

**MONITORING REPORT FORM (F-CDM-MR)**
Version 02.0**MONITORING REPORT**

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| Title of the project activity | N2O ABATEMENT PROJECT AT NITRIC ACID PLANT NO. 11 AT AFRICAN EXPLOSIVES LTD. (AEL), SOUTH AFRICA |
| Reference number of the project activity | 1364 |
| Version number of the monitoring report | 01 |
| Completion date of the monitoring report | 21/06/2012 |
| Registration date of the project activity | 08/02/2008 |
| Monitoring period number and duration of this monitoring period | - Number 5 - 07/08/2011 – 17/04/2012, 255 days |
| Project participant(s) | - African Explosives Ltd - N.serve Environmental Services GmbH - Electrabel NV/SA |
| Host Party(ies) | South Africa |
| Sectoral scope(s) and applied methodology(ies) | - Sectoral scope: Chemical industries (5) - AM0034 (Version 2) |
| Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD | 185,458 tCO ₂ e |
| Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period | 175,429 tCO ₂ e |

SECTION A. Description of project activity**A.1. Purpose and general description of project activity**

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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.)

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 section D.1. for details.

The parameters CL_{normal}, GS_{normal}, GC_{normal} and AFR_{max} were derived from the 5 historic campaigns that were defined in the PDD. The 5 campaigns are:

| Campaign | Start date | End date | In-/Excluded |
|----------|------------|------------|--------------|
| C10 | 29/05/2003 | 24/11/2003 | Included |
| C12 | 27/05/2004 | 12/12/2004 | Included |
| C13 | 15/12/2004 | 24/07/2005 | Included |
| C14 | 27/07/2005 | 28/01/2006 | Included |
| C15 | 03/02/2006 | 31/07/2006 | Included |

Baseline Campaign: BL – Campaign 20/07/2006 – 18/02/2007

Intermediate Campaign

Without secondary catalyst: 25/02/2007 – 18/08/2007

Installation of secondary catalyst: 12/09/2007

Starting Date of Crediting period: 08/02/2008

Project Campaigns completed prior to current monitoring period:



| | |
|-------------|-----------------------------|
| 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 |
| 4. Campaign | PC4 - 08/06/2009-27/12/2009 |
| 5. Campaign | PC5 - 30/12/2009-03/08/2010 |
| 6. Campaign | PC6 - 04/08/2010-16/11/2010 |
| 7. Campaign | PC7 - 19/11/2010-28/02/2011 |
| 8. Campaign | PC8 - 24/03/2011-06/08/2011 |

Project Campaigns covered by current Monitoring/Verification Period:

| | |
|-------------|-----------------------------|
| 9. Campaign | PC9 – 22/08/2011-17/04/2012 |
|-------------|-----------------------------|

Total emission reductions achieved in this monitoring period

The total amount of emission reductions achieved in this monitoring period is 175,429 t CO₂e.

A.2. Location of project activity

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Host Party: South Africa

Region/State/Province: Gauteng / Modderfontein

City/Town/Community: City of Johannesburg

Physical/Geographical location: 26°05'50'' South, 28°10'26'' East

A.3. Parties and project participant(s)

| Party involved (host) indicates a host Party) | Private and/or public entity(ies) project participants (as applicable) | Indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|--|--|
| South Africa (host) | African Explosives Ltd | No |
| United Kingdom of Great Britain and Northern Ireland | N.serve Environmental Services GmbH | No |
| United Kingdom of Great Britain and Northern Ireland | Electrabel NV/SA | No |
| Switzerland | N.serve Environmental Services GmbH | No |

A.4. Reference of applied methodology

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- a) AM0034 “Catalytic reduction of N₂O inside the ammonia burner of nitric acid plants” Version 2
(http://cdm.unfccc.int/filestorage/C/D/M/CDMWF_AM_HPMLB4XF5J1FZQGG1QSBKMKZSB_C570/EB27_repan05_AM0034_ver02.pdf?t=T2V8bTV4MTE1fDBiA2pXdOnYLJ-ocyQr664K)

For the baseline selection: AM0028 “Catalytic N₂O destruction in the tail gas of Nitric Acid or Caprolactam Production Plants” Version 03

- b) “Tool for the demonstration and assessment of additionality” Version 02

A.5. Crediting period of project activity

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Type: Non-renewable crediting period,

Start date: 08/02/2008

Length: 10 years 0 months

SECTION B. Implementation of project activity**B.1. Description of implemented registered project activity**

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Description of the installed technology, technical processes and equipment

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

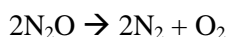
- 1.) secondary N₂O abatement technology
- 2.) Automated Monitoring System (AMS) for continuous N₂O measurement which is fully in compliance with European standard EN 14181 (see Section C for more detail)
- 3.) training of local staff on installation, operation and maintenance of catalyst and monitoring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

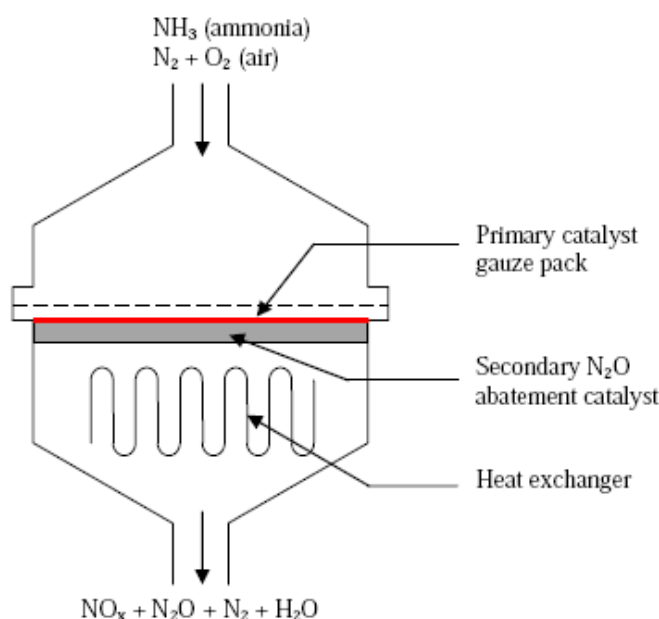
A secondary catalyst will reduce N₂O levels in the gas mix resulting from the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have shown to be of varied effectiveness in N₂O abatement catalysts. The YARA 58 Y 1® abatement catalyst is made of cylindrical pellets 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.

Information on the implementation and actual operation of the project activity, including relevant dates

The determination of the permitted operating conditions for operating temperature, operating pressure, maximum ammonia flow rate, maximum ammonia to air ratio normal gauze supplier and normal gauze composition was undertaken by the validating DOE (as it was clarified by the CDM EB in EB31 meeting that either validating or verifying DOE could undertake the task of determination of the permitted operating conditions). However the normal campaign length as well as the determination of the baseline emission factor was in the scope of the verifying DOE. These parameters were determined and verified within the course of the first verification. The baseline campaign that was operated from 20/07/2006 until 18/02/2007.

The secondary catalyst was installed on the 12/09/2007, which is the starting date of the project activity. The project got registered by UNFCCC on the 08/02/2008, which is the starting date of the crediting period.

For a more detailed list of secondary catalyst installation, AMS installation, continued operating periods and other relevant dates for the project activity, see Section A.1, paragraph “*Relevant dates for the project activity*” above.

The events or situations that occurred during the monitoring period that may impact the applicability of the applied methodology

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 demonstrates 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 | 22.08.2011 21:00 | | C25 | PC9 | New campaign start with fresh primary gauze, start of project campaign 9 |
| 2 | 26.08.2011 14:00 | 26.08.2011 23:00 | C25 | PC9 | Plant tripped on high absorption column level. |
| 3 | 14.09.2011 01:00 | 14.09.2011 14:00 | C25 | PC9 | Plant trip due to power dip. |
| 4 | 23.09.2011 23:00 | 24.09.2011 04:00 | C25 | PC9 | Plant trip due to power failure |
| 5 | 22.10.2011 08:00 | 23.10.2011 01:00 | C25 | PC9 | Tripped due to low instrument air. |
| 6 | 03.12.2011 22:00 | 04.12.2011 05:00 | C25 | PC9 | Plant tripped due to ammonia/air ratio |
| 7 | 08.12.2011 11:00 | 11.12.2011 20:00 | C25 | PC9 | Plant shutdown to inspect converter; Maintenance and basket repairs |
| 8 | 01.03.2012 12:00 | 01.03.2012 18:00 | C25 | PC9 | Instrument air failure |
| 9 | 17.04.2012 20:00 | | C25 | PC9 | Shutdown for maintenance and gauze change -End of campaign |

None of the events listed above and NO other events or incidents of any relevance in regard to impacting the applicability of the methodology occurred during this monitoring period.

No events or incidents that resulted in AMS downtime occurred during this second monitoring period or during the baseline campaign period. Per AM0034 no correction is needed for the plant downtime periods.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

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No temporary deviations from the registered monitoring plan or applied methodology have been applied during this monitoring period.

B.2.2. Corrections

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No corrections to project information or parameters fixed at validation have been approved during this monitoring period or submitted with this monitoring report.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

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No permanent changes from the registered monitoring plan or applied methodologies have been approved during this monitoring period or submitted with this monitoring report.

B.2.4. Changes to project design of registered project activity

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No changes to project design of the project activity have been approved during this monitoring period or submitted with this monitoring report.

B.2.5. Changes to start date of crediting period

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No changes to the start date of the crediting period have been approved during this monitoring period or submitted with this monitoring report.

B.2.6. Types of changes specific to afforestation or reforestation project activity

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Not applicable

SECTION C. Description of monitoring system

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1. General Description of the AMS

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 AO2040 Uras 14 during project campaigns.

5. Flow Meter

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

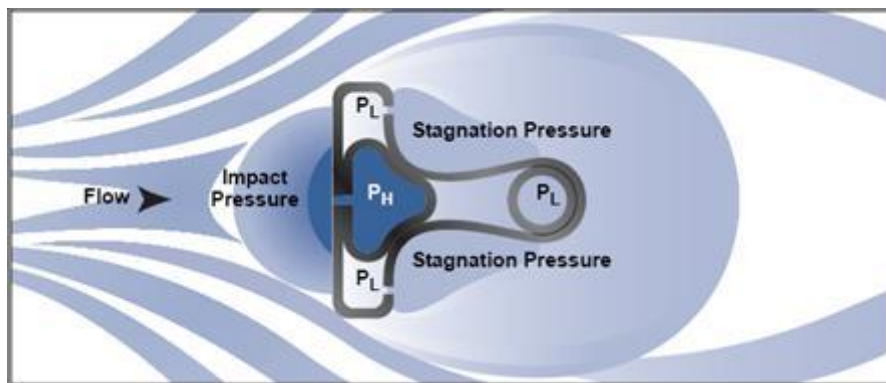
The Rosemount Annubar® 485 is a device used to measure the flow-velocity of a liquid, gas or steam fluid that passes through a pipe. It measures by creating a differential pressure (DP) that is proportional to the square of the velocity of the fluid in the pipe, in accordance with Bernoulli's theorem. 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. Nitric acid production measurement

NAP is continuously measured and determined by a Coriolis mass flow meter. The product density and temperature as measured by the mass flow meter are 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.

7. 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.

8. Application of EN 14181 procedures to the project

In the following, it is described how the procedures given in EN 14181 for QAL1, 2 have been practically applied at AEL No. 11 plant. QAL 3 procedures are described in section 9 below.

QAL 1

In accordance with EN 14181 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 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 5 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

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



SRM need to be conducted by an independent “testing house” or laboratory which has to be accredited to EN ISO/IEC 17025.

An annual surveillance test (AST) is performed between QAL2 tests to demonstrate that the AMS functions correctly, its performance remains valid and that the calibration function and variability derived during the QAL2 remains as previously determined.

9. 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.

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.

Analyser Zero and Span Calibrations

The N₂O analyzer is calibrated once per year by external QAL2 or AST test according to EN 14181. In addition according to the QAL1 reports and manufacturers specifications it is recommended to perform a zero/span calibration once every three weeks for the ABB URAS 14 analyzer, 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.

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) or by the supplier.

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

Flow meter calibration procedures

The flow meter is calibrated once per year by external QAL2 or AST test according to EN 14181. In addition 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 device 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.

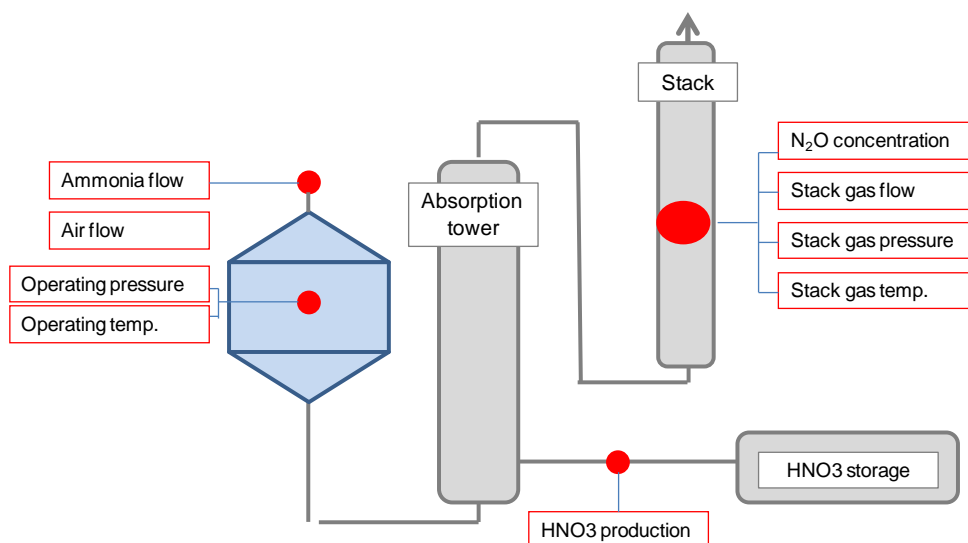


Figure: Monitoring Points for all relevant Parameters (NCSG, VSG, TSG, PSG, NAP, OTh, OPh, AFR, AIFR)

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.

9.1. 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 is sent to N.serve on a regular basis (e. g. after each campaign) where it is 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 fixed ex ante or at renewal of crediting period

| | |
|---------------------------|--|
| Data/Parameter | B.1 NCSG_{BC}³ |
| Unit | mg/Nm³ |
| Description | N ₂ O concentration in the stack gas during the baseline campaign. |
| Source of data | NDIR N ₂ O gas analyser (Environnement S.A. MIR 9000) |
| Value(s) applied | Value applicable for regular project campaigns exceeding CL _{normal} or CL _{BL} : 1,630.03 Value applicable for Project Campaign 9 : 1,630.03 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | A complete QAL2 audit in accordance with EN 14181 was conducted on the AMS in February 2008. During the QAL2 reference measurements it was determined that the analyser consistently overestimates the N ₂ O concentration in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 1.104 has to be applied to all NCSG measurements. Therefore, the mean NCSG value will be multiplied by 1.104 before going into the calculation of BE _{BC} . Calibration information During Baseline period 20.07.2006 – 18.02.2007: 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 (internal calibration by AEL) Documentation in form of calibration reports and shewart charts. First check for baseline period: 18/07/2006 During the baseline period: check performed twice per week Last check for baseline period: 17/02/2007 Next check after baseline period: 20/02/2007 Date of last external calibration: QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012 The calibration error as determined during the QAL2 test was retroactively applied to the NCSG results for the baseline period in a conservative manner. Moreover the overall uncertainty of the AMS was applied in a conservative manner to the results of baseline emissions. |

| | |
|---------------------------|---|
| Data/Parameter | B.2 VSG_{BC} |
| Unit | Nm³/h |
| Description | Normal gas volume flow rate of the stack gas during the baseline campaign. |
| Source of data | Gas Volume Flow meter, Emerson Rosemount Annubar® Model 485 |
| Value(s) applied | 72,468 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | The QAL2 test, performed by an independent 3rd party laboratory with EN ISO/IEC 17025 accreditation, include the test of the correct measurement of stack gas temperature and stack gas pressure by comparison of the AMS |

³ Please note that all baseline data and historic campaign data sets have been determined after the registration as a different baseline had been selected. Please refer to section E.1. below for further detail.



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| | <p>results of these parameters with the results of the reference measurement instruments of the testing laboratory. Moreover during the QAL2 test the correct normalization of the stack gas flow (VSG) to standard conditions is verified by comparison of the AMS results for normalized flow with the reference measurement results for normalized flow.</p> <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 multiplied by 1.01 before going into the calculation of BE_{BC}.</p> <p>Calibration information During Baseline period 20.07.2006 – 18.02.2007</p> <p>Internal calibrations: after each campaign Date of internal calibration :19/07/2006 Date of internal calibration :23/02/2007</p> <p>Date of last external calibration: QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012 The calibration error as determined during the QAL2 test was retroactively applied to the NCSG results for the baseline period in a conservative manner. Moreover the overall uncertainty of the AMS was applied in a conservative manner to the results of baseline emissions.</p> |
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| | |
|---------------------------|--|
| Data/Parameter | B.3 BE_{BC} |
| Unit | tN₂O |
| Description | Total N ₂ O mass flow during baseline campaign |
| Source of data | Calculation from measured data. |
| Value(s) applied | Value applicable for regular project campaigns exceeding CL_{normal} or CL_{BL} : 651.983 Value applicable for Project Campaign 9: 651.983 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

| | |
|---------------------------|---|
| Data/Parameter | B.4 OH_{BC} |
| Unit | hours |
| Description | Operating hours |
| Source of data | Production log and Process Control System. |
| Value(s) applied | 4,950 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |



| | |
|---------------------------|--|
| Data/Parameter | B.5 NAP_{BC} |
| Unit | tHNO₃ |
| Description | Metric tonnes of 100% concentrated nitric acid produced during the baseline campaign. |
| Source of data | Nitric acid flow meter Manufacturer: EMERSON, Type: Coriolis mass flow meter CMF 300 Laboratory results for verification purposes |
| Value(s) applied | 134,700 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | The nitric acid flow meter is subject of external calibration procedures every 3 years. Calibration information During Baseline period 20.07.2006 – 18.02.2007: External calibration by: ALPRET Controls Specialists Date 25/04/2006 and 06/09/2007; although the calibration is valid for 3 years, it is done more frequently |

| | |
|---------------------------|---|
| Data/Parameter | B.6 TSG |
| Unit | °C |
| Description | Temperature in the stack gas |
| Source of data | Stack temperature probe situated directly next to the volume flow meter; |
| Value(s) applied | Not applicable |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | The TSG result is automatically applied for calculating VSG at standard conditions Calibration information Calibration information During Baseline period 20.07.2006 – 18.02.2007 Internal calibrations: after each campaign Date of internal calibration :19/07/2006 Date of internal calibration :23/02/2007 Date of last external calibration: QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012 |

| | |
|---------------------------|--|
| Data/Parameter | B.7 PSG |
| Unit | mbar (absolute) |
| Description | Pressure in the stack |
| Source of data | Stack pressure probe situated directly next to flow meter |
| Value(s) applied | Not applicable |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | The PSG result is automatically applied for calculating VSG at standard conditions Calibration information Calibration information During Baseline period 20.07.2006 – 18.02.2007 Internal calibrations: after each campaign |



| | |
|--|---|
| | Date of internal calibration :19/07/2006 Date of internal calibration :23/02/2007 Date of last external calibration: QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012 |
|--|---|

| | |
|---------------------------|--|
| Data/Parameter | B.8 EF_{BL} |
| Unit | tN₂O / tHNO₃ |
| Description | Emissions factor for baseline period |
| Source of data | Calculated from measured data (tons of N ₂ O emitted / tons of nitric acid produced) |
| Value(s) applied | Value applicable for regular project campaigns exceeding CL _{normal} or CL _{BL} : 0.004647 Value applicable for Project Campaign 9: 0.004647 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

| | |
|---------------------------|---|
| Data/Parameter | B.9 UNC |
| Unit | % |
| Description | Calculated overall uncertainty of the Automated Monitoring System (AMS) |
| Source of data | UNC is determined by conducting reference measurements by an independent testing laboratory with EN ISO/IEC 17025 accreditation (QAL2). |
| Value(s) applied | 3.99 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

| | |
|---------------------------|---|
| Data/Parameter | B.10 AFR |
| Unit | tNH₃/h (converted from originally measured Nm³/h) |
| Description | Ammonia gas flow rate to the ammonia oxidation reactor |
| Source of data | Differential pressure measurement (orifice plate) Type: D/P |
| Value(s) applied | Not applicable, monitored data of AFR will be used to determine if plant was operating outside of AFR _{max} . |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | Calibration information During Baseline period 20.07.2006 – 18.02.2007 Calibration frequency: Once every six months. (only during plant shutdown between campaigns) Date of last calibrations: 31/05/2006, 01/11/2006: 19/02/2007 |

| | |
|---------------------------|--|
| Data/Parameter | B.11 AFR_{max} |
| Unit | tNH₃/h (converted from originally measured Nm³/h) |
| Description | Maximum Ammonia gas flow rate to the ammonia oxidation reactor |
| Source of data | AFR data |
| Value(s) applied | 9.094 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |



| | |
|---------------------------|---|
| Data/Parameter | B.12 AIFR |
| Unit | % v/v |
| Description | Ammonia to air ratio into the ammonia oxidation reactor |
| Source of data | Measurements of AFR and primary air flow rates (measured by differential pressure measurement). |
| Value(s) applied | Not applicable, monitored data of AIFR will be used to determine if plant was operating outside of $AIFR_{max}$. |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | Calibration information During Baseline period 20.07.2006 – 18.02.2007 Calibration frequency: Once every six months. (only during plant shutdown between campaigns) Date of last calibrations: 31/05/2006, 01/11/2006: 19/02/2007 |

| | |
|---------------------------|---|
| Data/Parameter | B.13 CL_{BL} |
| 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 | NAP _{BC} |
| Value(s) applied | 134,700 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | Adjustment of Baseline Campaign Length (CL_{BL}) As $CL_{BL} > CL_{normal}$, N ₂ O 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) have been eliminated from the calculation of EF_{BL} . |

| | |
|---------------------------|---|
| Data/Parameter | B.14 CL_{normal} |
| Unit | tHNO ₃ |
| Description | Average length of the historic campaigns measured in metric tonnes of 100% concentrated nitric acid produced during the historic campaigns. |
| Source of data | Flow meter measurements as described in NAP. |
| Value(s) applied | 127,302.4 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

| | |
|---------------------------|---|
| Data/Parameter | B. 15 $AIFR_{max}$ |
| Unit | % v/v |
| Description | Maximum Ammonia to air ratio into the ammonia oxidation reactor. |
| Source of data | AIFR Data |
| Value(s) applied | 11.5 |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |



| | |
|---------------------------|--|
| Data/Parameter | B.16 OT_h |
| Unit | °C |
| Description | Oxidation temperature for each hour during the baseline campaign |
| Source of data | Monitoring results of a thermocouple inside the ammonia oxidation reactor. |
| Value(s) applied | Not applicable |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | Calibration information During Baseline period 20.07.2006 – 18.02.2007 Calibration frequency: Once every six months, validity 8 month (only during plant shutdown between campaigns) Date of last calibrations: 17/08/2006, 14/03/2007 |

| | |
|---------------------------|---|
| Data/Parameter | B.17 OT_{normal} |
| Unit | °C (min and max) |
| Description | Normal range operating temperature |
| Source of data | Design specifications and operating manual of the No. 11 nitric acid plant (Technical Manual (TM4 June 1977, p. 250) ⁴ . |
| Value(s) applied | 820 (min) to 905 (max) |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

| | |
|---------------------------|---|
| Data/Parameter | B.18 OP_h |
| Unit | kPa (gauge) |
| Description | Oxidation Pressure for each hour during the baseline campaign |
| Source of data | Monitoring results of a pressure transmitter on the ammonia oxidation reactor (ammonia to air mixer). |
| Value(s) applied | Not applicable. |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | Calibration information During Baseline period 20.07.2006 – 18.02.2007 Calibration frequency: Once every six months. (only during plant shutdown between campaigns) Date of last calibrations: 31/05/2006, 01/11/2006; 19/02/2007 |

| | |
|---------------------------|---|
| Data/Parameter | B.19 OP_{normal} |
| Unit | kPa (gauge) min and max |
| Description | Normal range of operating pressure in the ammonia oxidation reactor |
| Source of data | 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) applied | 365 kPa – 450 kPa (gauge) |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

⁴ Copies of the technical plant manuals can be provided to the DOE upon request.



| | |
|---------------------------|---|
| Data/Parameter | B.20 GS_{normal} |
| Unit | Name of Supplier |
| Description | Gauze supplier for the operating condition (i.e. historic) campaigns |
| Source of data | Monitored / Invoices |
| Value(s) applied | W.C. Heraeus |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

| | |
|---------------------------|---|
| Data/Parameter | B.21 GS_{BL} |
| Unit | Name of Supplier |
| Description | Gauze supplier for the baseline condition campaign |
| Source of data | Monitored / Invoices |
| Value(s) applied | W.C. Heraeus |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

| Data/Parameter | B.23 GC _{normal} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|---|-------------------|--------|--------|--|----------|----------------|-------------------|--|--|--------|--------|--------|-----|---------|------|-----|------|-----|---------|------|-----|------|-----|---------|------|-----|------|-----|---------|------|-----|------|-----|---------|------|-----|------|---------|--|------|-----|------|
| 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 | Monitored / Gauze supplier invoices | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Value(s) applied | Platinum (Pt) 56.5%; Rhodium (Rh) 3.8%; Palladium (Pd) 39.7% Record of Gauze compositions installed during the historic campaigns ⁵ : <table><tr><th rowspan="2">Campaign</th><th rowspan="2">Gauze Supplier</th><th colspan="3">Gauze Composition</th></tr><tr><th>Pt (%)</th><th>Rh (%)</th><th>Pd (%)</th></tr><tr><td>C10</td><td>Heraeus</td><td>58.3</td><td>3.9</td><td>37.9</td></tr><tr><td>C12</td><td>Heraeus</td><td>56.1</td><td>3.8</td><td>40.1</td></tr><tr><td>C13</td><td>Heraeus</td><td>56.4</td><td>3.8</td><td>39.8</td></tr><tr><td>C14</td><td>Heraeus</td><td>56.1</td><td>3.8</td><td>40.1</td></tr><tr><td>C15</td><td>Heraeus</td><td>55.4</td><td>3.8</td><td>40.8</td></tr><tr><td colspan="2">Average</td><td>56.5</td><td>3.8</td><td>39.7</td></tr></table> | | | | | 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 |
| 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 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Additional comment | None | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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|---------------------------|---|
| Data/Parameter | B.24 GC_{BL} |
| 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 | Monitored / Gauze supplier invoices |
| Value(s) applied | Platinum (Pt) 56%; Rhodium (Rh) 3.8%; Palladium (Pd) 40.2% |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None |

⁵ 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.



| | |
|---------------------------|---|
| Data/Parameter | B.26 EF_{reg} |
| Unit | tN₂O/tHNO₃ |
| Description | Emissions cap for N ₂ O from nitric acid production set by government regulation |
| Source of data | Department of Environmental Affairs and Tourism |
| Value(s) applied | None |
| Purpose of data | Calculation of baseline emissions or baseline net GHG removals by sinks |
| Additional comment | None. |

D.2. Data and parameters monitored

| | |
|--|--|
| Data/Parameter | NCSG |
| Unit | mg / m³ (convertible from ppmv, if required) |
| Description | N ₂ O concentration in 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 | ABB AO2040 URAS 14 Continuous Emissions Analyser |
| Value(s) of monitored parameter | Value applicable for Project Campaign 9: 366.68 |
| Monitoring equipment | <p>Type: <i>ABB AO2040 URAS 14 Continuous Emissions Analyser, non-dispersive infrared analyser</i></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>External calibration: QAL2 every 5 years;</i> - <i>External calibration: AST every year;</i> - <i>Internal calibration: twice per week manual calibration with test gas</i> <p>Date of last external calibration:</p> <p><i>QAL2 Test (including AST) – 22.- 25.06.2011 valid until 21/08/2016</i></p> |
| Measuring/Reading/Recording frequency | Continuously (every 2 seconds) |
| Calculation method (if applicable) | <p>AM0034 requires the determination of the concentration of N₂O in the stack gas. 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> |



| | |
|---------------------------|---|
| QA/QC procedures | 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 (internal calibration by AEL) every 5 years QAL2 test (including AST) according to EN 14181 (External by qualified institute) yearly AST test according to EN 14181 (External by qualified institute) |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|---|
| Data/Parameter | VSG |
| 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 | Value applicable for Project Campaign 9: 78,897 |
| Monitoring equipment | <p>Type: Tail gas flow by differential pressure principle Overall measurement accuracy: 2.84% (<i>per QAL 2 report</i>) Combined uncertainty for the normalized stack gas flow at standard conditions: 2.96% (<i>per QAL 2 report</i>)</p> <p>Serial Number: <i>instrument number N/A</i> Calibration frequency: - External calibration: <i>QAL2 every 5 years;</i> - External calibration: <i>AST every year;</i> - Internal calibrations: <i>after each campaign (usually every 7 month)</i></p> <p>Date of last external calibration: <i>QAL2 Test (including AST) – 06.07.2010 – 08.07.2010 valid until 05/07/2015</i> <i>AST test 22.06.2011 – 25.06.2011 valid until 21/06/2012</i></p> <p><i>Date of internal calibrations: 10/08/2011, 21/04/2012</i></p> |
| Measuring/Reading/Recording frequency | Continuously (every 2 seconds). |



| | |
|---|--|
| Calculation method (if applicable) | <p>AM0034 requires the determination of the gas volume flow (VSG) in the stack. 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"> Calculate the sample mean (x) Calculate the sample standard deviation (s) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation) Eliminate all data that lie outside the 95% confidence interval 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 0.96 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 multiplied by 0.96 before going into the calculation of PE_n.</p> |
| QA/QC procedures | <p>Internal calibration at least once per year usually every 4 months after each campaign (the plant has to be shut down to conduct calibration) by the Instrument Department of AEL.</p> <p>every 5 years QAL2 test (including AST) according to EN 14181 (External by qualified institute)</p> <p>yearly AST test according to EN 14181 (External by qualified institute)</p> |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|---|
| Data/Parameter | PE_n |
| Unit | tN₂O |
| Description | Total mass N ₂ O emissions in each project campaign. |
| Measured/Calculated/Default | Calculated. |
| Source of data | Calculated from measured values. |
| Value(s) of monitored parameter | Value applicable for Project Campaign 9 : 153.67 |
| Monitoring equipment | Not applicable. |
| Measuring/Reading/Recording frequency | Not applicable. |
| Calculation method (if applicable) | $PE_n = VSG * NCSG * 10^{-9} * OH$ <p>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.</p> |
| QA/QC procedures | Not applicable. |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |

| | |
|--|--|
| Data/Parameter | OH_n |
| Unit | Hours |
| Description | Total operating hours during each project campaign |
| Measured/Calculated/Default | Measured. |
| Source of data | Production log and continuous monitoring. |
| Value(s) of monitored parameter | Project Campaign 9: 5,589 |
| Monitoring equipment | Not applicable. |
| Measuring/Reading/Recording frequency | The total operating hours are logged continuously. |
| Calculation method (if applicable) | Not applicable. |
| QA/QC procedures | The production logging process is subject to ISO 9001 procedures |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|--|
| Data/Parameter | NAP |
| Unit | tHNO₃ |
| Description | Metric tonnes of 100% concentrated nitric acid during each project campaign. |
| Measured/Calculated/Default | Measured / Calculated. |
| Source of data | Nitric acid flow meter Emerson coriolis mass flow meter |
| Value(s) of monitored parameter | Project Campaign 9: 154,842 |
| Monitoring equipment | Emerson coriolis mass flow meter CMF 200 Overall measurement accuracy: $\leq 0.1\%$ Serial Number: 414940 Calibration frequency: every 3 years Date of last calibration, 09/03/2011 valid until 08/03/2014 |
| Measuring/Reading/Recording frequency | NAP is determined by continuous measurement of the HNO ₃ production and concentration |
| Calculation method (if applicable) | 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 | The mass flow meter is calibrated in regular intervals. NAP results are crosschecked against process parameters as ammonia consumption and against product stock levels and product consumption |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|---|
| Data/Parameter | TSG |
| 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, directly used for normalization of tail gas volume flow measurement. |
| Monitoring equipment | <p>Type: Rosemont thermocouple, PT100_385 3-wire RTD Overall measurement accuracy: 2.55% (per QAL2 report) Serial Number: <i>instrument number N/A</i> Calibration frequency:</p> <ul style="list-style-type: none"> - <i>External calibration: QAL2 every 5 years;</i> - <i>External calibration: AST every year;</i> - <i>Internal calibrations: after each campaign (usually every 7 month)</i> <p>Date of last external calibration: <i>QAL2 Test (including AST) – 06.07.2010 – 08.07.2010 valid until 05/07/2015</i> <i>AST test 22.06.2011 – 25.06.2011 valid until 21/06/2012</i></p> <p><i>Date of internal calibrations: 10/08/2011, 21/04/2012</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. The resulting measurements are transferred to the data acquisition system and are applied to each VSG value for calculation of normal volume flow. |
| QA/QC procedures | <p>Internal calibration at least once per year usually every 4 months after each campaign (the plant has to be shut down to conduct calibration) by the Instrument Department of AEL. The validity of the internal calibrations is 1 year.</p> <p>every 5 years QAL2 test (including AST) according to EN 14181 (External by qualified institute)</p> <p>yearly AST test according to EN 14181 (External by qualified institute)</p> |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|---|
| Data/Parameter | PSG |
| Unit | mbar (absolute) |
| Description | Pressure in the stack |
| Measured/Calculated/Default | Measured. |
| Source of data | Stack pressure probe situated directly next to the volume flow meter. |
| Value(s) of monitored parameter | Not applicable, directly used for normalization of tail gas volume flow measurement. |
| Monitoring equipment | <p>Type: Rosemont</p> <p>Overall measurement accuracy: 0.7 % (per QAL2 report) Serial Number: <i>instrument number N/A</i></p> <p>Calibration frequency:</p> <ul style="list-style-type: none"> - <i>External calibration: QAL2 every 5 years;</i> - <i>External calibration: AST every year;</i> - <i>Internal calibrations: after each campaign (usually every 7 month)</i> <p>Date of last external calibration:</p> <p><i>QAL2 Test (including AST) – 06.07.2010 – 08.07.2010 valid until 05/07/2015</i></p> <p><i>AST test 22.06.2011 – 25.06.2011 valid until 21/06/2012</i></p> <p><i>Date of internal calibrations: 10/08/2011, 21/04/2012</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 | |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|--|
| Data/Parameter | EF_n |
| 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 9: 0.000992 |
| Monitoring equipment | 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 n the campaign specific emission factor is: $EF_n = PE_n / NAP_n$ |
| QA/QC procedures | Not applicable. |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |

| | |
|--|---|
| Data/Parameter | EF_{ma,n} |
| 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 9: 0.000986 |
| Monitoring equipment | 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: $EF_{ma,n} = (EF_1 + EF_2 + \dots + EF_n) / n$ 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. |
| QA/QC procedures | Not applicable. |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|--|
| Data/Parameter | EF_p |
| Unit | tN₂O/tHNO₃ |
| 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 9: 0.000992 |
| Monitoring equipment | 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 | Not applicable. |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |

| | |
|--|---|
| Data/Parameter | EF_{min} |
| Unit | tN₂O/tHNO₃ |
| 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 | n.a. |
| Monitoring equipment | Not applicable. |
| Measuring/Reading/Recording frequency | Not applicable. |
| Calculation method (if applicable) | <p>A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N₂O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum (EF_{min}). If any of the later project campaigns results in 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.</p> |
| QA/QC procedures | Not applicable. |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|---|
| Data/Parameter | EF_{reg} |
| Unit | tN₂O/tHNO₃ |
| Description | Emissions cap for N ₂ O from nitric acid production set by government regulation |
| Measured/Calculated /Default | Default |
| Source of data | Government policies |
| Value(s) of monitored parameter | No regulations or other requirements exist |
| Monitoring equipment | Not applicable. |
| Measuring/Reading/Recording frequency | Each reporting period |
| Calculation method (if applicable) | Not applicable |
| QA/QC procedures | Not applicable. |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |

| | |
|--|--|
| Data/Parameter | CL_n |
| 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 9: 154,842 |
| Monitoring equipment | 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 | See comments for NAP above |
| Purpose of data | Calculation of project emissions or actual net GHG removals by sinks |
| Additional comment | |



| | |
|--|--|
| Data/Parameter | OP_h |
| Unit | kPa (gauge) |
| Description | Oxidation Pressure for each hour |
| Measured/Calculated/Default | Measured. |
| Source of data | Pressure probe at 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. |
| Monitoring equipment | <p>Type: Yokogawa Press Tx – pressure transmitter Overall measurement accuracy: 1.7 % Serial Number: F576FB671708 Installation location: Compressor floor</p> <p>During project campaigns the calibration of operational parameters is not relevant. However the calibration dates are listed below for information only Calibration frequency: Once every seven months. (only during plant shutdown between campaigns) - Date of last calibration: 09/08/2011; 21/04/2012</p> |
| Measuring/Reading/Recording frequency | The measurement results are taken by the data acquisition and evaluation system. The system directly calculates hourly averages. |
| Calculation method (if applicable) | See above |
| QA/QC procedures | The instrument is subject to yearly internal calibrations. The QA/QC procedures are part of the ISO 9001 procedures. |
| Purpose of data | Not applicable |
| Additional comment | |



| | |
|--|--|
| Data/Parameter | OT_h |
| Unit | °C |
| Description | Oxidation temperature in the ammonia oxidation reactor (AOR) for each hour. |
| Measured/Calculated /Default | Measured. |
| Source of data | Thermocouples inside the ammonia oxidation reactor |
| 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. |
| Monitoring equipment | Type: Thermocouple products Type: K310 S/steel Thermocouple Overall measurement accuracy: 1 % Serial Number: TP3285-3290 Installation location: reactor During project campaigns the calibration of operational parameters is not relevant. However the calibration dates are listed below for information only Calibration frequency: Once every campaign (only during plant shutdown between campaigns) Date of last calibration: 08/08/2011;21/04/2012 |
| Measuring/Reading/Recording frequency | The measurement results are taken by the data acquisition and evaluation system. The system directly calculates hourly averages. |
| Calculation method (if applicable) | See above. |
| QA/QC procedures | The instrument is subject to yearly internal calibrations, which are part of the ISO 9001 procedures. |
| Purpose of data | Not applicable |
| Additional comment | |



| | |
|--|---|
| Data/Parameter | AFR |
| Unit | kgNH₃/h (converted from originally measured Nm³/h) |
| Description | Ammonia gas flow rate to the ammonia oxidation reactor. |
| Measured/Calculated/Default | Measured. |
| Source of data | Differential pressure measurement Manufacturer: Yokogawa Type: D/P |
| 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 |
| Monitoring equipment | Type: Yokogawa Orifice plate with D.P. transmitter Overall measurement accuracy: 1.25 % Serial Number: F570FD073708 During project campaigns the calibration of operational parameters is not relevant. However the calibration dates are listed below for information only Calibration frequency: Once every seven months. (only during plant shutdown between campaigns) Date of last calibration: 09/08/2011; 21/04/2012 |
| Measuring/Reading/Recording frequency | The measurement results are taken by the data acquisition and evaluation system. The system directly calculates hourly averages. |
| Calculation method (if applicable) | See above |
| QA/QC procedures | The instrument is subject to yearly internal calibrations, which are part of the ISO 9001 procedures. |
| Purpose of data | Not applicable |
| Additional comment | |



| | |
|--|---|
| Data/Parameter | AIFR |
| 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 |
| Monitoring equipment | <p>Equipment for Air Flow-rate to AOR: Type: Yokogawa Orifice plate with D.P. transmitter Overall measurement accuracy: 1,66% Serial Number: F570FD 069708</p> <p>During project campaigns the calibration of operational parameters is not relevant. However the calibration dates are listed below for information only</p> <p>Calibration frequency: Once every six months. (only during plant shutdown between campaigns) Date of last calibration: 09/08/2011; 21/04/2012</p> |
| Measuring/Reading/Recording frequency | The measurement results are taken by the data acquisition and evaluation system. The system directly calculates hourly averages. |
| Calculation method (if applicable) | The calculation of AIFR is based on the measurement of AFR and primary air flow-rate. The AFR measurement is described in section AFR above. The measurement of primary air flow-rate to AOR is based on differential pressure measurement principle. |
| QA/QC procedures | Not applicable. |
| Purpose of data | Not applicable. |
| Additional comment | |

| | |
|--|---|
| Data/Parameter | GS_{project} |
| 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 |
| Monitoring equipment | Not applicable. |
| Measuring/Reading/Recording frequency | Not applicable. |
| Calculation method (if applicable) | Not applicable. |
| QA/QC procedures | Not applicable. |
| Purpose of data | Not applicable. |
| Additional comment | |



| | | |
|--|---|--------------------|
| Data/Parameter | GC_{project} | |
| 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 | | Project campaign 9 |
| | Platinum (Pt) | 56% |
| | Rhodium (Rh) | 3.8% |
| | Palladium (Pd) | 40.2% |
| Monitoring equipment | Not applicable. | |
| Measuring/Reading/Recording frequency | Not applicable. | |
| Calculation method (if applicable) | Not applicable. | |
| QA/QC procedures | Not applicable. | |
| Purpose of data | Not applicable. | |
| Additional comment | | |

D.3. Implementation of sampling plan

>>

Not applicable

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

>>

Analysis of Historical campaign data

The determination of the permitted operating conditions for operating temperature, operating pressure, maximum ammonia flow rate, maximum ammonia to air ratio, normal gauze supplier and normal gauze composition was undertaken by the validating DOE (as it was clarified by the CDM EB in EB31 meeting that either the validating or verifying DOE could undertake the task of determination of the permitted operating conditions). However, the normal campaign length as well as the determination of the baseline emission factor was in the scope of the verifying DOE.

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.

Since no historical data were recorded and available, the allowable NH₃ to Air ratio AIFR_{max} was derived from technical plant manuals (controller data sheet).



The parameters CL_{normal} , GS_{normal} , GC_{normal} and AFR_{max} were derived from the 5 historic campaigns that were defined in the PDD. The 5 campaigns are:

| Campaign | Start date | End date | In-/Excluded |
|----------|------------|------------|--------------|
| C10 | 29/05/2003 | 24/11/2003 | Included |
| C12 | 27/05/2004 | 12/12/2004 | Included |
| C13 | 15/12/2004 | 24/07/2005 | Included |
| C14 | 27/07/2005 | 28/01/2006 | Included |
| C15 | 03/02/2006 | 31/07/2006 | Included |

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

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

CL_{normal} : 127,302.4 t HNO_3

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

Analysis of Baseline campaign data

As the baseline campaign for AEL No. 11 the campaign C16 (20.07.2006 – 18.02.2007) was used.

Analysis of Baseline campaign data

As the baseline campaign for AEL No. 11 the campaign C16 was used. The baseline campaign was in operation in the period 20.07.2006 – 18.02.2007. The baseline monitoring data, baseline calculation and baseline results were determined during the first verification and were verified by the DOE during the first verification.

The results are as follows:

| | | |
|-------------|----------------------|------------|
| $NCSG_{BL}$ | mg/Nm ³ | 1,630.03 |
| QAL2 NCSG | | 1.10 |
| VSG_{BL} | Nm ³ /h | 72,468.01 |
| QAL2 VSG | | 1.01 |
| OH_{BL} | h | 4,950.00 |
| NAP_{BL} | t HNO_3 | 134,699.80 |
| BE | t N_2O | 651.98 |
| UNC | | 3.99 |
| EF_{BL} | kg N_2O /t HNO_3 | 4.647 |

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 N_2O 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 N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tonnes produced) from the calculation of EF_{BL} .

For the project campaign 9 the CL_n is longer than CL_{BL} , therefore no adjustment of the Baseline emissions factor EF_{BL} is necessary.

Adjustment of Baseline emissions factor due to EF_{reg}

Should N_2O 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 N_2O emission factor shall be EF_{reg} for all calculations.

where:

Variable Definition

EF_{BL} Baseline emissions factor (t N_2O /t HNO_3)

EF_{reg} Emissions level set by newly introduced policies or regulations (t N_2O /t HNO_3).

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 N_2O regulation for nitric acid plants in South Africa therefore no adjustment of the Baseline emissions factor EF_{BL} is necessary.

E.2. Calculation of project emissions or actual net GHG removals by sinks

>>

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_2O in the stack gas for the project campaign (mg N_2O /m ³) |
| PE_n | Total N_2O emissions of the n th project campaign (t N_2O) |
| OH | Is the number of hours of operation in the specific monitoring period (h) |

Based on the total N_2O 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 ($kgN_2O/tHNO_3$) |
| PE_n | Total N_2O emissions of the n^{th} project campaign (tN_2O or kgN_2O) |
| 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 the complete project campaign.

| N.DBMS Project Campaign Calculation Project: AEL No. 11, Johannesburg, South Africa Campaign: C 25; 22.08.2011 - 17.04.2012 | | | | | | | | |
|---|-------|-----------------------|-------|------------|-------|---------------------------------------|---------------------|--------------------|
| Project campaign 9 Query 1: Without parameter limits | | | | | | | | |
| Parameter | OH | AFR | AIFR | Oph | OTh | NCSG | VSG | NAP |
| Unit | h | t NH ₃ / h | ratio | Pa | °C | mg N ₂ O / Nm ³ | Nm ³ / h | t HNO ₃ |
| Count | 5,760 | 5,760 | 5,759 | 5,760 | 5,760 | 5,760 | 5,760 | |
| Minimum | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0 | |
| Maximum | | 8.76 | 0.4 | 425,246.0 | 902 | 2,417.1 | 85,351 | |
| Mean | | 7.78 | 0.10 | 386,929.2 | 893 | 441.7 | 76,548 | |
| Standard deviation | | 1.380 | 0.04 | 64,942.49 | 22 | 427.2 | 13,333 | |
| 95% confidence level ($1.96 * Std.dev.$) | | 2.70 | 0.07 | 127,287.28 | 43 | 837 | 26,132 | |
| Sum | 5,760 | | | | | | | 154,842 |
| Limits acc. to consistency check | | | | | | | | |
| Lower limit | | | | | | | | |
| Upper limit | | | | | | | | |

According to this Query 1, the NAP value of Project campaign 9 is 154,842 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 25; 22.08.2011 - 17.04.2012 | | | | | | | | |
|---|-------|-----------------------|-------|------------|-------|---------------------------------------|---------------------|--------------------|
| Project campaign 9 Query 2: With operational limits | | | | | | | | |
| Parameter | OH | AFR | AIFR | Oph | OTh | NCSG | VSG | NAP |
| Unit | h | t NH ₃ / h | ratio | Pa | °C | mg N ₂ O / Nm ³ | Nm ³ / h | t HNO ₃ |
| Count | 5,589 | 5,589 | 5,589 | 5,589 | 5,589 | 5,589 | 5,589 | |
| Remaining share of data sets | 97.0% | 97.0% | 97.0% | 97.0% | 97.0% | 97.0% | 97.0% | |
| Minimum | | 0.46 | 0.09 | 44,180.00 | 824 | 21 | 8,569 | |
| Maximum | | 8.76 | 0.11 | 425,246.0 | 902 | 2,417 | 85,351 | |
| Mean | | 8.01 | 0.10 | 397,884.8 | 896 | 453 | 78,794 | |
| Standard deviation | | 0.288 | 0.002 | 13,812.621 | 2.5 | 428 | 3,375 | |
| 95% confidence level ($1.96 * Std.dev.$) | | 0.565 | 0.003 | 27,072.737 | 4.9 | 838 | 6,615 | |
| Sum | 5,589 | | | | | | | 154,841.6 |
| Limits acc. to consistency check | | | | | | | | |
| Lower limit | | | | | 820 | | | |
| Upper limit | | | | | | | | |

As a result of this query the number of operation hours OH of Project campaign 9 is 5,589 h.

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 25; 22.08.2011 - 17.04.2012 | | |
|--|-------|--------------------------------------|-------|------------|-----|---|-----------------|---------|
| Project campaign 9 | | Q6: Q2 + confidence levels | | | | 176 | 180 | 172 |
| 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 | | | | | | 5,215 | 5,576 | |
| Remaining share of data sets | | | | | | | | |
| Minimum | | 0.460 | 0.09 | 44,180.00 | 824 | 21 | 72,519 | |
| Maximum | | 8.76 | 0.11 | 425,246.0 | 902 | 1,291 | 85,351 | |
| Mean | | 8.01 | 0.10 | 397,884.8 | 896 | 366.68 | 78,897 | |
| Standard deviation | | 0.288 | 0.002 | 13,812.621 | 2.5 | 272 | 2,442 | |
| 95% confidence level (1.96 * Std.dev.) | | 0.565 | 0.003 | 27,072.737 | 4.9 | 533 | 4,786 | |
| Sum | 5,589 | | | | | | | 154,842 |
| Limits acc. to consistency check | | | | | | | | |
| Lower limit | | | | | 820 | 0.00 | 72,179 | |
| Upper limit | | | | | | 1,291.14 | 85,409 | |
| | | | | | | 0.9900 | 0.9600 | |
| Correction factors resulting from QAL2 | | | | | | | | |
| Campaign emissions | PE | = VSG * NCSG * Oh * 10 ⁻⁹ | | | | | t N2O | 153.671 |
| Emission factor | EF_n | = PE / NAP * 10 ³ | | | | | kg N2O / t HNO3 | 0.992 |
| As a result of this query the mean NCSG value for Project campaign 9 is 366.68 mg N2O / Nm3 | | | | | | | | |
| As a result of this query the mean VSG value for Project campaign 9 is 78,897 Nm3 / h | | | | | | | | |
| As a result of this query the result for EFn for Project campaign 9 is 0.992 kg N2O / t HNO3 | | | | | | | | |

Sample calculation for campaign emissions (PE) and Emission factor (EF_n) for the 9th project campaign:

| | | |
|--|---|---|
| PE [tN ₂ O] = | 78,897 [Nm ³ /h] * 0.960 [QAL2 factor] * 366.68 [mg/Nm ³] * 0.990 [QAL2 factor] * 5,589 [h] * 10 ⁻⁹ = | 153.671 [tN ₂ O] |
| EF [kgN ₂ O/tHNO ₃] = | 153.671 [tN ₂ O] / 154,842 [tHNO ₃] * 10 ³ = | 0.992 [kgN ₂ O/tHNO ₃] |

Note that small deviations occur due to rounding. Please refer to the calculation excel file for details.

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 campaign covered by this monitoring report are:

| Campaign | PE | EF _n |
|----------------------------------|---------------------------|--|
| 9 th Project Campaign | 153.671 tN ₂ O | 0.992 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).

For the project campaign 9 the CL_n is longer than CL_{BL}, therefore no adjustment of the Baseline emissions factor EF_{BL} is necessary.

E.3. Calculation of leakage

>>

No leakage occurs under this project type.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

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 reduction s (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 an EF_n that is lower than EF_{min} , the calculation of the emission reductions for that particular campaign shall use EF_{min} and not EF_n .

Since only 9 project campaigns are completed, the minimum emissionsfactor is not yet established.

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:

$$ER = (EF_{BL} - EF_p) * NAP * 10^{-3} * GWP_{N_2O} \text{ (tCO}_2\text{e)}$$

Sample calculation of emission reductions:

| | | | | | | | | | | | |
|---|--------|---|--------|---|---|---------|-----------------------|---|--------------------------|----------------|---------------------------|
| 9 th PC: ER [tCO ₂ e] = | (4.647 | - | 0.992) | [kg N ₂ O/t HNO ₃] | * | 154,842 | [t HNO ₃] | * | 10 ⁻³ * 310 = | 175,429 | [tCO₂e] |
|---|--------|---|--------|---|---|---------|-----------------------|---|--------------------------|----------------|---------------------------|

Note that small deviations occur due to rounding. Please refer to the calculation excel file for details. The final result is rounded down.

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 ($kgN_2O/tHNO_3$) |
| GWP_ N_2O | Global Warming Potential of N_2O (310 tCO_2e/tN_2O) |

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:

| | | Project campaign 9 C 25; 22.08.2011 - 17.04.2012 |
|---|--|---|
| NCSG _{BL} | mg/Nm ³ | 1,630.03 |
| QAL2 NCSG | | 1.10 |
| VSG _{BL} | Nm ³ /h | 72,468 |
| QAL2 VSG | | 1.01 |
| OH _{BL} | h | 4,950 |
| NAP _{BL} | t HNO ₃ | 134,700 |
| BE | t N ₂ O | 651.98 |
| UNC | | 3.99 |
| EF_{BL} | kg N₂O/t HNO₃ | 4.647 |
| | | |
| NCSG _n | mg/Nm ³ | 366.68 |
| QAL2 NCSG | | 0.99 |
| VSG _n | Nm ³ /h | 78,897 |
| QAL2 VSG | | 0.96 |
| OH _n | h | 5,589 |
| NAP _n | t HNO ₃ | 154,842 |
| PE _n | t N ₂ O | 153.671 |
| EF _n | kg N ₂ O/t HNO ₃ | 0.992 |
| EF _{ma,n} | kg N ₂ O/t HNO ₃ | 0.986 |
| EF _{min} | kg N ₂ O/t HNO ₃ | n.a. |
| EF_p | kg N₂O/t HNO₃ | 0.992 |
| NAP | t HNO₃ | 154,842 |
| GWP | tCO₂e/tN₂O | 310 |
| ER | tCO₂e | 175,429 |
| Total ER for the monitoring period | | 175,429 |

Summary of calculation of emission reductions

| Time Period | Baseline emissions or baseline net GHG removals by sinks | Project emissions or actual net GHG removals by sinks | Leakage | Emission reductions or net anthropogenic GHG removals by sinks |
|--------------|--|---|----------------------|--|
| | (tCO ₂ e) | (tCO ₂ e) | (tCO ₂ e) | (tCO ₂ e) |
| Total | 223,066.99 | 47,637.91 | 0 | 175,429.08 |
| | | | | rounded: 175,429 |

AM0034 requires calculating emission reductions by establishing product related baseline and project emission factors and multiplying the difference with the nitric acid production. The baseline emissions and

the project emissions stated in the summary of calculations have been calculated only for the purpose of this table. The calculations are not in line with the methodology. However, the values are correct besides the rounding issue described above. The values have been calculated by using the following formula:

Campaign 9:

Baseline Emissions (BE) = $EF_{BL} * NAP_9 * GWP * 10^3 = 4.647 * 154,842 * 310 / 10^3 = 223,066.99$

Project Emissions (PE) = $EF_{P9} * NAP_9 = 0.992 * 154,842 * 310 / 10^3 = 47,637.91$

Emission Reductions = $BE - PE = 223,066.99 - 47,637.91 = 175,429.08$ (**175,429** CERs claimed due to rounding in calculation)

Note that small deviations occur due to rounding. Please refer to the calculation excel file for details. The final result is rounded down.

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

| Item | Values estimated in ex-ante calculation of registered PDD | Actual values achieved during this monitoring period |
|---|---|--|
| Emission reductions or GHG removals by sinks (tCO ₂ e) | 185,458 (calculated for a monitoring period of 255 days) | 175,429 (during the monitoring period of 255 days) |

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

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Not applicable as the actual GHG emission reductions achieved during this monitoring period are below the values estimated in ex-ante calculation of the registered PDD.

History of the document

| Version | Date | Nature of revision |
|---|--------------------------------|--|
| 02.0 | EB 66 13 March 2012 | Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20). |
| 01 | EB 54, Annex 34 28 May 2010 | Initial adoption. |
| Decision Class: Regulatory Document Type: Form Business Function: Issuance | | |