}$ and EF_n shall be applied as the emission factor relevant for the particular campaign to be used to calculate emissions reductions (EF_p). Thus:

If $EF_{ma,n} > EF_n$ then $EF_p = EF_{ma,n}$
If $EF_{ma,n} < EF_n$ then $EF_p = EF_n$

As this is the first project campaign, then n=1 and $\mathbf{EF_{ma,1} = EF_1}$
.

6.7 Minimum project emission factor

A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential built up of platinum deposits. After the first ten (10) campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum (EF_{min}). If any of the later project campaigns results in a EF_n that is lower than EF_{min}, the calculation of the emission reductions for that particular campaign shall use EF_{min} and not EF_n.
Not applicable for the moment as this is the first project campaign.

6.8 Project Campaign Length

If the length of each individual project campaign CL_n is longer than or equal to the average historic campaign length CL_{normal}, then all N_2O values measured during the baseline campaign can be used for the calculation of EF (subject to the elimination of data from the Ammonia/Air analysis, see above).
If $CL_n < CL_{normal}$, recalculate EF_{BL} by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tones produced) from the calculation of EF_n.
The length of the first project campaign was longer than CL_{normal},, so all N_2O values measured during the baseline campaign can be used for the calculation of EF.

6.9 Emission Reductions

The emission reductions for the project activity over a specific campaign are determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$\mathbf{ER = (EF_{BL} - EF_P) \times NAP \times GWP_{N2O}\ (tCO_2e)}$$

As stated in AM0034, the nitric acid production (NAP) during the project campaign shall not exceed the design capacity of the nitric acid plant on a yearly basis.

The nameplate capacity of the Paulínia Nitric Acid Plant is 55 900 metric tonnes per year of 100% nitric acid and the product is sent to storage as a 60% solution. Therefore, the nitric acid plant shall not be eligible to earn CERs for any tonnes of nitric acid produced exceeding that value on a yearly basis.

In order to verify the compliance with such production cap for the calculation of CERs, in this project activity the yearly production is calculated based on the anniversary date of the project. The N2O emissions reduction of this project started up on July 28, 2007 when the first load of secondary catalyst initiated the first project campaign. Thus for any project campaign it is verified whether the accumulated production since the last date July 28 has exceeded 55 900 tonnes. If that limit is exceeded then no CERs are claimed on the nitric acid production made from the day the yearly cap is achieved until the new date July 28. This verification is automatically made in the “Workbook ER_Nitric-Paulínia.xls” which is used to store and calculate all the data pertinent to the project campaigns.

6.10 Data and parameters of baseline campaign – Annex 1

6.11 Data and parameters of the present project campaign – Annex 2

7. Monitoring plan:

7.1 General description

The overall responsibility, including the publication of the monitoring report, is with Rhodia Energy SAS represented by the CO2 operations director.

The monitoring process is under the responsibility of the Nitric Acid Plant Manager. The description of these activities is made at the Data Handling Protocol. This document is included in the plant quality system and is available to audit.

The monitoring procedures for baseline and project campaigns are described below.

7.1.1 Data collection

The production supervisor and/or plant operations technician are responsible by data collection during plant operation.

7.1.2 Data processing

These data are processed, validated, adjusted, if necessary, and recorded. The nitric acid plant process engineer is in charge of programming all formulae in the spreadsheets which are used. The plant operations technician processes the data, checks the data for consistency, validates them, and records them every day as an electronic file. In case of failure of an instrument, or inconsistency of the data, he adjusts the data according to the Data Handling Protocol. In case the failure is not covered by the procedure, the nitric acid plant Manager makes the decision to correct the figures or to abandon the data.

7.1.3 Data archiving

The nitric acid plant Production Engineer or Process Engineer is responsible for archiving the data. Once validated, the data are input in an electronic folder and protected against any modification. A backup of all the data is made every day on the plant server. Both original document and the backup file are kept for the project crediting period.

7.1.4 Calculation of Emission Reductions

Calculation of emission reductions is done after each campaign by the nitric acid plant Production Engineer or Process Engineer, based on the campaign data, and validated by the nitric acid plant Manager. This last one is responsible, too, by declaring Emission Reductions.

7.1.5 Training

As Paulínia nitric acid plant is certified in ISO 9001:2000, the requirement 6.2.2 Competence, Awareness and Training of ISO 9001:2000 is met. There is a training procedure for the nitric acid plant (ISAL-EQ-002) and the changes introduced due to this project were done according to that procedure for the operation team. For the lab team, which is responsible for the adjustments, calibration and operation of the N2O analyzer, the corresponding training was done according to the procedure PIP-DCA-RH-013.

7.2 Good monitoring practice and performance characteristics

The nitric acid plant on Rhodia site at Paulínia is ISO9001 and ISO14000 certified.

All measured variables to be collected for the baseline and on project activity campaigns are considered critical process variable, The critical variables instruments calibration plan follow the critical variables procedures, and are included in the scope the yearly ISO9001 audit.

The European Norm EN 14181:2004 is recommended as guidance regarding the selection, installation and operation of the Automatic Measuring System (AMS) under Monitoring Methodology AM0034, and stipulates three levels of Quality Assurance Levels (QAL):

QAL1: Suitability of the AMS for the specific measuring task.
The EN 14181: 2004 QAL1 report was provided by the equipment manufacturer considering the performance characteristics as measured by a qualified Technical Inspection Authority. The QAL1 report confirmed that N2O analyzer (an AO 2000- URAS 14 NDIR supplied by ABB GmbH) is suitable to perform the indicated analysis (N2O concentration). The equipment manufacture report was handed to the DOE for verification.

QAL2: Validation of the AMS following the installation.
QAL2 describes a procedure for the determination of the calibration function and its variability, by means of certain number of parallel measurements, performed with a Standard Reference Method (SRM). The testing performing the measurements with the SRM shall have an accredited quality assurance system according to EN ISO/IEC 17025 or relevant (national) standards.
QAL2 tests were performed for N_2O Analyzer on October 2006 and on August 2007. QAL2 test for stack gas flow meter was performed on June 2007. The QAL2 reports were made available for verification of DOE.

QAL3: Ongoing quality assurance during operation.
According to EN 14181: 2004 drift and precision are checked 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 CUSUM (Cumulative Sum) control charts as recommended in Annex C of EN 14181:2004. 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 site and available for auditing purposes.

8. GHG emission reductions calculations

8.1 Baseline emissions

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

Determination of the normal operating conditions
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 plant design data. Those parameters, called by the methodology normal operating conditions, are: oxidation temperature, oxidation pressure, ammonia flow to the reactor and ammonia-to-air flow ratio.

The normal operating conditions which are in the PDD are the technical operating limits of the nitric acid plant in Paulínia. The upper limits for oxidation temperature and oxidation pressure are given by safety criteria, while for the lower limit corresponds to operation limit, and is part of the safety system of the plant. Both the lower limit and the upper limit are recorded in the Plant Operating Manual (a document controlled in the Rhodia Quality System) and are also in the plant operators log sheet. The ammonia flow to the reactor and ammonia-to-air flow ratio values are based on the maximum value of each one taking into account the five (5) operational campaigns.

Normal operating conditions determined for nitric acid plant at Paulínia are:

Parameter	Data unit	Value applied
Normal Operating Temperature, OT_{normal} (range of temperature)	ºC	840 – 920
Normal Operating Pressure, OP_{normal} (range of pressure)	kgf/cm^2 gauge	3.26 – 4.28
Maximum Ammonia Flow Rate, AFR_{max}	kg NH_3/hour	1.960
Maximum Ammonia-to-Air Flow Ratio, $AIFR_{max}$	% mass kg NH_3/kg (NH_3 + air)	7.1

In compliance with the methodology, the PDD states in paragraph B.6.1.1.i that "The "permitted range" for oxidation temperature and pressure is to be determined using historical data for the operating range of temperature and pressure from the previous five campaigns". In consequence, Rhodia used this criterion to determine the "permitted range" which is the range of operating parameters that should be used to determine the valid N2O data for estimating the baseline emission factor.

According to the criterion selected, the permitted range is determined through a statistical analysis of the historical data in which the time series data is to be interpreted as a sample for a stochastic variable. All data that falls within the upper and lower 2.5% percentiles of the sample distribution is defined as abnormal and shall be eliminated. The permitted range of operating temperature and pressure is then assigned as the historical minimum (value of parameter below which 2.5% of the observation lie) and maximum operating conditions (value of parameter exceeded by 2.5% of observations). For complementing, as for normal operation conditions, ammonia flow to the reactor and ammonia-to-air flow ratio values are based on the maximum value of each one taking into account also the five (5) operational campaigns.

Permitted range operating conditions determined for nitric acid plant at Paulínia are:

Parameter	Data unit	Value applied
Permitted range Temperature, OT_{normal} (range of temperature)	ºC	880 – 902
Permitted range Pressure, OP_{normal} (range of pressure)	kgf/cm^2 gauge	3.66 – 3.93

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 lied 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))

The baseline emissions are calculated using the following formulae:

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

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

where:
BE_{BC} : total N2O emissions during the baseline campaign (t N_2O)
VSG_{BC} : mean gas volume flow rate at the stack in the baseline measurement period (Nm^3/h)
$NCSG_{BC}$: mean concentration of N2O in stack gas in the baseline campaign (mg N_2O /Nm^3)
OH_{BC} : operating hours of the baseline campaign (h)
EF_{BL} : baseline N_2O emissions factor (t N_2O /t HNO_3)
BE_{BC} : total N_2O emissions during the baseline campaign (t N_2O)
NAP_{BC} : nitric acid production during the baseline campaign (t HNO_3)

UNC : overall uncertainty of the monitoring system (%), 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 (CL_{normal}) length value obtained for nitric acid plant at Paulínia was 29 695 t.

According to AM0034:

If Baseline Campaign Length (CL_{BL}) ≤ CL_{normal}, all N_2O values measured during the baseline campaign can be used for the calculation of EF_{BL} (subject to the elimination of data that was monitored during times where the plant was operating outside of the "permitted range").

If CL_{BL} > CL_{normal}, N_2O values that were measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) are to be eliminated from the calculation of EF_{BL}.

At Paulínia plant, baseline campaign took place from September 15, 2006 to April 05, 2007. The production achieved during that period was 32 330 t which is bigger than CL_{normal} (29 695 t). Therefore, according to the rules indicated above the CL_{BL} is 29 695 t HNO_3, which was reached on March 20, 2007.

As the **CL_{BL} > CL_{normal}** then was used the CL_{normal} as NAP_{BC}.

The values obtained in the baseline campaign are:

Parameter	Data unit	Value
VSG_{BC}	Nm^3/h	23 456
$NCSG_{BC}$	mg N_2O/Nm^3	1 756
OH_{BC}	h	4 424.6
NAP_{BC}	t HNO_3	29 695
UNC	%	6.12

The emission factor for the baseline campaign (EF_{BL}) is then calculated as follow:

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

$$BE_{BC} = 23\,456 \times 1\,756 \times 10^{-9} \times 4\,424.6 = 182.278 \text{ t } N_2O$$

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

$$EF_{BL} = (182.278 / 29\,695) \times (1 - 6.12/100) = 0.005763 \text{ t } N_2O/\text{t } HNO_3$$

The actual value of BE_{BC} is slightly different from the value obtained by direct calculation shown above due to a rounding effect. The value of EF_{BL} is more accurate calculated in the workbook.

The plant baseline campaign was valid since for more than 50% of the duration of the campaign, the plant was operated within the normal operating conditions. The value obtained was 82.37% for both NCGS and VSG.

8.2 Project emissions

The monitoring system is installed according to the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for a defined period of time (e.g. every hour of operation, i.e. an average of the measuring values of the past 60 minutes). Error readings (e.g. downtime or malfunction) and extreme values are eliminated from the output data series.

The emissions due to project activity in a campaign (PE_n) are the total emissions of N_2O during the nth campaign were obtained from the following formulae (equations 3 and 4 from AM0034):

$$\mathbf{PE_n = VSG \times NCSG \times 10^{-9} \times OH}$$

$$\mathbf{EF_n = PE_n / NAP_n}$$

where:

PE_n : total Project emissions of the nth campaign (t N_2O)
VSG : mean stack gas volume flow rate for the nth project campaign (Nm^3/h)
NCSG : mean concentration of N_2O in the stack gas for the project campaign (mg N_2O/Nm^3)
OH : number of operating hours in the project campaign (h)
EF_n : emission factor calculated for the nth campaign (t N_2O/t HNO_3)
NAP_n : nitric acid production in the nth campaign (t 100% HNO_3)

The following values were obtained in this project campaign:

Parameter	Data unit	Value
VSG_n	Nm^3/h	23 442
$NCSG_n$	mg N_2O/Nm^3	165
OH_n	h	5 237.5
NAP_n	t HNO_3	35 838

The emission factor for this project campaign (EF_n) is then calculated as follow:

$PE_n = VSG \times NCSG \times 10^{-9} \times OH$

$PE_n = 23\,442 \times 165 \times 10^{-9} \times 5\,237.5 = 20.237$ t N_2O

$EF_n = PE_n / NAP_n$

$EF_n = 20.237 / 35\,838 = 0.000565$ t N_2O /t HNO_3

The actual value of PE_n is slightly different from the value obtained by direct calculation shown above due to a rounding effect. The value of EF_n is more accurate calculated in the workbook.

Since this is the 1_{st} project campaign then n=1 and $EF_{ma,1} = EF_1$.
The value of EF_n can be used as such for the emission reduction calculation of this campaign .

8.3 Emission reductions

The emission reductions for the project activity over a specific campaign is determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O, as according to AM0034 version 2:

$ER = (EF_{BL} - EF_P) \times NAP \times GWP_{N2O}$

where:
ER : emission reductions of the project for the specific campaign (t CO_2e)
NAP : nitric acid production for the project campaign (t HNO_3). The maximum value of NAP shall not exceed the design capacity.
EF_{BL} : baseline emissions factor (t N_2O/t HNO_3)
EF_P : emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)
GWP_{N2O} : global warming potential of N_2O set as 310 t CO_2e/t N_2O by the IPCCC

The total emission reduction achieved by this project activity during this campaign is therefore

ER = $(EF_{BL} – EF_{P})$ x NAP x GWP_{N2O}

ER = (0.005763 – 0.000565) x 35 838 x 310 = 57 751 t CO_2e

The actual value of ER is slightly different from the value obtained by direct calculation shown above due to a rounding effect. The value of ER is more accurate calculated in the workbook.

The above emission reduction covers the generation of N2O in the nitric acid production during this campaign.

Annex 1 – Data and parameters of baseline campaign

Data / Parameter:	**$NCSG_{BC}$**
Data unit:	mg/Nm^3
Description:	N_2O concentration in the stack gas
Source of data used:	N_2O analyzer
Value monitored:	**1 756**
Description of measurement methods and procedures applied:	ABB Infrared analyzer model AO2040 URAS 14. The Measurement Principle is a non-dispersive infrared absorption in the $\lambda = 2.5–8$ µm wavelength range Because of analyzer technology, water has to be removed. So, this is a dry-basis measurement. The direct measurement is corrected to compensate the water removal allowing to a good N_2O flow rate evaluation.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is followed-up by the quality system
Any comment:	

Data / Parameter:	**VSG_{BC}**
Data unit:	Nm^3/h
Description:	Volume flow rate of the stack gas
Source of data used:	Gas volume flow meter
Value monitored:	**23 456**
Description of measurement methods and procedures applied:	Venturi flow meter built according to standard ISO 5167 - 2003 Edition.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is followed-up by the quality system.
Any comment:	

Data / Parameter:	**OH_{BC}**
Data unit:	Hours
Description:	Total operating hours
Source of data used:	Production log
Value monitored:	**4 424.6**
Description of measurement methods and procedures applied:	The value is obtained from operational log and can be compared with on-line instruments data. The responsible people for this data is informed on Data Handling Protocol and these information can be checked by the auditors on document during audits
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	BE_{BC}
Data unit:	t N_2O
Description:	Total N_2O for baseline campaign
Source of data used:	Calculated : $\mathbf{BE_{BC}} = VSG_{BC} \times NCSG_{BC} \times 10^{-9} \times OH_{BC}$
Value obtained:	**182.278**
Description of measurement methods and procedures applied:	Calculated from monitored data
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	$\mathbf{NAP_{BC}}$
Data unit:	t HNO_3
Description:	Nitric acid (100% concentrated) over baseline campaign
Source of data used:	Production log
Value monitored:	**29 695**
Description of measurement methods and procedures applied:	Flow meter (totalizer) and plant accounting system
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	**TSG**
Data unit:	°C
Description:	Temperature of stack gas during baseline campaign
Source of data used:	Probe (part of the gas volume flow meter)
Value monitored::	**137.9**
Description of measurement methods and procedures applied:	Temperature measured, each 2 sec, by probe installed in the Venturi flow meter to correct the flow.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	Value shown was obtained as average from baseline campaign data.

Data / Parameter:	PSG
Data unit:	bar abs
Description:	Pressure of stack gas during baseline campaign
Source of data used:	Probe (part of the gas volume flow meter)
Value monitored:	**0.91**
Description of measurement methods and procedures applied:	Pressure measured, each 2 sec, by probe installed in the Venturi flow meter to correct the flow.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	Value shown was obtained as average from baseline campaign data.

Data / Parameter:	UNC
Data unit:	%
Description:	Overall measurement uncertainty of the monitoring system
Source of data used:	Calculated of the combined uncertainty of the applied monitoring equipment
Value applied:	**6.12**
Description of measurement methods and procedures applied:	The overall uncertainty is determined as the combined uncertainty of the flow meter and uncertainty of the N2O concentration measurement.
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	$\mathbf{EF_{BL}}$
Data unit:	$t\ N_2O\ /\ t\ HNO_3$
Description:	Emissions factor for baseline period
Source of data used:	Calculated : $\mathbf{EF_{BL}} = BE_{BC} / NAP_{BC} \times (1-UNC/100)$
Value obtained:	**0.005763**
Description of measurement methods and procedures applied:	Calculated from monitored data
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	AFR
Data unit:	kg NH_3/h
Description:	Ammonia gas flow rate
Source of data used:	Flow meter
Value monitored:	**Not applicable: AFR values are used to determine if plant is operating outside AFR_{max}**
Description of measurement methods and procedures applied:	NH3 mass flow by a Venturi flow meter with temperature and pressure automatic correction.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	AFR_{max}
Data unit:	kg NH_3/h
Description:	Maximum Ammonia flow rate
Source of data used:	Flow meter
Value monitored:	**1.960**
Description of measurement methods and procedures applied:	NH3 mass flow by a Venturi flow meter with temperature and pressure automatic correction.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	Maximum value of five (5) operational campaigns before baseline campaign

Data / Parameter:	AIFR
Data unit:	% mass
Description:	Ammonia to air ratio
Source of data used:	Ratio of NH3 mass flow per (NH3 mass flow + Air mass flow)
Value obtained:	**Not applicable: AIFR data are used to determine if plant was operating outside $AIFR_{max}$**
Description of measurement methods and procedures applied:	NH3 mass flow and air mass flow measured by two Venturi flow meters with temperature and pressure automatic correction.
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	AIFRmax
Data unit:	% mass
Description:	Maximum ammonia to air ratio
Source of data used:	Calculated : Ratio of NH3 mass flow per (NH3 mass flow + Air mass flow)
Value monitored:	**7.1**
Description of measurement methods and procedures applied:	NH3 mass flow and air mass flow measured by two Venturi flow meters with temperature and pressure automatic correction.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	Maximum value of five (5) operational campaigns before baseline campaign

Data / Parameter:	**CL_{BL}**
Data unit:	t HNO_3
Description:	Campaign length of baseline campaign
Source of data used:	Calculated from nitric acid production data
Value monitored:	**29 695**
Description of measurement methods and procedures applied:	Flow meter (totalizer) and plant accounting system
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	**CL_{normal}**
Data unit:	t HNO_3
Description:	Normal campaign length
Source of data used:	Calculated from nitric acid production data (average historical campaign length during the operation condition campaign)
Value monitored:	**29 695**
Description of measurement methods and procedures applied:	Flow meter (totalizer) and plant accounting system
QA/QC procedures applied:	QA/QC not applicable
Any comment:	The value reported in the PDD (32 444 tons) was an indicative ex-ante estimation

Data / Parameter:	**OT_h**
Data unit:	°C
Description:	operating temperature for each hour
Source of data used:	Thermocouple
Value monitored:	**Not applicable; OT_h values are used to determine if the plant was operating outside OT_{normal}**
Description of measurement methods and procedures applied:	Three temperature probes under the catalyst gauzes are able to measure an average temperature.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	**OT_{normal}**
Data unit:	°C
Description:	Normal operating temperature
Source of data used:	Thermocouple
Value monitored:	**880 – 902**
Description of measurement methods and procedures applied:	Three temperature probes under the catalyst gauzes are able to measure an average temperature.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	Calcultated according to the methodology definition of the "permitted range". The ex-ante values 920-840 which are in the PDD are the technical operating limits of the nitric acid plant in Paulínia

Data / Parameter:	**OP_h**
Data unit:	kgf/cm^2 gauge
Description:	Oxidation pressure for each hour
Source of data used:	Pressure probe
Value monitored:	**Not applicable; OP_h values are used to determine if the plant was operating outside OP_{normal}**
Description of measurement methods and procedures applied:	A manometer, installed on the reactor, give to the control room reliable pressure measurement, accurate enough for the operation purposes.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	OP_{normal}
Data unit:	kgf/cm^2 gauge
Description:	Normal operating pressure
Source of data used:	Pressure probe
Value monitored:	**3.66 – 3.93**
Description of measurement methods and procedures applied:	A manometer, installed on the reactor, give to the control room reliable pressure measurement, accurate enough for the operation purposes.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	Calcultated according to the methodology definition of the "permitted range". The ex-ante values (3.26-4.28 kgf/cm^2 or 320 000-420 000 Pa) which are in the PDD are the technical operating limits of the nitric acid plant in Paulínia

Data / Parameter:	GS_{normal}
Data unit:	Name of supplier
Description:	Normal gauze supplier for the operation condition campaign
Source of data used:	certificate of analysis /invoices
Value monitored:	**Umicore**
Description of measurement methods and procedures applied:	Umicore provides catalyst gauzes and technical assistance to Rhodia. Umicore is a traditional supplier of kind of gauzes.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. The gauze supplier complies with standards of the Rhodia Quality System.
Any comment:	OM Group was the gauze supplier to Rhodia until 2003 when its precious metal activity were acquired by Umicore

Data / Parameter:	GS_{BL}
Data unit:	Name of supplier
Description:	Gauze supplier for baseline campaign
Source of data used:	certificate of analysis/invoices
Value monitored:	**Umicore**
Description of measurement methods and procedures applied:	Umicore provides catalyst gauzes and technical assistance to Rhodia. Umicore is a traditional supplier of kind of gauzes.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. The gauze supplier complies with standards of the Rhodia Quality System.
Any comment:	

Data / Parameter:	**GC_{normal}**
Data unit:	%
Description:	Gauze composition during the operation campaign
Source of data used:	Certificate of analysis
Value monitored:	**95% mass Pt 5% mass Rh**
Description of measurement methods and procedures applied:	The supplier sends the gauzes with a certificate of analysis that is kept in the plant files.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This gauzes supplier complies with standards of the Rhodia Quality System.
Any comment:	

Data / Parameter:	**GC_{BL}**
Data unit:	%
Description:	Gauze composition during the Baseline campaign
Source of data used:	Certificate of analysis
Value monitored:	**95% mass Pt 5% mass Rh**
Description of measurement methods and procedures applied:	The supplier sends the gauze with a composition analytical certificate that is kept in the plant files.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This gauzes supplier complies with standards of the Rhodia Quality System.
Any comment:	

Data / Parameter:	**EF_{reg}**
Data unit:	
Description:	Emissions level set by incoming policies or regulations
Source of data used:	
Value monitored:	**Not existent in Brazil**
Description of measurement methods and procedures applied:	At date of introducing or change of regulation. Rhodia follows the evolution of Brazilian legislation about N2O emissions that could affect the project Emission Reduction through the parameter EF_{reg} as part of the ISO 14000 requirements. Rhodia has hired an external company specialized in regulations. It sends to GSIMAP (Rhodia Industrial Platform) all the changes in regulations that may impact Rhodia. GSIMAP team evaluates the changes and discusses the applicability to the Rhodia operations in a steering committee. The conclusions from this steering committee are then presented to the Quality representatives of all plant units in a formal meeting that happens every three months. Furthermore GSIMAP experts on environmental issues participate on meetings held on external organizations (such as ABIQUIM - Brazilian Association of Chemical Industries, CETESB - local environmental agency) that discuss draft regulations. Those experts know in advance what comes next in terms of environmental laws.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 14000 certified. Existing procedures assure the follow-up of any evolution of EFr_{eg}.
Any comment:	

Annex 2 – Data and parameters of the present project campaign

Data / Parameter:	**NCSG**
Data unit:	mg/Nm^3
Description:	N_2O concentration in the stack gas
Source of data used:	N_2O analyzer
Value monitored:	**165**
Description of measurement methods and procedures applied:	ABB Infrared analyzer **model AO2040 URAS 14**. **The** Measurement Principle is a non-dispersive infrared absorption in the λ = 2.5–8 µm wavelength range Because of analyzer technology, water has to be removed. So, this is a dry-basis measurement. The direct measurement is corrected to compensate the water removal allowing to a good N_2O flow rate evaluation.
QA/QC procedures applied:	This monitoring equipment is serviced, calibrated and maintained according to the manufacture's instructions. Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	**VSG**
Data unit:	Nm^3/h
Description:	Volume flow rate of stack gas
Source of data used:	Gas volume flow meter
Value monitored:	**23 442**
Description of measurement methods and procedures applied:	Venturi flow meter built according standard ISO 5167 - 2003 Edition. It's considered a critical variable, so included in the ISO-9001 Nitric Acid Plant procedures.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	**OH**
Data unit:	Hours
Description:	Operating hours
Source of data used:	Production log
Value monitored:	**5 237.5**
Description of measurement methods and procedures applied:	The value is obtained from operational log and can be compared with on-line instruments data. The responsible people for this data is informed on Data Handling Protocol and these information can be checked by the auditors on document during audits
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This data is considered as a critical data on the ISO 9001 quality system
Any comment:	

Data / Parameter:	**PE_n**
Data unit:	t N_2O
Description:	N_2O emissions of nth project campaign
Source of data used:	Calculated : $\mathbf{PE_n}$ = VSG x NCSG x 10^{-9} x OH
Value obtained:	**20.237**
Description of measurement methods and procedures applied:	Calculated from monitored data
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	**NAP**
Data unit:	t HNO_3
Description:	Nitric acid production (100% concentrate)
Source of data used:	Production log
Value monitored:	**35 838**
Description of measurement methods and procedures applied:	Flow meter (totalizer). Plant accounting
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This data is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	TSG
Data unit:	°C
Description:	temperature of stack gas during project campaign
Source of data used:	Probe (part of gas volume flow meter)
Value monitored:	**133.7**
Description of measurement methods and procedures applied:	Temperature measured, each 2 sec, by probe installed in the Venturi flow meter to correct the flow
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	Value shown was obtained as average from project campaign data.

Data / Parameter:	PSG
Data unit:	bar abs
Description:	pressure of stack gas during project campaign
Source of data used:	Probe (part of gas volume flow meter)
Value monitored::	**0.97**
Description of measurement methods and procedures applied:	Pressure measured, each 2 sec, by probe installed in the Venturi flow meter to correct the flow
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	Value shown was obtained as average from project campaign data.

Data / Parameter:	AFR
Data unit:	kg NH_3/h
Description:	Ammonia gas flow rate
Source of data used:	Flow meter
Value monitored:	**Not applicable: AFR values are used to determine if plant is operating outside AFR_{max}**
Description of measurement methods and procedures applied:	NH3 mass flow by a Venturi flow meter with temperature and pressure automatic correction.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	AIFR
Data unit:	% mass
Description:	Ammonia to air ratio
Source of data used:	Ratio of NH3 mass flow per (NH3 mass flow + Air mass flow)
Value obtained:	**Not applicable**
Description of measurement methods and procedures applied:	NH3 mass flow and air mass flow measured by two Venturi flow meters with temperature and pressure automatic correction.
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	OT_h
Data unit:	°C
Description:	operating temperature for each hour
Source of data used:	Thermocouple
Value monitored:	**Not applicable**
Description of measurement methods and procedures applied:	Three temperature probes under the catalyst gauzes are able to measure an average temperature.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	OP_h
Data unit:	kgf/cm^2 gauge
Description:	Oxidation pressure for each hour
Source of data used:	Pressure probe
Value monitored:	**Not applicable**
Description of measurement methods and procedures applied:	A manometer, installed on the reactor, give to the control room reliable pressure measurement, accurate enough for the operation purposes.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Any comment:	

Data / Parameter:	$\mathbf{EF_n}$
Data unit:	t N_2O / t HNO_3
Description:	Emissions factor calculated for nth campaign
Source of data used:	Calculated : $\mathbf{EF_n}$ = PE_n / NAP_n
Value obtained:	**0.000565**
Description of measurement methods and procedures applied:	Calculated from monitored data
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	$\mathbf{EF_{ma,n}}$
Data unit:	t N_2O / t HNO_3
Description:	Moving average emissions factor
Source of data used:	Calculated from campaign emissions factors
Value obtained:	**0.000565**
Description of measurement methods and procedures applied:	Calculated from monitored data
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	$\mathbf{CL_n}$
Data unit:	t HNO_3
Description:	Campaign length
Source of data used:	Calculated from nitric acid production data
Value monitored:	**35 838**
Description of measurement methods and procedures applied:	Calculated from monitored data
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	EF_p
Data unit:	t N_2O / t HNO_3
Description:	Emissions factor used to determine emissions reductions
Source of data used:	Calculated : **EF_p function of EF_n and $EF_{ma,n}$**
Value obtained:	**0.000565**
Description of measurement methods and procedures applied:	Calculated from monitored data If $EF_{ma,n} > EF_n$ then $EF_p = EF_{ma,n}$ If $EF_{ma,n} < EF_n$ then $EF_p = EF_n$
QA/QC procedures applied:	QA/QC not applicable
Any comment:	

Data / Parameter:	$GS_{project}$
Data unit:	Name of supplier
Description:	Gauze supplier for the project campaign
Source of data used:	certificate of analysis/invoices
Value monitored:	**Umicore**
Description of measurement methods and procedures applied:	Umicore provides catalyst gauzes and technical assistance to Rhodia. Umicore is a traditional supplier of kind of gauzes.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. The gauze supplier complies with standards of the Rhodia Quality System.
Any comment:	

Data / Parameter:	$GC_{project}$
Data unit:	%
Description:	Gauze composition during project campaigns
Source of data used:	Certificate of analysis
Value monitored:	**95% mass Pt 5% mass Rh**
Description of measurement methods and procedures applied:	The supplier sends the gauze with a composition analytical certificate that is kept in the plant files.
QA/QC procedures applied:	Paulínia nitric acid plant is ISO 9001 certified. This gauzes supplier complies with standards of the Rhodia Quality System.
Any comment:	