

MONITORING REPORT FORM (CDM-MR) *
Version 01 - in effect as of: 28/09/2010

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* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

MONITORING REPORT

Version 01; 26.11.2010

TITLE: “N₂O ABATEMENT PROJECT AT NITRIC ACID PLANT NO. 11 AT AFRICAN EXPLOSIVES LTD. (AEL), SOUTH AFRICA”

Reference Number: 1364

Monitoring period: No 02, 24.05.2009 – 16.11.2010

SECTION A. General description of the project activity

A.1. Brief description of the project activity:

Purpose of the project activity and measures taken to reduce GHG emissions

The sole purpose of the project activity is to significantly reduce former levels of N₂O emissions from the production of nitric acid at AEL's nitric acid plant No. 11 (“AEL-11”) in Modderfontein, South Africa, by implementation of a secondary N₂O abatement catalyst.

Brief description of the installed technology and equipments

The employed secondary N₂O abatement catalyst technology is supplied by Yara International ASA. Continuous monitoring of emission reductions is assured by an Automated Measuring System (AMS), consisting of stack gas volume flow meter, N₂O Analyzer, and respective data logging facilities. The AMS as well as its installation complies with the requirements of the European Norm EN 14181 as required by the methodology.

Relevant dates for the project activity

Registration Date: 08.02.2008

Installation of AMS: January 2006 (The N₂O analyser was replaced in September 2007, after the baseline measurement). Because of some technical difficulties with the Environnement MIR9000 analyser on the No. 9 plant, AEL has decided to install two completely new analysers (ABB Uras 14) in both the No. 9 and the No. 11 plant in 2007.)

Baseline Campaign: BL – Campaign 20.07.2006 – 18.02.2007

Installation of secondary catalyst: 12.09.2007

Starting Date of Project Activity: 08.02.2008

Project Campaigns:	1. Campaign	PC1 - 12/09/2007-19/03/2008
	2. Campaign	PC2 - 20/03/2008-28/09/2008
	3. Campaign	PC3 - 04/10/2008-23/05/2009

Project Campaigns covered by current Monitoring/Verification Period:

4. Campaign	PC4 - 08.06.2009-27.12.2009
5. Campaign	PC5 - 30.12.2009-16.11.2010

Total emission reductions achieved in this monitoring period

The total amount of emission reductions achieved in this monitoring period is 394,459 t CO₂e.

A.2. Project Participants

Name of Party involved	Project Participants	Party involved considered as project participant
South Africa (host)	African Explosives Ltd	No

United Kingdom	N.serve Environmental Services GmbH	No
United Kingdom	Electrabel NV/SA	No
Switzerland	N.serve Environmental Services GmbH	No

A.3. Location of the project activity:

The project activity is located in: Modderfontein (approx. 20 km north-east of Johannesburg). Postal address: PO Modderfontein 1645. Coordinates of the plant are 26°05'50'' South and 28°10'26'' East.

A.4. Technical description of the project

The project activity entails the installation and implementation of the following technical equipment and quality measures:

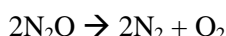
- 1.) secondary N₂O abatement technology
- 2.) Automated Monitoring System (AMS) for continuous N₂O measurement which is fully in compliance with European standard EN 14181 (see Section C for more detail)
- 3.) training of local staff on installation, operation and maintenance of catalyst and monitoring equipment, etc. as well as implementation of quality check and quality assurance measures (see Section C for more detail)

Catalyst Technology

AEL has contracted with Johnson Matthey plc who exclusively markets a secondary catalyst technology that has been developed by YARA International ASA (Norway). AEL has contracted with Johnson Matthey plc to install the YARA 58 Y 1® catalyst system consisting of an additional base metal catalyst that is installed below the standard precious metal gauze pack. This technology has been implemented inside the AEL-11 ammonia oxidation reactor.

The precious metal gauze pack – i.e. the primary catalyst required for the actual production of nitric acid – has been supplied to AEL by W.C. Heraeus. for a number of years. The precious metal composition of that gauze pack remains unchanged during the crediting period of the project.

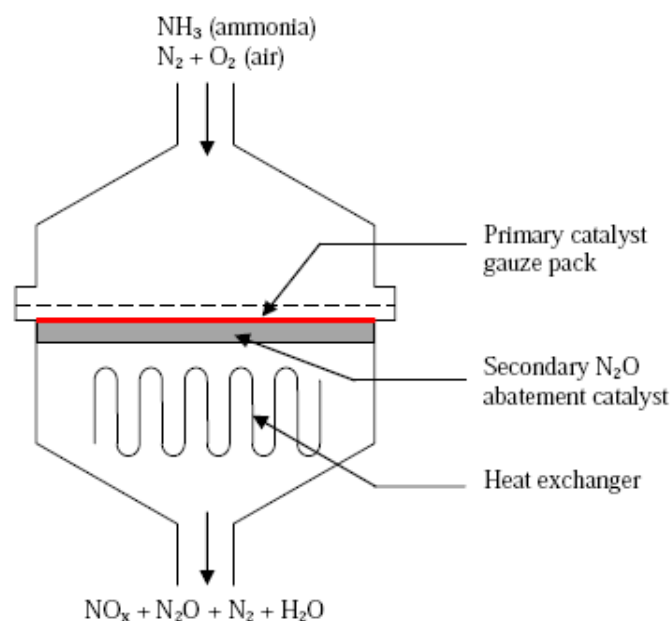
A secondary catalyst will reduce N₂O levels in the gas mix resulting from the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have shown to be of varied effectiveness in N₂O abatement catalysts. The YARA 58 Y 1® abatement catalyst is made of cylindrical pellets containing cobalt as an active ingredient. The catalyst has been tried and tested in a number of nitric acid plants in Europe. The abatement efficiency has been shown to be more than 80% in the following reaction:



If operated properly, the secondary catalyst system has a lifetime of several campaigns and may reduce N₂O emissions to a level satisfactorily below the baseline for about two years, before the catalyst material needs to be replaced. The YARA 58 Y 1® abatement catalyst does not contaminate the nitric acid produced in the respective nitric acid plant, neither with Cobalt nor with any of the other catalyst materials. It does not require additional heat or other energy input, because the temperature levels present inside the Ammonia Oxidation Reactor suffice to ensure its optimum abatement efficiency. There are no additional greenhouse gases or other emissions generated by the reactions at the N₂O abatement catalyst.

N₂O abatement catalyst installation

The secondary catalyst itself is easily installable during a routine plant shut-down and gauze change. The pellets are poured into the support basket / heat shield arrangement and raked level. The gauze pack is then installed above this bed using the support mechanism provided by the heat shield.



AEL's nitric acid plant No.11 operates at a pressure of around 4.5 bars inside the ammonia oxidation reactor. Through the introduction of the secondary catalyst into the ammonia reactor, a slight pressure drop ($\bullet P$) is expected to occur. This $\bullet P$ may lead to a very slight reduction in ammonia conversion efficiency and hence a very small reduction in nitric acid output. In practice, this loss of production will be insignificant.

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

This project activity is based on Approved Baseline and Monitoring methodologies AM0034 (Version 2): "Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants". Furthermore, the project draws on approved baseline methodology AM0028 (Version 04.2) for the baseline scenario selection and employs the "Tool for the demonstration and assessment of additionality".

A.6. Registration date of the project activity:

Registration Date of project activity: 08.02.2008

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

Crediting period: 10 years; Start date: 08.02.2008

A.8. Name of responsible person(s)/entity(ies):

Contact information of the person(s)/entity(ies) responsible for completing the monitoring report form (CDM-MR).

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SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

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The secondary catalyst was installed on the 12th September 2007. The project got registered by UNFCCC on the 8th of February 2008, which is the starting date of the project activity as well as for the crediting period.

As to the characteristics of this specific project type certain production related events and incidents may affect the performance of the project or influence the monitoring of emission reductions in addition to possible failure of the installed monitoring equipment. The below table and lists demonstrate all relevant events and incidents related to production and/or emission monitoring which have occurred during actual operation within this specific monitoring period, as well as the measures taken for addressing any resulting problems and issues.

#	Start of the event	End of the event	Campaign		Short description
			AEL designation	Project campaign	
1	09.06.2009 13:00	10.06.2009 18:45	C21	4	Fire on plant
2	11.06.2009 07:30	11.06.2009 22:00	C21	4	Power failure due to water leak at substation
3	21.06.2009 14:40	24.06.2009 12:00	C21	4	Plant off line for capacity control
4	08.07.2009 21:45	12.07.2009 14:30	C21	4	Fire on plant at oil accumulator
5	24.07.2009 07:30	24.07.2009 17:00	C21	4	Plant tripped on ratio
6	11.08.2009 18:00	15.08.2009 06:00	C21	4	Plant off line for capacity control
7	31.08.2009 10:30	02.09.2009 07:30	C21	4	Plant off line for capacity control
8	28.09.2009 17:45	29.09.2009 10:30	C21	4	Plants tripped due to lightening strike
9	03.10.2009 10:00	04.10.2009 05:00	C21	4	Plant off line due to power failure
10	22.10.2009 20:30	23.10.2009 14:45	C21	4	All the plants off line due to a power failure
11	24.10.2009 10:30	24.10.2009 23:45	C21	4	Plant tripped on ratio
12	12.11.2009 09:00	12.11.2009 18:45	C21	4	Plant tripped on expander overspeed
13	14.11.2009 04:30	14.11.2009 21:00	C21	4	Plant off line due to power failure
14	26.12.2009 19:45	30.12.2009 07:00	C21	4	Bursting disk failure and gauze change
15	14.02.2010 14:30	14.02.2010 22:45	C22	5	Faulty ammonia evaporator level indicator
16	29.03.2010 04:00	29.03.2010 06:30	C22	5	Plant off line due to power failure
17	29.04.2010 11:00	01.05.2010 23:00	C22	5	Plant off line due to power failure and maintenance work

					done
18	25.05.2010 22:00	26.05.2010 10:00	C22	5	Plant off line for capacity control
19	25.06.2010 16:30	26.06.2010 05:45	C22	5	Plant off line due to power failure and instrumentation air tripped.
20	02.08.2010 12:00	03.08.2010 16:30	C22	5	Plant taken off for maintenance and gauze inspection
21	08.09.2010 14:00	09.09.2010 01:45	C22	5	Plant off line due to power failure
22	08.09.2010 16:00	05.11.2010 08:00	C23	5	AMS Data collection interrupted - NCSG and VSG data replaced by Campaign maximum
23	16.11.2010 17:00	19.11.2010 18:00	C23	5	Plant offline for maintenance and gauze change

During project campaign 5 for the period 08 September 16:00 until 05 November 08:00 the data collection was interrupted due to a faulty cable connection. The missing data for NCSG and VSG was replaced with the maximum hourly average value that was recorded during that project campaign.

NO events or incidents of any relevance in regard to impacting the applicability of the methodology occurred during this 2nd monitoring period.

B.2. Revision of the monitoring plan

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The monitoring plan has not been revised.

B.3. Request for deviation applied to this monitoring period

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NO deviation was applied to this monitoring period.

B.4. Notification or request of approval of changes
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NO notifications or request for approval of changes of the project activity as described in the registered CDM-PDD have been made.

SECTION C. Description of the monitoring system

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1. General Description of the AMS (ABB URAS 14)

A complete Automated Monitoring System (AMS) to monitor the mass emissions of N₂O at the stack of AELs No.11 nitric acid plant was installed and has been operated since January 2006. The Manufacturer and type of the first N₂O Analyser was Environnement S.A. MIR 9000. After the measurements for the baseline campaign were completed it was replaced by a ABB AO2040 Uras 14 NDIR analyser in 2007. Because of some technical difficulties with the Environnement MIR9000 analyser on the No. 9 plant, AEL has decided to install two completely new analysers (ABB Uras 14) in both the No. 9 and the No. 11 plant in 2007.

2. Sample point

The location of the sample point was selected to provide ease of access and a location close to the analyser. The most suitable position is in tail gas of the plant downstream of all process equipment.

3. Sample Conditioning System

The gas sample is continuously taken via a heated probe and filter unit and a heated sample line. Before entering the analyzer the gas is treated by a dryer unit to avoid possible moisture effects.

4. Analyser

NCSG measurements: Environnement S.A. MIR 9000 (during baseline Campaign), ABB AO2040Uras 14 during project campaigns.

5. Flow Meter

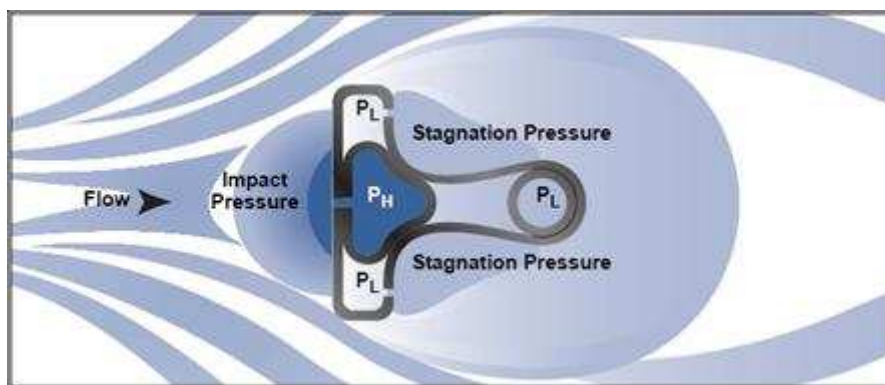
The Emerson Rosemount Flow Meter Annubar®, model no. 485, relies on the Averaging Pilot Tubes (APTs).

The Rosemount Annubar® 485 is a device used to measure the flow-velocity of a liquid, gas or steam fluid that passes through a pipe. It measures by creating a differential pressure (DP) that is proportional to the square of the velocity of the fluid in the pipe, in accordance with Bernoulli's theorem. This DP is measured and converted into a flow rate using a secondary device, such as a DP pressure transmitter.

The Annubar generates a DP by partially blocking the flow. The velocity of the fluid is decreased and stalled as it reaches the upstream surface of the Annubar sensor, thus creating the Impact Pressure. The Rosemount 485 Annubar® senses the impact pressure by utilizing a frontal slot design, which opens into the high pressure chamber.

This high pressure chamber connects directly into the DP transmitter for measurement.

As the fluid continues around the Annubar sensor, it creates a lower velocity profile on the back of the sensor, creating the low/suction pressure downstream. Individual ports, located on the backside of the Annubar sensor measure this low pressure. Working on the same principle as with high pressure, an average low pressure value is obtained in the low pressure chamber that connects directly into the transmitter for measurement. The resulting differential pressure is the difference between the impact (high) pressure reading and the suction (low) pressure reading as seen below.



6. Monitoring plan and responsibilities

The emission reductions achieved by the project activity are monitored based on the approved monitoring methodology AM0034 (Version 2) as prepared by N.serve Environmental Services GmbH. It is the appropriate monitoring methodology to be used in conjunction with the baseline methodology AM0034, “Catalytic reduction of N₂O inside the ammonia burner of nitric acid plants”. Its applicability depends on the same prerequisites as the mentioned baseline methodology.

AM0034 requires the use of the European Norm EN14181 (2004) “Stationary source emissions - Quality assurance of automated measuring systems” as a guidance for installing and operating the Automated Monitoring System (AMS) in the nitric acid plants for the monitoring of N₂O emissions.

As an operator of the nitric acid plants since 1932 and of the No. 11 nitric acid plant since 1979, AEL staff in general and its Instrument Department in particular is accustomed to operating technical equipment to a high level of quality standards.

The Production Manager (PM) has the overall responsibility for the ongoing operation of the project.

The Engineering Team Manager Electrical/Instrument (ETM E/I) is responsible for the day-to-day calibration procedure and any adjustments required to the instruments as a result of the calibrations.

The Process Controller (PC) checks the analyser regularly to see if there are any abnormal occurrences. These checks are done using a plausibility checklist, which is filled in and filed, in the control room. If there are any problems the ETM E/I is notified so that the problem can be rectified.

Operation, maintenance, calibration and service intervals are being carried out by staff from the instrumentation department according to the vendor’s specifications.

All monitoring procedures at AEL are also conducted and recorded in accordance with the well established procedures under ISO 9001/14001 which is regularly audited by the South African Bureau of Standards, an independent auditing firm accredited for ISO 9001/14001 certification.

AEL derives hourly averages for all of the monitored parameters and delivers these data to N.serve. Albrecht von Ruffer, Managing Director of N.serve, is responsible for the correct analysis of the delivered data in accordance with the methodology.

7. Application of EN 14181 procedures to the project

In the following, it is described how the procedures given in EN14181 for QAL1, 2 and 3 have been practically applied at AEL No. 11 plant.

QAL 1

In accordance with EN14181 an AMS shall have been proven suitable for its measuring task (composition of the flue gas) by use of the QAL1 procedure as specified by EN ISO 14956. Using this standard, it shall be proven that the total uncertainty of the results obtained from the AMS meets the

specification for uncertainty stated in the applicable regulations. Such suitability testing has to be carried out under specific conditions by an independent third party on a specific testing site. A test institute shall perform all relevant tests on two identical AMS. These two AMS have to be tested in the laboratory and field.

At the time of purchasing of the AMS by AEL, no AMS vendors had yet conducted the QAL 1 suitability testing for N₂O and it was not known if any vendors were in the process of obtaining this. The chosen gas analyser MIR9000 from Environnement however, has passed the QAL1 suitability for measurements of NO_x and other gaseous emissions. In addition QAL1 laboratory tests for N₂O were successfully performed in 2007 by an independent 3rd party testing laboratory with EN ISO/IEC 17025 accreditation. The Environnement S.A. MIR9000 analyser was used during the baseline campaign. Before start of the first project campaign it was replaced by a ABB AO2040 Uras 14 NDIR analyser.

According to ABB's own certificate, this analyser has an accuracy of better than 1% of range. This analyser has been certified¹ as meeting the requirements (QAL1) of the German emissions standards 17th BImSchV and 13th BImSchV (waste incineration plants, large furnaces and others) for the components NO, CO and SO₂. At the time of commissioning of the AMS by AEL no AMS was available that had been certified according with EN 14181 QAL1 for N₂O measurements. However, ABB has conducted and successfully completed the QAL1 tests² for the follow-up model of this analyser module within the same analyser series (ABB AO2040 Uras 26). Since there are no major technical differences between the two analyser models it can be assumed that the Analyser installed at the AEL No. 11 nitric acid plant meets the requirements of the QAL1 test in the same way as the follow-up model.

QAL2 and Standard Reference Measurements (SRM)

QAL2 is a procedure for the determination of the calibration function and its variability, and a test of the variability of the measured values of the AMS compared with the uncertainty given by legislation. The QAL2 tests are performed on suitable AMS that have been correctly installed and commissioned on-site (as opposed to QAL 1 which is conducted off-site). QAL 2 tests are to be performed at least every 3 years according to EN 14181 but also after major changes to the plant or changes or repairs to the AMS, which will influence the results obtained significantly.

A calibration function is established from the results of a number of parallel measurements performed with a Standard Reference Method (SRM). The variability of the measured values obtained with the AMS is then evaluated against the required uncertainty. According to EN14181, both the QAL 2 procedures and the SRM need to be conducted by an independent "testing house" or laboratory which has to be accredited to EN ISO/IEC 17025.

A series of QAL2 specific reference measurements using a the SRM method as per EN 14181 for guidance has been carried out at the plant for both above mentioned analysers separately by an accredited testing house (TÜV SÜD Industrie Service GmbH Germany; Müller BBM GmbH, Germany) to ensure the AMS' suitability, establish the calibration curve and test the variability of the measurements. The results of these SRM are available to the DOE as part of the verification process. The AMS calibration function as well as the total uncertainty of the AMS was determined. The results were applied in the calculation of EF_{BL} and EF_n.

In June 2009 and July 2010 an Annual Surveillance Tests (AST) has been successfully performed by an accredited testing house. The test was performed in accordance with EN14181. The AST is a series of measurements that need to be conducted by independent measurement equipment in parallel to the existing AMS.

¹ TÜV Süddeutschland Bau und Betrieb GmbH (Report number 170 608), March 2003

² TÜV Süd Industrie Service GmbH, München (Report number 821029) June 2006

8. AMS calibration and QA/QC procedures

AEL is certified according to ISO 9001 and 14001 standards for quality and environmental management respectively. The procedures for monitoring, regular calibrations and QA/QC are fully embedded into the procedures required by ISO 9001/14001 and documented in the applicable ISO handbooks. The South African Bureau of Standards (SABS) is the designated auditor for these standards at AEL. Therefore, all of the monitoring equipment is subjected to the regular “SABS testing loops” as part of the ISO 9001/14001 procedures.

Calibration Gas

A certified N₂O Calibration gas (balance being N₂) with a precision of $\pm 2\%$ is used in the span calibrations. The calibration gas is certified by an independent laboratory (Modderfontein Laboratory Services).

Modderfontein Laboratory Services (Pty) Ltd. is an independent chemical analysis laboratory which is certified by the South African Bureau of Standards (SABS).

Analyser Zero and Span Calibrations

According to the QAL 1 reports and manufacturers specifications it is recommended to perform a zero/span calibration every 7 days for the Environnement MIR 9000 analyser and once every three weeks for the ABB URAS 14 analyser, however AEL decided to do it twice per week in order to have a closer control over the instrument. For the zero calibration pure nitrogen is used, for the span calibration a certified calibration gas is used. The results of the calibrations are recorded according to the related CDM procedure.

Flow meter calibration procedures

The flow meter is calibrated at least once per year (the plant has to be shut down to conduct calibration) by the Instrument Department of AEL. The pressure transmitter is disconnected from the Annubar and the transmitter is then connected to an absolute pressure simulator that has been approved by the South Africa Bureau of Standards (SABS).

If the deviation exceeds 1% of range, then the pressure transmitter is recalibrated and the previous procedure repeated.

The Annubar itself does not need to be calibrated since it is a physical devise which will not have drift. Therefore, it is sufficient to regularly inspect the physical condition of the Annubar. Therefore, the Annubar is taken out of the stack once per year for physical inspection.

The results of these calibration procedures are then recorded in the Calibration Procedure log sheet.

Training

Operations staff at the nitric acid plant who are responsible for the operation of the AMS and regular calibrations, visual and physical checks have been trained appropriately by the AMS vendors and AELs' own instrumentation engineers.

QAL 3

QAL3 is a procedure which is used to check drift and precision in order to demonstrate that the AMS is in control during its operation so that it continues to function within the required specifications for uncertainty.

This is achieved by conducting periodic zero and span checks on the AMS and then evaluating the results obtained using control charts. Zero and span adjustments or maintenance of the AMS, may be necessary depending on the results of this evaluation.

8. Data Acquisition System and Emergency Procedures

The analogue signal (4 to 20 mA) output from the Analyser and Flow meter are converted by the Programmable Logic Controller (PLC) into a digital signal which is then fed into the SCADA data acquisition and database system.

Each of AEL's two nitric acid plants has its own SCADA system on a dedicated PC near the respective plant itself. However, the two SCADA PCs are directly connected to each other and each of the PCs receives all of the measured data from the AMS and stores them. That way there is a constant redundancy of data acquisition and storage. In addition, the instrumentation engineer transfers the data at least once a week into AEL's main IT system as well as making a complete copy of that weeks data (2-second, hourly and daily averages) onto an external disc drive. That way there are already four copies of the original and unchanged data stored in four different locations. In addition, the hourly data are sent to N.serve on a regular basis (e. g. after each campaign) where they are also stored.

The SCADA system automatically produces comma separated files stored in Microsoft Excel of the 2-second values and it also automatically produces hourly and daily average values for each of the measured parameters. The hourly averages are the basis of the analysis of the data for the purpose of the calculation of the emissions factors for the baseline and for the project campaigns. These are then extracted and converted into excel files which can then be imported into the N.serve Database Management System (N.DBMS).

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data / Parameter:	B.1 NCSG_{BC}
Data unit:	mg/Nm³
Description:	N ₂ O concentration in the stack gas during the baseline campaign.
Source of data used:	NDIR N ₂ O gas analyser (Environnement S.A. MIR 9000)
Value(s) :	Value applicable for regular project campaigns exceeding CL _{normal} or CL _{BL} : 1,630 Value applicable for Project Campaign 4: 1,630 Value applicable for Project Campaign 5: 1,630
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations
Additional comment:	

Data / Parameter:	B.2 VSG_{BC}
Data unit:	Nm³/h
Description:	Normal gas volume flow rate of the stack gas during the baseline campaign.
Source of data used:	Gas Volume Flow meter, Emerson Rosemount Annubar® Model 485
Value(s) :	72,468
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.3 BE_{BC}
Data unit:	tN₂O
Description:	Total N ₂ O mass flow during baseline campaign
Source of data used:	Calculation from measured data.
Value(s) :	Value applicable for regular project campaigns exceeding CL _{normal} or CL _{BL} : 651.983 Value applicable for Project Campaign 4: 651.983 Value applicable for Project Campaign 4: 651.983
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.4 OH_{BC}
Data unit:	hours
Description:	Operating hours
Source of data used:	Production log
Value(s) :	4,950
Indicate what the data are used for (Baseline/	Baseline emission calculations.

Project/ Leakage emission calculations)	
Additional comment:	None

Data / Parameter:	B.5 NAP_{BC}
Data unit:	tHNO₃
Description:	Metric tonnes of 100% concentrated nitric acid produced during the baseline campaign.
Source of data used:	Coriolis mass flow meter measurements
Value(s) :	134,700
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	The nitric acid flow meter is subject of external calibration procedures every 3 years.

Data / Parameter:	B.6 TSG
Data unit:	°C
Description:	Temperature in the stack gas
Source of data used:	Stack temperature probe situated directly next to the volume flow meter.
Value(s) :	Not applicable
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	

Data / Parameter:	B.7 PSG
Data unit:	Pa
Description:	Pressure in the stack
Source of data used:	Stack temperature probe situated directly next to the volume flow meter.
Value(s) :	Not applicable
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	The PSG result is automatically applied for calculating VSG at standard conditions

Data / Parameter:	B.8 EF_{BL}
Data unit:	tN₂O / tHNO₃
Description:	Emissions factor for baseline period
Source of data used:	Calculated from measured data (tons of N ₂ O emitted / tons of nitric acid produced)
Value(s) :	Value applicable for regular project campaigns exceeding CL _{normal} or CL _{BL} : 0,004647 Value applicable for Project Campaign 4 : 0,004647 Value applicable for Project Campaign 4 : 0,004647
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.

Additional comment:	None
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Data / Parameter:	B.9 UNC
Data unit:	%
Description:	Calculated overall uncertainty of the Automated Monitoring System (AMS)
Source of data used:	Engineering reports and calculations conducted by the manufacturer of the components of the AMS.
Value(s) :	3,99%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline / Project emission calculations.
Additional comment:	None

Data / Parameter:	B.10 AFR
Data unit:	tNH ₃ /h
Description:	Mean Ammonia gas flow rate to the ammonia oxidation reactor
Source of data used:	Orifice plate
Value(s) :	Not applicable, monitored data of AFR will be used to determine if plant was operating outside of AFR _{max} .
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.11 AFR_{max}
Data unit:	tNH ₃ /h
Description:	Maximum Ammonia gas flow rate to the ammonia oxidation reactor
Source of data used:	AFR data
Value(s) :	9.094 kgNH₃/h
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.12 AIFR
Data unit:	% v/v
Description:	Mean Ammonia to air ratio into the ammonia oxidation reactor
Source of data used:	Measurements of AFR and primary air flow rates (measured by orifice plate).
Value(s) :	8.3 to 11.5 (AIFR will be used to determine AIFR_{max}).
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.13 CL_{BL}
Data unit:	tHNO ₃
Description:	Length of the baseline campaign measured in metric tonnes of 100% concentrated nitric acid produced during that baseline campaign.
Source of data used:	NAP _{BC}

Value(s) :	134,700
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.14 CL_{normal}
Data unit:	tHNO₃
Description:	Average length of the historic campaigns measured in metric tonnes of 100% concentrated nitric acid produced during the historic campaigns.
Source of data used:	Coriolis Flow meter as described in NAP.
Value(s) :	127,302.4
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline / Project emission calculations.
Additional comment:	None

Data / Parameter:	B. 15 AIFR_{max}
Data unit:	% v/v
Description:	Maximum Ammonia to air ratio into the ammonia oxidation reactor.
Source of data used:	Plant operating manual
Value(s) :	11.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.16 OT_h
Data unit:	°C
Description:	Oxidation temperature for each hour during the baseline campaign
Source of data used:	Monitoring results of three thermocouples inside the ammonia oxidation reactor and recorded by the data acquisition system.
Value(s) :	Not applicable
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.17 OT_{normal}
Data unit:	°C (min and max)
Description:	Normal range operating temperature
Source of data used:	Design specifications and operating manual of the No. 11 nitric acid plant (Technical Manual (TM4 June 1977, p. 250) ³ .
Value(s) :	820 °C (min) to 905 °C (max)
Indicate what the data are used for (Baseline/	Baseline emission calculations.

³ Copies of the technical plant manuals can be provided to the DOE upon request.

Project/ Leakage emission calculations)	
Additional comment:	None

Data / Parameter:	B.18 OP_h
Data unit:	kPa (gauge)
Description:	Oxidation Pressure for each hour during the baseline campaign
Source of data used:	Design specifications and operating manual of the No. 11 nitric acid plant (Drawing No. D31 113-4, Sheet 2, December 1977; Operating Instructions No. M69.0300.2008, 1978; No 11 Plant Understanding, p. 10).
Value(s) :	Not applicable.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	The uncertainty of the pressure sensor is 0.125% according to the vendor. However, since the measurement uncertainty during the baseline campaign and during the project campaigns is the same, the two data series will always be comparable.

Data / Parameter:	B.19 OP_{normal}
Data unit:	kPa (gauge) min and max
Description:	Normal range of operating pressure in the ammonia oxidation reactor .
Source of data used:	Plant operating manual
Value(s) :	365 kPa – 450 kPa (gauge)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.20 GS_{normal}
Data unit:	Name of Supplier
Description:	Gauze supplier for the operating condition (i.e. historic) campaigns
Source of data used:	Monitored / Invoices
Value(s) :	W.C. Heraeus
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.21 GS_{BL}
Data unit:	Name of Supplier
Description:	Gauze supplier for the baseline condition campaign
Source of data used:	Monitored / Invoices
Value(s) :	W.C. Heraeus
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Additional comment:	None

Data / Parameter:	B.23 GC_{normal}
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Data unit:	%				
Description:	Gauze composition during the historic operating campaigns expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.				
Source of data used:	Monitored / Gauze supplier invoices				
Value(s) :	Platinum (Pt) 56.5%; Rhodium (Rh) 3.8%; Palladium (Pd) 39.7%				
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.				
Additional comment:	Record of Gauze compositions installed during the historic campaigns ⁴ :				
	Campaign	Gauze Supplier	Gauze Composition		
			Pt (%)	Rh (%)	Pd (%)
	C10	Heraeus	58.3	3.9	37.9
	C12	Heraeus	56.1	3.8	40.1
	C13	Heraeus	56.4	3.8	39.8
	C14	Heraeus	56.1	3.8	40.1
	C15	Heraeus	55.4	3.8	40.8
Average		56.5	3.8	39.7	

Data / Parameter:	B.24 GC_{BL}
Data unit:	%
Description:	Gauze composition during the baseline campaign expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Source of data used:	Monitored / Gauze supplier invoices
Value(s) :	Platinum (Pt) 56%; Rhodium (Rh) 3.8%; Palladium (Pd) 40.2%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline / Project emission calculations.
Additional comment:	None

Data / Parameter:	B.26 EF_{reg}
Data unit:	tN ₂ O/tHNO ₃
Description:	Emissions cap for N ₂ O from nitric acid production set by government regulation
Source of data used:	Department of Environmental Affairs and Tourism
Value(s) :	None
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline / Project emission calculations.
Additional comment:	None.

D.2. Data and parameters monitored

Data / Parameter:	NCSG
Data unit:	mg / m³ (convertible from ppmv, if required)
Description:	N ₂ O concentration in the stack gas during each project campaign.

⁴ The figures shown here are rounded figures. More exact figures are commercially sensitive information but can be inspected by the DOE during the site visit and can be made available to the CDM EB upon request.

Measured /Calculated /Default:	Measured/Calculated - every 2 sec. used for calculation of campaign mean (average, after exclusion of extreme values and outliers)
Source of data:	NDIR N2O gas analyser (ABB AO2040 Uras-14)
Value(s) of monitored parameter:	Project Campaign 4: 431 Project Campaign 5: 200
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<p>Type: N2O gas analyser, nondispersive infrared sensor (NDIR) spectrometry</p> <p>Measurement accuracy (for N₂O): 2.83%</p> <p>Serial Number: <i>Instrument number 3.346854.7</i></p> <p>Calibration frequency:</p> <ul style="list-style-type: none"> - <i>Annually by AST;</i> - <i>At least every 3 years QAL2</i> - <i>Bi-weekly Zero and span check and calibration in case of deviation >1% of range of analyzer against zero gas and certified calibration gas cylinder</i> <p>Date of last calibration: <i>QAL2 Test – Feb 2008, valid until 2011</i> <i>AST Test – June 2009</i> <i>AST Test – July 2010, valid until 2011</i></p>
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds)
Calculation method (if applicable):	<p>NCSG is continuously monitored with an NDIR gas analyser and monitoring results are taken and recorded for every two seconds of plant operation. Hourly means for NCSG are derived by the data acquisition system. NCSG data taken during times when the plant was out of operation were eliminated. Also readings that were taken during malfunction of the monitoring system were eliminated. The remaining hourly average values were subjected to the following statistical analysis:</p> <ol style="list-style-type: none"> 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 NCSG values <p>During the QAL2 reference measurements it was determined that the analyser consistently overestimates the N₂O concentration in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 0.99 will have to be applied to all NCSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean NCSG value will be multiplied by 0.99 before going into the calculation of PE_n.</p> <p>During project campaign 5 for the period 08 September 16:00 until 05 November 08:00 the data collection was interrupted due to a faulty cable connection. The missing data was replaced with the maximum hourly average value that was recorded during that project campaign.</p>
QA/QC procedures applied:	Bi-weekly Zero and Span check and calibration performed by trained

	AEL personnel. Documentation in form of calibration reports and Shewart charts
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Data / Parameter:	VSG
Data unit:	Nm³/h
Description:	Normal gas volume flow rate of the stack gas during each project campaign.
Measured /Calculated /Default:	Measured/Calculated - every 2 sec. used for calculation of campaign mean (average, after exclusion of extreme values and outliers)
Source of data:	Gas Volume Flow meter, Emerson Rosemount Annubar® Model 485
Value(s) of monitored parameter:	Project Campaign 4: 78,080 Project Campaign 5: 79,104
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<p>Type: Tail gas flow by differential pressure principle</p> <p>Overall measurement accuracy: 2.79%</p> <p>Serial Number: <i>instrument number N/A</i></p> <p>Calibration frequency:</p> <ul style="list-style-type: none"> - <i>Annually by AST</i> - <i>At least every 3 years QAL2</i> <p>Date of last calibration: <i>QAL2 Test – July 2010 valid until 2013</i> <i>AST Test – June 2009</i> <i>AST Test – July 2010 valid until 2011</i></p>
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds).
Calculation method (if applicable):	<p>VSG is continuously monitored with a flow meter and monitoring results are taken and recorded for every two seconds of plant operation. Hourly means for VSG are derived by the data acquisition system. Temperature and pressure is also continuously measured in the stack and the VSG values subsequently adjusted to derive the VSG at normal conditions (i.e. standard pressure and temperature).</p> <p>VSG data taken during times when the plant was out of operation were eliminated.</p> <p>The resulting hourly average VSG values are now expressed in Nm³/h as required by AM0034 and where subsequently subjected to the following statistical analysis:</p> <ol style="list-style-type: none"> 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 VSG values <p>During the QAL2 reference measurements it was determined that the flow meter consistently underestimates the total gas volume flow in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 1.01 will have to be applied to all VSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean VSG value will be</p>

	<p>multiplied by 1.01 before going into the calculation of PE_n.</p> <p>During project campaign 5 for the period 08 September 16:00 until 05 November 08:00 the data collection was interrupted due to a faulty cable connection. The missing data was replaced with the maximum hourly average value that was recorded during that project campaign.</p>
QA/QC procedures applied:	The flow meter is calibrated annually by AST and QAL2 test according to EN 14181.

Data / Parameter:	PE_n
Data unit:	tN_2O
Description:	Total mass N_2O emissions in each project campaign.
Measured /Calculated /Default:	Calculated.
Source of data:	Calculated from measured values.
Value(s) of monitored parameter:	Project Campaign 4: 149.70 Project Campaign 5: 119.32
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	$PE_n = VSG * NCSG * 10^{-9} * OH$ A special correction function is applied to the results for NCSG and VSG values. These correction factors were determined during the QAL2 test according to EN 14181. QAL2 correction functions are applied in the calculation
QA/QC procedures applied:	Not applicable.

Data / Parameter:	OH_n
Data unit:	Hours
Description:	Total operating hours during each project campaign
Measured /Calculated /Default:	Measured.
Source of data:	Process Control System.
Value(s) of monitored parameter:	Project Campaign 4: 4,444 Project Campaign 5: 7,535
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.

Measuring/ Reading/ Recording frequency:	The total operating hours are logged continuously.
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	The production logging process is subject to ISO 9001 procedures

Data / Parameter:	NAP
Data unit:	tHNO₃
Description:	Metric tonnes of 100% concentrated nitric acid during each project campaign.
Measured /Calculated /Default:	Measured / Calculated.
Source of data:	Coriolis mass flow meter measurements.
Value(s) of monitored parameter:	Project Campaign 4: 129,361 Project Campaign 5: 222,621
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Emerson CMF 300, Coriolis mass flow meter Overall measurement accuracy: $\leq 0,1\%$ Serial Number: 12038740 Calibration frequency: once every 3 years (although the calibration is valid for 3 years, it is done more frequently) Date of last calibration: <i>September 2010 valid until 2013</i>
Measuring/ Reading/ Recording frequency:	Continuously
Calculation method (if applicable):	NAP is determined in the following way: NAP is determined by a mass flow meter according to the following procedures: The density and temperature as measured by the mass flow meter is used to calculate the concentration of the nitric acid produced. This value is then used to convert the total mass flow to 100% nitric acid produced. The correct measurement of acid concentration is checked by manual tests.
QA/QC procedures applied:	Subjected to complete SABS testing loops as part of the ISO 9001/14001 procedures. The mass flow meter is calibrated in regular intervals.

Data / Parameter:	TSG
Data unit:	°C
Description:	Temperature in the stack gas
Measured /Calculated /Default:	Measured.
Source of data:	Stack temperature probe situated directly next to the volume flow meter;
Value(s) of monitored parameter:	Not applicable
Indicate what the data are used for (Baseline/ Project/	Project emission calculations.

Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<p>Type: Rosemont thermocouple, PT100_385 3-wire RTD</p> <p>Overall measurement accuracy:</p> <p>Serial Number: <i>instrument number N/A</i></p> <p>Calibration frequency:</p> <ul style="list-style-type: none"> - Annually by QAL2/AST - At least every 3 years QAL2 <p>Date of last calibration: <i>QAL2 Test –July 2010 valid until 2013</i> <i>AST Test – June 2009</i> <i>AST Test – July 2010 valid until 2011</i></p>
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds)
Calculation method (if applicable):	AM0034 requires the determination of gas volume flow at normal conditions in the stack. In order to calculate from the measured VSG values to VSG at normal conditions, the actual temperature in the stack is measured by a temperature probe as part of the flow meter.
QA/QC procedures applied:	ISO9001/14001 procedures and documented in the applicable ISO handbooks

Data / Parameter:	PSG
Data unit:	bar (absolute)
Description:	Pressure in the stack
Measured /Calculated /Default:	Measured.
Source of data:	Stack pressure probe situated directly next to flow meter
Value(s) of monitored parameter:	Not applicable, directly used for normalization of tail gas volume flow measurement.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<p>Type: Rosemont</p> <p>Overall measurement accuracy:</p> <p>Serial Number: <i>instrument number N/A</i></p> <p>Calibration frequency:</p> <ul style="list-style-type: none"> - <i>Annually by AST</i> - <i>At least every 3 years QAL2</i> <p>Date of last calibration: <i>QAL2 Test –July 2010 valid until 2013</i> <i>AST Test – June 2009</i> <i>AST Test – July 2010 valid until 2011</i></p>
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds).
Calculation method (if applicable):	AM0034 requires the determination of gas volume flow at normal conditions in the stack. In order to calculate from the measured VSG values to VSG at normal conditions, the actual pressure in the stack has to be determined and applied to each hourly mean VSG value. The measurements are taken continuously by a pressure probe inside the stack very close to the stack gas volume flow meter.
QA/QC procedures applied:	ISO9001/14001 procedures and documented in the applicable ISO

	handbooks.
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Data / Parameter:	EF_n
Data unit:	tN₂O/tHNO₃
Description:	Emissions factor for campaign n.
Measured /Calculated /Default:	Calculated.
Source of data:	Calculation from total mass N ₂ O emissions of campaign n (PE _n) and total nitric acid production (NAP _n)
Value(s) of monitored parameter:	Project Campaign 4: 0.00116 Project Campaign 5: 0.00054
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	The campaign specific emissions factor for each campaign during the project's crediting period is calculated by dividing the total mass of N ₂ O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign. For campaign <i>n</i> the campaign specific emission factor is: $EF_n = PE_n / NAP_n$
QA/QC procedures applied:	Not applicable.

Data / Parameter:	EF_{ma,n}
Data unit:	tN₂O/tHNO₃
Description:	Moving average emissions factor derived over time from campaign specific emissions factors.
Measured /Calculated /Default:	Calculated.
Source of data:	Calculation from campaign specific emissions factors (EF _n)
Value(s) of monitored parameter:	Project Campaign 4: 0.00107 Project Campaign 5: 0.00096
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	In order to take into account possible long-term emissions trends over the duration of the project activity and to take a conservative approach the moving average emission factor is determined as follows:

	$EF_{ma,n} = (EF_1 + EF_2 + \dots + EF_n) / n$ <p>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.</p>
QA/QC procedures applied:	Not applicable.

Data / Parameter:	EF_p
Data unit:	$tN_2O/tHNO_3$
Description:	Emissions factor used for the specific campaign n to determine the emission reductions of that campaign
Measured /Calculated /Default:	Calculated.
Source of data:	Calculation of EF_n and $EF_{ma,n}$.
Value(s) of monitored parameter:	Project Campaign 4: 0.00116 Project Campaign 5: 0.00096
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	<p>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:</p> <p>If $EF_{ma,n} > EF_n$ then $EF_p = EF_{ma,n}$</p> <p>If $EF_{ma,n} < EF_n$ then $EF_p = EF_n$</p>
QA/QC procedures applied:	Not applicable.

Data / Parameter:	EF_{min}
Data unit:	$tN_2O/tHNO_3$
Description:	EF_{min} is equal to the lowest EF_n observed during the first 10 campaigns of the project crediting period.
Measured /Calculated /Default:	Calculated.
Source of data:	Calculations from EF_n
Value(s) of monitored parameter:	Project Campaign 4: 0.00090 Project Campaign 5: 0.00054
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.

Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N ₂ O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF _n observed during those campaigns will be adopted as a minimum (EF _{min}). If any of the later project campaigns results in a EF _n that is lower than EF _{min} , the calculation of the emission reductions for that particular campaign shall used EF _{min} and not EF _n .
QA/QC procedures applied:	Not applicable.

Data / Parameter:	CL_n
Data unit:	tHNO₃
Description:	Length of each project campaign measured in metric tonnes of 100% concentrated nitric acid produced during that campaign.
Measured /Calculated /Default:	Measured.
Source of data:	NAP
Value(s) of monitored parameter:	Project Campaign 4: 129,361 Project Campaign 5: 222,621
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	See comments for NAP above
Measuring/ Reading/ Recording frequency:	See comments for NAP above
Calculation method (if applicable):	In accordance with AM0034 the project length (CL _n) has to be compared to the established average historic campaign length (CL _{normal}); and 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 ₂ O values measured during the baseline campaign can be used for the calculation of EF (subject to the elimination of data from the operational parameters analysis). If CL _n < CL _{normal} , recalculate EF _{BL} by eliminating those N ₂ O values that were obtained during the production of tonnes of nitric acid beyond the CL _n (i.e. the last tonnes produced) from the calculation of EF _n .
QA/QC procedures applied:	See comments for NAP above

Data / Parameter:	OP_h
Data unit:	bar (gauge)
Description:	Oxidation Pressure for each hour
Measured /Calculated /Default:	Measured.
Source of data:	Discharge of the air compressor before the ammonia to air mixer
Value(s) of monitored parameter:	Not applicable. Used to determine when plant is operating outside of permitted range during baseline campaign or if the plant is out

	of operation.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Continuously
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Subject to ISO 9001/14001 procedures.

Data / Parameter:	OT_h
Data unit:	°C
Description:	Oxidation temperature in the ammonia oxidation reactor (AOR) for each hour.
Measured /Calculated /Default:	Measured.
Source of data:	Monitoring results of three thermocouples inside the ammonia oxidation reactor and recorded by the data acquisition system.
Value(s) of monitored parameter:	Not applicable. Used to determine when plant is operating outside of permitted range during baseline campaign or if the plant is out of operation.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	Continuously
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Subject to ISO 9001/14001 procedures.

Data / Parameter:	AFR
Data unit:	tNH₃/h
Description:	Ammonia gas flow rate to the ammonia oxidation reactor.
Measured /Calculated /Default:	Measured.
Source of data:	Orifice plate
Value(s) of monitored parameter:	Not applicable, monitored data of AFR will be used to determine if the plant operating outside of AFR_{max} during the baseline campaign or for plausibility checks
Indicate what the data are used for (Baseline/ Project/ Leakage emission)	Not applicable.

calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	The ammonia flow is continuously measured by orifice plate.
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Subject to ISO 9001/14001 procedures.

Data / Parameter:	AIFR
Data unit:	% v/v
Description:	Ammonia to air ratio into the ammonia oxidation reactor
Measured /Calculated /Default:	Calculated (primary air flow measured as basis for AIFR).
Source of data:	Calculation for each hour of plant operation based on measurements of AFR and primary air flow rates.
Value(s) of monitored parameter:	Not applicable, monitored data of AIFR will be used to determine if the plant operating outside of AIFR_{max} during the baseline campaign or for plausibility checks
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	AIFR is calculated from AFR and the primary air flow to the ammonia oxidation reactor. The airflow rate is measured by orifice plate and expressed in kg/hr and is then converted to Nm ³ /h, which is used in the ratio calculation.
QA/QC procedures applied:	Subject to ISO 9001/14001 procedures.

Data / Parameter:	GS_{project}
Data unit:	Name of Supplier
Description:	Gauze supplier for the project campaign
Measured /Calculated /Default:	Not applicable.
Source of data:	Monitored / Invoices
Value(s) of monitored parameter:	W.C. Heraeus
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable.
Monitoring equipment (type, accuracy class, serial number, calibration	Not applicable.

frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	Not applicable.

Data / Parameter:	GC_{project}
Data unit:	%
Description:	Gauze composition during the project campaign expressed as % by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Measured /Calculated /Default:	Not applicable.
Source of data:	Monitored / Gauze supplier invoices
Value(s) of monitored parameter:	Platinum (Pt) 56%; Rhodium (Rh) 3.8%, Palladium (Pd) 40.2%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable.
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	Not applicable.
QA/QC procedures applied:	Not applicable.

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

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The monitoring results for Oxidation Temperature and Pressure have been routinely discarded in the past and are therefore not available to establish the normal range. As a substitute, the technical manuals of the No. 11 nitric acid plant were used to derive these normal ranges. See Annex 1 for details.

Historic data of daily NH₃ consumption was used to determine the range of AFR for the five historic campaigns (excluding abnormal campaigns). After removing the top 2.5 percentile values the maximum daily flow rate was derived which was then converted into an hourly Ammonia flow rate, which was used to determine AIFR.

The following data was established from the above mentioned sources as permitted operating conditions:

Oxidation temperature (min – max): 820 °C – 905 °C

Oxidation pressure (min – max): 365,000 Pa – 450,000 Pa

Maximum ammonia flow rate : 9.094 t/h

Maximim ammonia to air ratio: 0,115 or 11,5 %

This permitted range is then applied in the baseline evaluation in Query 5 below.

The analysis of the historical campaigns is now complete. Next, the analysis of the baseline data can be conducted applying the results of the analysis of the historical data.

It should be noted that all values presented in excel tables are displayed (in the tables) as rounded values due to the function of excel as a program. However, actual calculations have been conducted using the exact values, which explains possible differences compared to calculating with the rounded parameter values as displayed in the tables. This applies to all presented excel tables not only those related to baseline emission calculations.

As Baseline the campaign C16 (20.07.2006 – 18.02.2007) was selected.

Analysis of Historical campaign data and determination of permitted operating ranges

Historical Query 1 (Raw data): Analysis of historical campaign data

In a first step, a number of statistical calculations are carried out for the historical and baseline data using Query 1:

- Number of data sets
- Minimum value
- Maximum value
- Mean value and/or sum (depending on the character of the parameter)
- Standard deviation
- 95% confidence interval

The resulting MS Access table shows the following numbers:

AEL No 11:

Query 1: Without parameter limits

ProjId	CampType	Count(DT)	Count(AFR)	Min(AFR)	Max(AFR)	Max(AIFR)	Min(Oph)	Max(Oph)	Min(OTh)	Max(OTh)	Sum(NAP)
7/B		5.128,00	5.120,00	0,01	8,58	0,99	139,00	425.428,00	800,48	901,94	134.699,80

For convenience of handling, the data from this Access table is exported into Excel for further analysis. The result of this export is shown below:

N.DBMS	AEL No. 11 Johannesburg, South Africa				Campaign:		C16	20.07.06 - 18.02.07	
Baseline campaign	Query 1: Without parameter limits								
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG	VSG	NAP	
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3	Nm3 / h	t HNO3	
Count	5,128	5,127	5,127	5,127	5,127	5,127	5,127		
Minimum		0.01	0.000	139	800	4	0		
Maximum		8.58	0.993	425,428	902	3,122	84,962		
Mean		7.37	0.107	380,705	896	1,549	70,159		
Standard deviation		1.40	0.037	69,293	18	314	13,850		
Sum	5,128							134,700	
Baseline emissions	BE	= VSG * NCSG * OH					t N2O	557.4	
Emission factor	EF	= BE / NAP					kg N2O / t HNO3	4.14	

This table gives the raw results for NAP, OH, NCSG, VSG and EFBL.

According to this Query 1, the NAP value of the baseline campaign is 134,700 tonnes.

Baseline Query 2: Elimination of faulty data outside operational limits

In this query (Query 2), the operational limits of the plant are applied. Lines of data in which at least one value indicates that the plant is out of operation (trip values) are completely eliminated from further analysis. During the project, the following “trip conditions” are used:

Since the design plant operating temperature is between 820°C and 905°C, by definition the plant is offline if the temperature recorded is at or below 800°C. For practical purposes, each hour for which the ammonia oxidation temperature (OTh) was recorded to be below 820°C is excluded from the determination of operating hours and all NCSG and VSG data is excluded from the further analysis if the temperature is below 820 °C.

N.DBMS	AEL No. 11 Johannesburg, South Africa					Campaign:		C16	20.07.06 - 18.02.07	
Baseline campaign	Query 2: With limits on historical data									
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG	VSG		NAP	
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3	Nm3 / h		t HNO3	
Count	4,950	4,950	4,950	4,950	4,950	4,950	4,950			
Remaining share of data set	97%	97%	97%	97%	97%	97%				
Minimum		1.50	0.095	84,380	822	4	14,343			
Maximum		8.58	0.108	425,428	902	2,470	84,962			
Mean		7.62	0.103	393,337	899	1,595	72,570			
Standard deviation		0.37	0.001	17,062	3	191	5,435			
95% confidence level		0.72	0.002	33,441	6	374	10,653			
Sum	4,950								134,700	
Limits acc. to consistency check										
Lower limit						820				
Upper limit										

According to this Query 2, the OH value of the baseline campaign is 4,950 hours.

Baseline Query 5: Applying the permitted operating range from historical data

After conducting Queries 2 and 5 which effect the elimination of

- all invalid (i.e. obviously inconsistent) baseline data sets
- all baseline data sets registered while the plant was operating outside the historic operational parameters

99% of all original data sets remain.

The remaining data sets are those recorded when the plant was operating normal.

N.DBMS	AEL No. 11 Johannesburg, South Africa				Campaign:		C16	20.07.06 - 18.02.07	
Query 5a: Permitted range from hist. campaigns applied to BL data, invalid data sets excluded and Query 5b: Permitted range from hist. campaigns applied to BL data, invalid data sets excluded, NCSG beyond Clnormal excluded									
Baseline campaign									
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG	VSG	NAP	
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3	Nm3 / h	t HNO3	
Count	4,915	4,915	4,915	4,915	4,915	4,642	4,915		
Remaining share of data set	99%	99%	99%	99%	99%	94%	99%		
Minimum		7.04	0.099	365,059.0	894	6	64,035		
Maximum		8.58	0.108	425,428.0	902	1,909	84,962		
Mean		7.64	0.103	393,956	899	1,587	72,699		
Standard deviation		0.30	0.001	13,398.9	1	193	5,037		
95% Confidence Interval		0.59	0.002	26,261.9	2	378	9,872		
Sum	4,950							134,700	
Limits acc. to consistency check						6.2.07 21:00			
Lower limit			0	365,000	820				
Upper limit		9.094	0.115	450,000	905				
Baseline emissions	BE	= VSG * NCSG * OH					t N2O		571.2
Emission factor	EF	= BE / NAP					kg N2O / t HNO3		4.24

This query excludes those NCSG and VSG data from the calculation of BE that were taken during times when the plant was operating outside of the permitted operating range during the baseline campaign. Only those VSG and NCSG values were taken into account for which a matching AFR, AIFR, OPh and OTh value was available.

CL_{normal} for AEL No. 11 is: 127,302.4 tonnes of HNO₃

CL_{BL} for AEL No. 11 is: 134,700 tonnes of HNO₃

Therefore CL_{BL} > CL_{normal} and all NCSG datasets were excluded from that operating hour onwards when the nitric acid production during the baseline campaign exceeded the CL_{normal} value.

The remaining share of the operating data after Query 5 is 99% of the raw data and therefore meets the criterion set by AM0034 that the plant must be operating within the permitted range at least 50% of the time during the baseline campaign.

Query 6 a + b: Application of 95% confidence interval, AMS UNC and calculation of EFBL

The 95% confidence level of NCSG and VSG values is derived, thereby excluding outliers and determining the mean values that are to be applied to the calculation of BE. Also the correction factors for NCSG and VSG that are determined during QAL2 test as well as UNC (AMS uncertainty) are applied.

N.DBMS	AEL No. 11 Johannesburg, South Africa					Campaign:	C16	20.07.06	-	18.02.07
Baseline campaign		Query 6a+b: Confidence levels for NCSG and VSG								
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG		VSG		NAP
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3		Nm3 / h		t HNO3
Count						4,323		4,810		
Minimum		7.036	0.099	365,059.0	894	1,210		64,035		
Maximum		8.584	0.108	425,428.0	902	1,909		82,563		
Mean		7.636	0.103	393,955.8	899	1,630		72,468		
Standard deviation						110		4,839		
95% Confidence Interval										
Sum	4,950									134,700
Limits acc. to consistency check						6.2.07 21:00				
Lower limit			0	365,000	820	1,209.2		62,827		
Upper limit		9.094	0.115	450,000	905	1,965.6		82,571		
	Correction factors resulting from QAL2					1.104		1.010		
Baseline emissions	BE	= VSG * NCSG * OH						t N2O		652.0
Emission factor	EF	= BE / NAP * (1 - UNC/100)						kg N2O / t HNO3		4.647
Uncertainty	UNC									3.99

Resulting EF_{BL}

The EF_{BL} derived from this analysis of historic and baseline data is 4.647 kg N₂O/tHNO₃.

Adjustment of Baseline Emission Factor if $CL_n < CL_{normal}$

If the length of an individual project campaign CL_n is longer than or equal to the average historic campaign length CL_{normal} , then all N₂O values measured during the baseline campaign can be used for the calculation of EF_{BL}. If $CL_n < CL_{normal}$, EF_{BL} has to be recalculated by eliminating those N₂O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tonnes produced) from the calculation of EF_{BL}.

Since for both campaigns of this monitoring period $CL_n > CL_{BL}$, the above determined EF_{BL} is valid and will be used for the calculation of respective emission reduction.

Adjustment of Baseline emissions factor due to EF_{reg}

Should N₂O emissions regulations that apply to nitric acid plants be introduced in the host country or jurisdiction covering the location of the project activity, such regulations shall be compared to the calculated baseline emission factor for the project (EF_{BL}). If the regulatory limit is lower than the baseline factor determined for the project, the regulatory limit shall serve as the new baseline emission factor, that is:

if $EF_{BL} > EF_{reg}$,

then the baseline N₂O emission factor shall be EF_{reg} for all calculations.

where:

Variable Definition

EF_{BL} Baseline emissions factor (tN₂O/tHNO₃)

EF_{reg} Emissions level set by newly introduced policies or regulations (tN₂O/tHNO₃).

Such EF_{reg} shall be determined according to the nature of the regulation (e.g. in terms of absolute emission, by-product rate, concentration in stack gas), as described in the approved methodology AM0028.

There is currently no N₂O regulation for nitric acid plants in South Africa therefore no adjustment of the Baseline emissions factor EF_{BL} is necessary.

E.2. Project emissions calculation

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Project emissions are calculated according to the following formula:

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

Variable	Definition
VSG	Mean stack gas volume flow rate for the project campaign (m ³ /h)
NCSG	Mean concentration of N ₂ O in the stack gas for the project campaign (mgN ₂ O/m ³)
PE _n	Total N ₂ O emissions of the n th project campaign (tN ₂ O)
OH	Is the number of hours of operation in the specific monitoring period (h)

Based on the total N₂O emissions of each project campaign the specific project campaign emission factor is calculated as:

$$EF_n = PE_n / NAP_n$$

Where:

Variable	Definition
EF _n	Project Emission Factor for n th project campaign (kg N ₂ O/t HNO ₃)
PE _n	Total N ₂ O emissions of the n th project campaign (tN ₂ O or kg N ₂ O)
NAP _n	Campaign length of the n th project campaign (tHNO ₃)

Before calculation of the Project Emissions (PE) the same statistical analysis as for the calculation of the baseline emission factor (EF_{BL}) is applied to the monitoring raw data (hourly average values) of each project campaign.

The respective correction functions for NCSG and VSG as determined during the relevant QAL2 test are applied within the calculation.

Analysis of Project campaign data

Query 1 (Raw data): Analysis of the raw campaign data

This set of data shows a summary of the collected raw data for both complete project campaigns.

N.DBMS Project Campaign Calculation Project: AEL No. 11, Johannesburg, South Africa Campaign: C 21 08.06.09 - 27.12.09									
Project campaign 4 Query 1: Without parameter limits 68									
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG	VSG	NAP	
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3	Nm3 / h	t HNO3	
Count	4,850	4,850	4,850	4,850	4,850	4,850	4,850		
Minimum		0.01	0.00	152	801	0.00	0		
Maximum		8.66	1.0	425,671	902	2,662	86,029		
Mean		7.48	0.11	355,286	889	446	71,409		
Standard deviation		2.283	0.08	103,748	27	451	21,512		
95% confidence level (1.96 * Std.dev.)		4.47	0.15	203,346	53	884	42,163		
Sum	4,850								129,361
Limits acc. to consistency check									
Lower limit									
Upper limit									
Correction factors based on QAL2 reference measurements						0.990	1.010		
Campaign emissions	PE	= VSG * NCSG * Oh					t N2O		154.4
Emission factor	EF _n	= PE / NAP					kg N2O / t HNO3		1.19

N.DBMS Project Campaign Calculation Project: AEL No. 11, Johannesburg, South Africa Campaign: C 22 30.12.09 - 16.11.10									
Project campaign 5 Query 1: Without parameter limits 108									
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG	VSG	NAP	
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3	Nm3 / h	t HNO3	
Count	7,724	6,339	6,291	6,339	7,724	7,724	7,724		
Minimum		0.00	0.00	0	801	0.00	0		
Maximum		8.61	1.0	426,044	901	559	86,197		
Mean		7.85	0.11	378,335	880	260	77,047		
Standard deviation		1.550	0.07	68,545	31	145	12,861		
95% confidence level (1.96 * Std.dev.)		3.04	0.14	134,348	61	283	25,208		
Sum	7,724								222,621
Limits acc. to consistency check									
Lower limit									
Upper limit									
Correction factors based on QAL2 reference measurements						0.990	1.010		
Campaign emissions	PE	= VSG * NCSG * Oh					t N2O		154.9
Emission factor	EF _n	= PE / NAP					kg N2O / t HNO3		0.70

These tables give the raw results for NAP, OH, NCSG, VSG and EF_n.

According to this Query 1, the NAP value of the 4th project campaign is 129,361 t of nitric acid and the NAP value of the 5th project campaign is 222,621 t of nitric acid.

Query 2: Elimination of faulty data outside operational limits

In this query (Query 2), the operational limits of the plant are applied. Lines of data in which at least one value indicates that the plant is out of operation (trip values) are completely eliminated from further analysis. The design “trip” temperature, i.e. the temperature inside the ammonia oxidation reactor below which the plant shuts down automatically has been applied to exclude such lines of data. During the project, the “trip temperature” of 820°C will be applied as the exclusion criterion for determining those hours during which the plant was offline during a campaign.

N.DBMS Project Campaign Calculation Project: AEL No. 11, Johannesburg, South Africa Campaign: C 21 08.06.09 - 27.12.09									
Project campaign 4 Query 2: With operational limits 72									
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG		VSG	NAP
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3		Nm3 / h	t HNO3
Count	4,444	4,444	4,444	4,444	4,444	4,444		4,444	
Remaining share of data sets	91.6%	91.6%	91.6%	91.6%	91.6%	91.6%		91.6%	
Minimum		1.23	0.07	88,015	820	100		13,379	
Maximum		8.66	0.10	425,671	902	2,662		86,029	
Mean		8.15	0.10	385,718	897	484		77,725	
Standard deviation		0.444	0.002	21,134	5.9	451		5,036	
95% confidence level (1.96 * Std.dev.)		0.870	0.003	41,422	11.5	885		9,870	
Sum	4,444								129,361
Limits acc. to consistency check									
Lower limit					820				
Upper limit									
Correction factors based on QAL2 reference measurements						0.9900		1.0100	
Campaign emissions	PE		= VSG * NCSG * Oh					t N2O	167.3
Emission factor	EF_n		= PE / NAP					kg N2O / t HNO3	1.29

N.DBMS Project Campaign Calculation Project: AEL No. 11, Johannesburg, South Africa Campaign: C 22 30.12.09 - 16.11.10									
Project campaign 5 Query 2: With operational limits 112									
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG		VSG	NAP
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3		Nm3 / h	t HNO3
Count	7,535	6,150	6,102	6,150	7,535	7,535		7,535	
Remaining share of data sets	97.6%	97.0%	97.0%	97.0%	97.6%	97.6%		97.6%	
Minimum		0.00	0.09	0	821	86		37,117	
Maximum		8.61	0.10	426,044	901	559		86,197	
Mean		8.09	0.10	389,237	882	266		78,930	
Standard deviation		0.755	0.001	27,934	28.9	141		4,909	
95% confidence level (1.96 * Std.dev.)		1.480	0.002	54,751	56.7	277		9,622	
Sum	7,535								222,621
Limits acc. to consistency check									
Lower limit					820				
Upper limit									
Correction factors based on QAL2 reference measurements						0.9900		1.0100	
Campaign emissions	PE		= VSG * NCSG * Oh					t N2O	158.3
Emission factor	EF_n		= PE / NAP					kg N2O / t HNO3	0.71

As a result of this query the number of operation hours OH of the 4th project campaign is 4,444 hours and 7,535 hours of the 5th project campaign.

Query 6: application of confidence interval to eliminate outliers

The 95% confidence interval for NCSG and VSG values is derived and the outliers excluded individually for VSG and NCSG. Hence, the remaining number of data sets may differ between NCSG and VSG.

N.DBMS Project Campaign Calculation Project: AEL No. 11, Johannesburg, South Africa							Campaign: C 21 08.06.09 - 27.12.09		
Project campaign 4 Q6: Q2 + confidence levels							76	80	72
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG	VSG		NAP
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3	Nm3 / h		t HNO3
Count						4,228	4,399		
Remaining share of data sets									
Minimum		1.228	0.07	88,015	820	100	68,127		
Maximum		8.66	0.10	425,671	902	1,369	86,029		
Mean		8.15	0.10	385,718	897	431	78,080		
Standard deviation		0.444	0.002	21,134	5.9	394	3,311		
95% confidence level (1.96 * Std.dev.)		0.870	0.003	41,422	11.5	772	6,489		
Sum		4,444							129,361
Limits acc. to consistency check									
Lower limit						810	-400.47		67,855
Upper limit							1,369.30		87,595
Correction factors based on QAL2 reference measurements						0.9900	1.0100		
Campaign emissions	PE	$= VSG * NCSG * Oh$					t N2O		149.70
Emission factor	EF_n	$= PE / NAP$					kg N2O / t HNO3		1.16

N.DBMS Project Campaign Calculation Project: AEL No. 11, Johannesburg, South Africa							Campaign: C 22 30.12.09 - 16.11.10		
Project campaign 5 Q6: Q2 + confidence levels							116	120	110
Parameter	OH	AFR	AIFR	Oph	OTh	NCSG	VSG		NAP
Unit	h	t NH3 / h	ratio	Pa	°C	mg N2O / Nm3	Nm3 / h		t HNO3
Count						6,149	7,431		
Remaining share of data sets									
Minimum		0.000	0.09	0	821	86	69,311		
Maximum		8.61	0.10	426,044	901	411	86,197		
Mean		8.09	0.10	389,237	882	200	79,104		
Standard deviation		0.755	0.001	27,934	28.9	27	4,657		
95% confidence level (1.96 * Std.dev.)		1.480	0.002	54,751	56.7	53	9,128		
Sum		7,535							222,621
Limits acc. to consistency check									
Lower limit						810	-10.47		69,308
Upper limit							542.87		88,551
Correction factors based on QAL2 reference measurements						0.9900	1.0100		
Campaign emissions	PE	$= VSG * NCSG * Oh$					t N2O		119.32
Emission factor	EF_n	$= PE / NAP$					kg N2O / t HNO3		0.54

Relevant Project Emissions (PE_n) and respective Project Emission Factors (EF_n)

The resulting project emissions (PE_n) and project emission factor (EF_n) for the project campaigns covered by this monitoring report are:

Campaign	PE	EF _n
4 th project campaign	149.70 tN ₂ O	1.16 kgN ₂ O/tHNO ₃
5 th project campaign	119.32 tN ₂ O	0.54 kgN ₂ O/tHNO ₃

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} or to the baseline campaign length whichever is shorter, then all N₂O values measured during the baseline campaign can be used for the calculation of EF (subject to the elimination of data from the operational limits analysis, see above under recalculation of Baseline Emission factor).

Both project campaigns length values for this monitoring period are higher than the CL_{normal} and value. Therefore no recalculation of the EF_{BL} value is required.

E.3. Leakage calculation

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No leakage occurs under this project type.

E.4. Emission reductions calculation / table

>>

Emission reductions

A **moving average emissions factor** must be calculated at the end of a campaign n as follows:

$$EF_{ma,n} = (EF_1 + EF_2 + \dots + EF_n) / n$$

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.

To calculate the total emission reductions achieved in a campaign according to the formula below, 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 $EF_p = EF_n$

In addition a campaign-specific **minimum emissions factor** (EF_{min}) shall be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum emission factor (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 . As this project campaign of this current monitoring period is only the 8th project campaign consideration of EF_{min} is not yet of relevance.

The emission reductions for the project activity during this monitoring period 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 according to:

$$ER = (EF_{BL} - EF_p) * NAP * GWP_{N_2O} (tCO_2e)$$

Where:

Variable	Definition
ER	Emission reductions of the project for the specific campaign (tCO ₂ e)
NAP	Nitric acid production for the project campaign (tHNO ₃). The maximum value of NAP shall not exceed the design capacity.
EF _{BL}	Baseline emissions factor (kgN ₂ O/tHNO 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) (kgN ₂ O/tHNO ₃)
GWP _{N₂O}	Global Warming Potential of N ₂ O (310 tCO ₂ e/tN ₂ O)

The resulting emission reductions (ER) for each of the project campaigns covered by this monitoring report and all relevant monitoring results are summarized in the table below:

Parameter	Unit	4 th project campaign	5 th project campaign
Baseline			
NCSG _{BL}	mg/Nm ³	1,630	1,630
QAL2 NCSG		1.104	1.104
VSG _{BL}	Nm ³ /h	72,468	72,468
QAL2 VSG		1.010	1.010
OH _{BL}	h	4,950	4,950
NAP _{BL}	tHNO ₃	134,700	134,700
BE _{BL}	tN ₂ O	651.983	651.983
UNC	percent	3.99%	3.99%
EF _{BL}	kg N ₂ O/tHNO ₃	4.647	4.647
Project Campaigns			
NCSG _n	mg/Nm ³	431	200
QAL2 NCSG		0.990	0.990
VSG _n	Nm ³ /h	78,080	79,104
QAL2 VSG		1.010	1.010
OH _n	h	4,444	7,535
NAP _n	tHNO ₃	129,361	222,621
PE _n	tN ₂ O	149.70	119.32
EF _n	kg N ₂ O/tHNO ₃	0.00116	0.00054
EF _{ma,n}	kg N ₂ O/tHNO ₃	0.00107	0.00096
EF _{min}	kg N ₂ O/tHNO ₃	0.00090	0.00054
EF _p	kg N ₂ O/tHNO ₃	0.00116	0.00096
Emission reductions			
GWP	tCO ₂ e/tN ₂ O	310	310
ER	tCO ₂ e	139,952	254,507
Total ER for the monitoring period		394,459	

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

>>

This section shall include a comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the registered CDM-PDD.

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO₂e)	394,190	394,459

E.6. Remarks on difference from estimated value in the PDD

>>

The estimated annual emission reductions as of the registered PDD are 265,460 tCO₂e. The total monitoring period covers 542 days and the respective estimated emission reductions for the monitoring period are 394,190 tCO₂e. This is reasonably close to the actual emission reductions of 394,459 tCO₂e achieved during this monitoring period.

History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
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